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2002-09-27

Social Simulations

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1 Introduction

In the society of today there is a lot of technological aid to support information distribution in organizations. It brings possibilities and benefits but also problems. One of the problems is to predict whether the information distribution will be better or more effective with more computers or other sort of technological artifact. Because of this, many organizations would find it useful to be able to make some sort of theoretical experiments with different solutions. These experiments could give the organization the possibility to study different kinds of information system before actually buying all the expensive technical equipment. They would also give the organizations possibilities to see what could be better in existing information systems.

To make this sort of experiment possible, the AMSIDO project intends to create a simulation of information distribution in organization.

"*The purpose with the AMSIDO project is to create a practical and theoretical base for a decision support system focusing on the efficiency of information distribution in organizations. The system is to be able to propose, evaluate, describe and visualize different possible information systems on different organization levels in a valid and usable manner."*

This sub report is one part of the AMSIDO-2 report and it is possible to get an overall and complete picture over the whole project in the reports AMSIDO-1 and AMSIDO-2, Main Report.

There are some basic assumptions in the project providing the base for this report: First, the information distribution includes both humans and technological artifact. Secondly, humans are the most important component in an information distributing system (for a more elaborate background, see the report "AMSIDO-2, Validation and data collection").

One possible way to create a model of a social system is to study the different levels in the system. The assumption is that the first level in our particular system to study contains the individual and the technological artifact. In the meaning of how the agents/humans act individually, the next higher level is the group and the specific phenomena on that level.

As a consequence of the assumptions, one overall purpose with this report is to study what have been done so far in the field of simulations of human societies. This theoretical base would show ways forward for a next step in the AMSIDO project.

The overview of the research field began with the study of communication and simulation. Rather soon, however, it became obvious that "social simulations" was one possible approach for AMSIDO. The reason for this is that social simulations try to create simulations of the complexity and dynamics in human societies. The purpose of social simulations is to study specific social phenomenon. The researchers in the field come from many different disciplines like psychology, sociology and computer science.

The development of social simulations has been ongoing since the 60's, which makes it an established discipline able to provide a stable base to future work in AMSIDO.

AMSIDO has an overall purpose, but it is necessary to break down that big purpose into more specific and narrow research questions. The focus in this report is the social sciences, the real world and what is possible to put into in a simulation. In other words, the focus is on human phenomena in information distribution (in relation to the above).

My assumption is that the following questions are the most important in order to study in the military work activity, focusing on the information flow:

What do people do, when they distribute information?
- How do they seek and receive information?
- How do they process information?
- How do they send information?

What in this situation is depending on the individual and what on the group?
What in this situation is dependent on the interaction with technological artifact? Has the situation to be described in a way different than in the case of a face to face meeting?

It is also important to study the information as such, to provide a basis for knowledge of the concept in itself and how it distributes.

The purpose for this report is to focus on the phenomenon information distribution and through that aspect creates a conceptual model for human behavior in an organization.

The purpose is not to create a model of the whole human being with all his different aspects and complexity, although this report does include some different aspect in Social Science and Psychology.

1.1 Method and Disposition

The method used for producing this report is mostly an unstructured literature review, combined with some of the results from the sub report "Validation". The review starts with the phenomenon "communication" and then continues towards the direction of social simulations. The literary sources are fetched from internet, books and papers.

The first part of the report discusses the field "simulation in the social sciences". It should be noted that the intention is not to give a *technical* view of simulations. Instead, the purpose is to study how simulation as a method has been *used* in the social sciences. The overview is later in the document used to discuss some important social concepts for AMSIDO from a simulation perspective.

The last parts in the report discuss agents in social simulation in general and in AMSIDO in particular.

The interaction between a technological artifact and the human being was discussed during a kind of "rich picture seminar (with a method fetched from Checkland, 1990). The students J. Holmström and M. Kristofersson, who had written about information as a concept and about information nodes, were the main participants of this seminar. The technological artifact that was discussed during this seminar was E-mail since the usual way of interacting during an exercise was through E-mail (see AMSIDO-2, Validation and Data Collection).

2 Social simulation

The definition of simulation in this report is the same as the one used by Gilbert and Troitzsch (1999), namely *"running the model forward through (simulated) time and watching what happens"*.

Simulation as method is suitable for complex dynamic processes. Social dilemmas can without doubt be called a complex dynamic process:

"*Social dilemmas are interpersonal and intergroup situations that are characterized by an unfortunate pattern of incentives.* (Liebrand, 1998)*"*

This sort of dilemma could easily be seen as a process which involves three key issues:

- *at the level of individual agents, people decide whether or not they will act in their own direct interest;*
- *at the aggregate level, we observe processes and characteristics which cannot necessarily be explained by a simple generalization from behavior of a single agent, and which in their turn may influence the agent's behavior at the micro level;*
- *trough time, choices at the individual level influence that aggregate level and vice versa, creating dynamic processes which may(or may not) stabilize for longer or shorter periods.* (Liebrand, 1998)

2.1 Creating a Social Simulation

The first phase, when creating a social simulation, is to identify the "target". The target is the real world phenomenon that will be studied. In social science the "target" always is dynamic, complex and changing over time. It also reacts to the environment. The consequence is that the only way to study such target is through a simulation. (Gilbert and Troitzsch 1999)

After identifying the target it is possible to begin creating the model. The model is a "picture" of the target not of the real world. In a simulation the model, as well as the initial conditions, is very important for the result. (Gilbert and Troitzsch 1999)

According to Schmidt (2000) it is important to identify the components in the model, which is representing the real world. A component in a model is identified by name, quantity of attributes and by its dynamic behavior. Further, it is important to describe the structure of the model. The structure determines how the components in the model communicate and cooperate with each other.

Simulation is an experimental methodology and it is possible to change parameters and execute the simulation many times. This gives opportunities, but it is also important to remember that the simulation is an experiment with the *model* not with the real phenomenon. (Gilbert and Troitzsch 1999)

2.1.1 Some criticism of social simulation

There are several points of critique against simulation as a method in social science. Some will be discussed below.

Halfpenny (1997) describes the problem to position different simulations according to sociological theories. This depends partly on the consequences of sociology being a multi-perspective field. He thinks it could be useful to put simulation in relation to some major perspectives such as positivism, realism and interpretivism instead. He also thinks that simulation cannot replace theories or empirical questions, but could act as a bridge between theory and empiricism.

One of the main problem pointed out by Byrne, is the problem of setting up the initial parameters in a simulation when the world it would represent is chaotic and complex. After deciding the initial parameters, the simulation is running in the way it might have happened in the real world. He thinks that this makes the results uncertain. (Byrne,1997)

Another approach of criticism against simulation is the way simulations can be used in an organization. According to Friman (1997), simulations could be a used as an instrument of force in an organization. Even if he mostly discusses simulations of war in a military organization, he thinks it is an important aspect of simulations in general. He points at the necessity to discuss for whom the simulation is constructed and for what purpose.

2.2 Social simulation, an overview

The most important issue to remember is that a simulation could be seen as a model of the real world, but it can never be reality. A simulation can be used as a method for the study of social science, and it has been a common method Halpin (1999).

There are some arguments in favor of simulation as a method for studying societies. One indicator is that the number of studies which use simulation as method has expanded. Another argument is that the number of disciplines involved has grown to encompass fields like cognitive science, biology, and neuroscience. Still another argument is the increase of number of theoretical perspectives involved. (Conte and Nigel, 1995)

Gilbert and Troitzsch (1999) maintain that simulation in social science is just in its early stages and that there is much to do within the field. In spite of this, simulation in sociology is not a new method. There is a number of review papers about it, like as an example Moretti (2002) and Halpin (1999). Their papers show that the quantity of simulations and methods for constructing a simulation is huge.

Figure 1 is a free interpretation of their papers and other authors like Gilbert and Troitzsch(1999). It shows the great variety of methods and lists some important researchers in the field. The purpose is not to give a complete view of the simulation field and all techniques available. Rather, it shows the use, connection and development of simulation from a social science point of view.

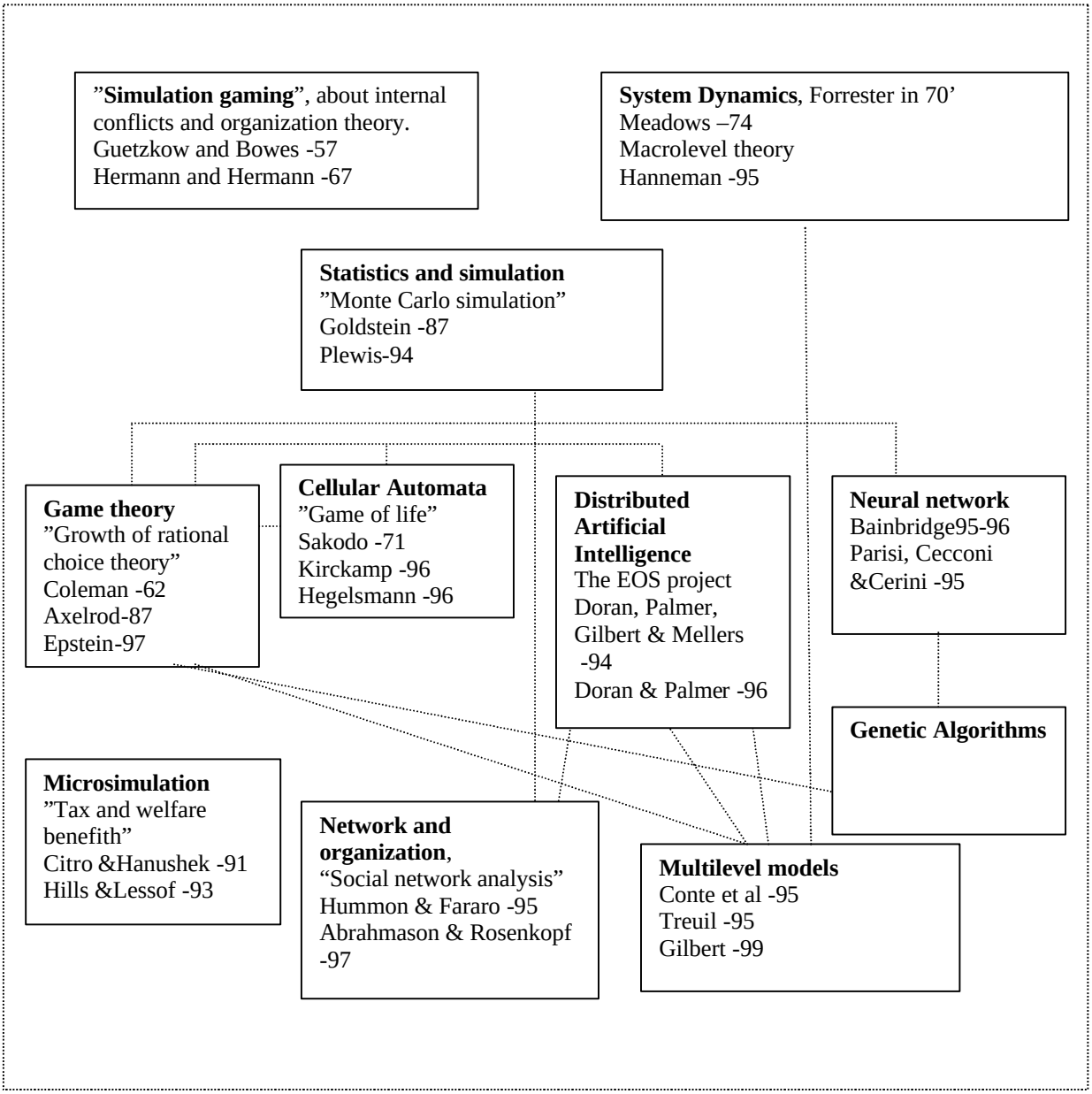

Figure no.1 : Simulation in the Social Sciences

In the beginning of social simulations field, the two most important traditions were Simulation gaming and System Dynamics according to Halpin (1999).

2.2.1 Simulation Gaming

The first traditions was simulation gaming and it had its roots in social psychology. This sort of simulation often describes international relations or organization theory. (Halpin 1999)

Guetzkow and Bowes (1957) study the structure of organizations. In their study they used role-played participants and not computers. This simulation could be seen as a beginning for simulation in sociology. Another example of simulation about internal relations is Hermann and Hermann (1967) who created a model of the outbreak of World War I.

2.2.2 System Dynamics

The second tradition began with Forrester in the early 60's. He worked in the field of System Dynamics and was focusing on the global characteristics of social structures. (Halpin, 1999)

Cybernetics and System theory are the roots for System Dynamics, and its purpose in the beginning was to understand management better. Afterwards, the area has grown to include studies about social science systems, global politics and international relations. The purpose of using System Dynamics is often to make a decision and predict social events. System dynamic has an important role in management and is useful for exploring policies and making decisions. (Morreti, 2002)

System Dynamics has also been useful for the explanation of macro sociological theories. One example is Hannerman et. al. (1995). Another example of macro level theory development using System Dynamics for a study of norms is given by Jacobsen and Vanki (1996).

System Dynamics is limited to a macro level in the way that the model shows the target as an undifferentiated whole. It has its base in systems of difference and differential equations. (Gilbert and Troitzsch 1999)

Forrester's first work was a model about worldwide growth, pollution and population (Forrester, 1973). Another important researcher is Meadows (1974), who describe a more sophisticated world model with different age groups, distinguished between industrial and service capital. Hanneman (1988) is yet another researcher who did a comprehensive description of System Dynamics oriented simulation methods.

According to Halpin (1999), models and simulations in System Dynamics often have high levels of aggregation, some subjective assumptions and weak empirical bases. System Dynamics is still the common way of creating simulations, even if it does not live up to its initial promise. It is a possible way to study sociological phenomena if there is a very stylized model and a careful manipulation of parameters. Through this it can be possible to draw conclusions about interesting relationships.

2.2.3 Statistics and simulation

Statistics and simulation has a long tradition together. In three ways statistics is important for simulation in sociology:

1. *"Statistical models of data are, in an important sense, case of simulation*
2. *Simulations require Statistical analysis for interpretation, and, perhaps most important,*
3. *The boundary between "pure" statistics and statistically formulated sociological theories is not sharp"* (Halpin, 1999)

The intersection of statistics, simulation and sociology is important for the development of sociology, especially when applied to complex situations. Simulation like the famous statistical "Monte Carlo" method is not really a sociological method, but other simulations in this field are closer to sociology. (Halpin, 1999)

2.2.4 Game theory

Game theory is a major tradition in social science, especially in economics and in the growth of the rational choice theory. It is associated with Cellular Automata for the reason that it allows players to be placed in a pseudo spatial structure. (Halpin, 1999)

Game theory is one type of application of Genetic Algorithms in Sociology. Game theory deals with rational behavior of individuals, in the formal way that humans never do anything if they do not gain anything from it. The simulation can be seen as an evolution of behavior. The evolution shows that the survival choice will be the alternative that gives the most benefits for the most individuals. (Morreti, 2002)

This kind of evolution could represent the emergence of cooperation phenomenon. “The prisoner’s dilemma” is a very common kind of simulation demonstrating this type of phenomena. (Axelrod,1987; Epstein,1997).

2.2.5 Cellular Automata

As early as in the 40’s, Neumann and Stanislaw made their definition of Cellular Automata. Cellular Automata makes it possible to create simulative models of biological evolution and self-reproduction. (Neumann, 1966)

This tool makes it possible to create simulations of complex dynamics, like with the dynamics of international conflicts. Cellular Automata is when a cell in a grid is dependent on its neighborhood. A classic example of this is the “game of life”. Every cell could be dead or alive depending on the state of their neighbors. (Halpin, 1999)

Cellular Automata is quite similar to Multi Agent System in the way that Cellular Automata is a kind of Multi Agent System where agents have their specific and determined position. The agents are also homogenous in their behavior and in there interaction with each other. Cellular Automata has the ability to demonstrate emerging properties of a social system and self-organization and social systems can be studied this way. (Morreti, 2002)

The limitation for this sort of simulations is the use of synchronous updating of state, something which will not be found in any real social processes. Another limit is the spatial structure: each individual only interacts with a subset of the whole population. In the real world this is not common since people can, as an example, interact with someone who is not “physically” close during a phone call. (Morreti, 2002)

Cellular Automata has been used in a lot of simulations similar to Conway's “game of life”. That simulation was not exactly sociological but it has been developed into different models about other group interaction, as an example by Sakoda (1971).

According to Halpin (1999), Cellular Automata has often been used to demonstrate the sociological phenomenon "group segregation".

“Prisoner’s dilemma” is another very common way to use Cellular Automata. It makes it possible to study evolution in cooperation. Some examples of this are Hegselmann (1996) and Kirchkamp (1996).

STRATMAS is another type of system with a Cellular Automata approach. It is a system for simulating combat. (Woodcock et. al[1])

Both Hegselmann (1999) and Leydesdorff (1995) are arguing in favor of the use of Cellular Automata simulations in social research. One argument is the insight in the emergence of macro phenomena the models give.

2.2.6 Genetic Algorithm

Genetic Algorithms can be traced back to 70's. They have their base in Darwin's theory of evolution. The processes of crossover and processes of mutation together create the overall evolution process. This natural selection selects the individuals better adapted to the environment. Genetic algorithms are often used in Game theory and to simulate cultural evolution. (Morreti, 2001)

There are some problems with using genetic algorithms in social simulations, and it has also been criticized by many social scientists. Part of the problem is that there is a difference between social evolution and biological evolution, and that this difference must be clarified. It must also be made clear which part it is that stores and develops social behavior. (Morreti, 2001)

2.2.7 Neural network

Neural Network has been used in the construction of agent learning ability. The benefit for social simulation is the possibilities for agent to learn. Their ability to classify based on experience has produced a lot of simulations, like Bainbridge (1995) and Parisi et al. (1995).

One study made in this field is a simple model of the emergence of language. This study is very promising for the possibilities to study sociology through simulation (Hutchins and Hazlehurst, 1995)

2.2.8 Distributed Artificial Intelligence

Distributed Artificial Intelligence is a system containing a number of Artificial Intelligent agents interacting with each other and their environment. "Distributed" could mean that the agent is in different places, but this is not necessary. The agents could be used in many different ways. One way is to study social phenomena. One example of this is Doran and Palmer (1995) and Doran et al. (1994) in the EOS project. They study stone-age social change in France using a Distributed Artificial Intelligence test bed.

Conte and Castelfranchi (1995) describe an experiment exploring the role of norms in the control of aggression. In this work they form a bridge between Cellular Automata, Game Theory and Distributed Artificial Intelligence.

According to Halpin (1999), Distributed Artificial Intelligence approaches have two advantages:

[1] The address is: http://www.dodccrp.org/Proceedings/DOCS/wcd00000/wcd0005c.htm. Unfortunately, this page has no timestamp.

"(1) More interesting (or realistic) phenomena may emerge from complex blocks, and (2) it may be easier to account for the emergence of "meso"-level phenomena, such as groups within societies."

2.2.9 Network

According to Halpin (1999) social network analysis and "computational" organization theory are two important fields for sociology. In both cases, simulations offering the possibilities to study the high complex level are used. Social network simulations are rather common, like for example Hummon and Fararo (1995), Abrahmason and Rosenkopf (1997); Anderson (2002); Stocker et al. (2001).

It is important to not confuse social network theory and actor network theory. According to Latour (1996) in his popular description of actor network theory, social networks can be described as a part in actor network theory, but not the only part of actor network theory. It is also difficult to grasp the social theory in actor network theory.

2.2.10 Micro simulation

Micro simulation is based on low-level units like individuals. One common way to use such simulations is to study tax and welfare benefit, like for example Citro and Hunushek (1991), Hills and Lessof (1993).

Halpin (1999) maintains that in this sort of simulation it is more technical knowledge than theory used and that it is not general enough for sociology. Even if there are many ways to use Micro simulation in sociology and social processes, very little has been done in that direction.

2.2.11 Multiagent system

During the last decades, the Multiagent System has been used a lot for creating simulations in sociology. This approach studies processes at all levels: individual, intermediate and macro.

"*This approach builds into the simulation a recognition of a layered structure to societies, such as student within classes within schools within a school system, or individuals within groups within societies.*" (Halpin, 1999)

A simulation with Multiagent systems has its origin in Distributed Artificial Intelligence. The purpose with such simulations is often to create "autonomous agents". This type of agent has the ability to learn and to adapt to the external world. One feature with multiagent system is the possibility to study social interactions to verify which patterns they cause in the higher level of system.

"*Multiagent simulation is based on a theory of individual behavior, but, at the end of the simulation, we may discover structures that emerged at a macro level and are not included in the initial "programmed" units.*" (Morreti, 2002)

This is helpful for resolve the conflict between the micro and macro approach.

The definition of a Multiagent system includes a list or rules for the agents' behavior. The list concerns protocols for communication and decision making procedures if the environment changes, and rules for interaction with other agents. This makes multiagent system very appropriate for simulating social interaction. (Morreti, 2002)

Simulations in the field of archaeology have been done by Doran et.al (1994), based on microeconomics theory. Like the agents have to collaborate with each other to survive. [Jag försöker förklara vad jag menar med mikroekonomi i sammanhanget]

The emergence of social norms has been studied in multiagent simulations by Conte and Castelfranchi (1995), Hutchins and Hazlehurst (1995) and Treuil (1995).

2.2.12 Papers about simulation

During a quick search in "Science Direct" [http://www.sciencedirect.com/] in one occasion and with the specific terms in the figure no.1: Simulation in the Social Sciences, the following results were acquired:

- Simulating gaming: 10
- Systems dynamics: 1134
- Game theory: 1112
- Cellular Automata: 835
- Distributed Artificial Intelligence: 51
- Neural Network: (to many to give a result)
- Network and organization: 2023
- Multilevel nodes: 182
- Micro simulation: 25

The results do not show simulation in social science in specific, but it shows some of the interest for simulations and different methods.

2.3 Problems and possibilities with social science simulations

There are some problem and possibilities that are important to discuss before creating a simulation.

According to Goldspink (2002) there is a growing interest in simulation methods in social science. He maintains that social researchers have problems with isolating phenomena of interest from other environmental variables. He recommends a combination of simulation and some other existing methods for such studies:

"*The method of simulation would seem to offer most then when used in conjunction with some existing methods which help to test its theoretical and empirical relevance if not validity."*

2.3.1 Identify the "target"

It is also clear that it is important to first look at the phenomenon that would be studied and identify the mechanisms that rules it. Then you have to study the level above the chosen phenomenon. (Goldspink, 2002).

After that it is possible to choose a technique. According to Halpin (1999), the opposite is a very common problem for simulation in sociology: the one who creates simulations first look at the techniques and then try finding a phenomenon.

Brent and Thompson (1999) recommend a framework with three dimensions for helping and understanding the range of important sociological knowledge that can be modeled in a social simulation:

"(a) generalizing versus differentiating, (b) contextual versus pervasive, and (c)interactions versus structures."

With "generalizing" it is meant that all that is general for people in common and with "differentiating" the social characteristics that differ between people of different races, genders or social classes.

Contextual effects are limited by context and the effect which is not limited is pervasive. Interactions include negotiations, exchanges and differences in interaction style by gender, race and social class. Structures means differences in educational or job opportunities, as well as study of objects rates.

2.3.2 Product or process

Brent and Thompson (1999) discuss the differences in various simulations: some simulations are made focusing on the product of the interaction and some simulations focusing on the process. According to them there are more differences between simulations: one such distinction is "deep modeling" of interactions versus "acceptability".

In some simulations, only acceptability is necessary. There is no need for mirroring the deep underlying psychological or sociological processes. Even in deep modeling, unfortunately, important social factors are often neglected. One important social aspect of social interaction according to Brent and Thompson is the issue of social roles. Their opinion is that much more work has to be done, especially in the implementation of systems. They do, however, think that the technologies are promising in this field. (Brent and Thompson, 1999)

2.3.3 Possibilities for social simulations

Goldspink (2000) writes about a meta-model for social simulations, something which he describes as a project for the future even if it possible today with techniques from, as an example, SWARM. [http://www.swarm.org/]. The characteristic for human social systems is that they are comprised with humans and that these humans have the ability for language and self-awareness.

Richardson (2002) is arguing against Goldspink and his bottom-up computer simulations, even if he thinks they are very promising. He think that this model is suffering from the same problems as a linear approach.

2.3.4 Social science simulation techniques

Gilbert and Troitzsch (1999) have made a comparison of social science simulation techniques, in which they compare

- Number of levels, like individual and group. This also includes the interaction between the levels.
- Communication between agents, for example passing messages.
- Complexity of agents

- Number of agents in a simulation.

The recommendations by Gilbert and Troitzsch (1999) are:

- System Dynamics is useful when there is no communication between agents with low complexity. The level is one as well as the number of agents, because this type of model is oriented to the development of models of a whole system.

- Micro simulation can have many agents and it can describe two levels. There is no communication between the agents but the agents have high complexity.

- Multilevel simulations can handle more than two levels including many agents. The complexity of the agents is low but the simulation can manage some sort of communication between agents.

- Cellular Automata is for simulation with a lot of low complexity agents and these agents can communicate with other agents. Cellular Automata also manages to handle two levels.

- Distributed Artificial Intelligence can handle a few, high complex agents that could communicate with each other. Distributed Artificial Intelligence deal with more than two levels.

These definitions may be discussed in regard to their correctness, but they are included here as a base for discussion.

2.4 The "target" in AMSIDO

In AMSIDO-2 we have had to keep some assumptions about important social concepts or phenomena in relation to organization in general and military exercises in specific. The "target" must be identified. The most important material for identifying the target can be read in the sub report "Validation and data collection". The below figure is a result from that report and it shows the two most important ways to distribute information.

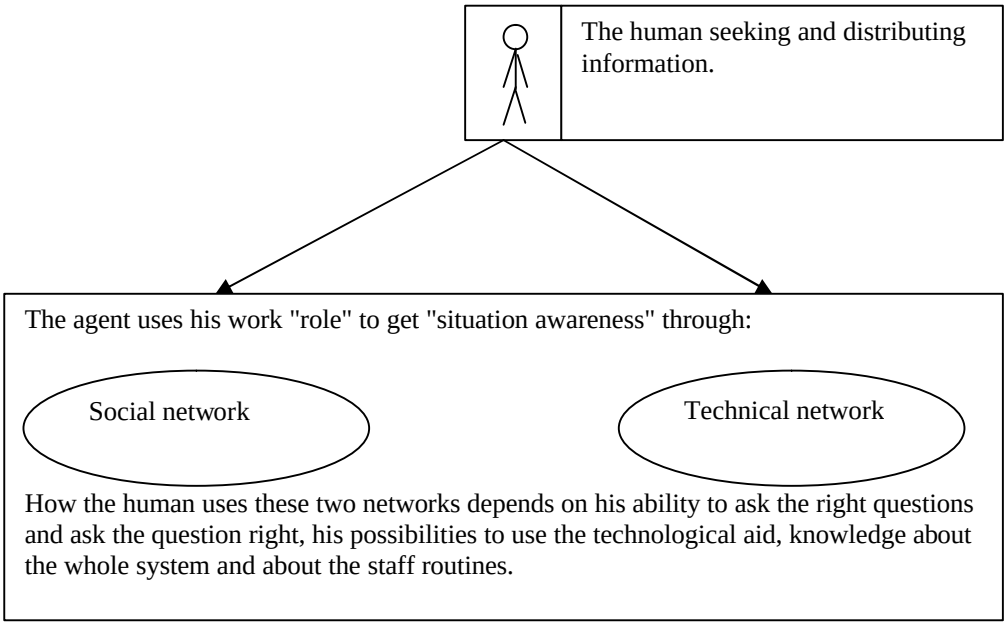

Figure no.2 : The "Target" (From AMSIDO-2 Validation and data collection) .

The two most important ways to mediate or distribute information during the case study, was emails and meetings between two or more people. The humans were located in a geographically limited area consisting of walls and doors at one floor at SwNDC.

The humans have different activities, possible to classify into four important concepts.

- **Group behavior**, the most frequent concept is about coordination and collaboration.
- **Decision** includes different sorts of decision making, as an example delegation.
- **Activity rhythm** is the work activity, such as planning and orientation.
- **Handle information** includes how the individual handles information, in order to, as an example, filter it.

In a similar study of information behavior in command and control conducted by the US Army, the conclusion was that the important concepts were interwoven situational awareness, dense social networks and contested collaboration. The purpose with that study was to give proposals to education and development. (Sonnenwald and Pierce, 2000)

Interwoven situational awareness includes individual, intragroup and intergroup shared understanding of the situation. A dense social network is the close communication between participants about the work process and the situation. "Contested collaboration" means that

the team members maintain that they are collaborating, but instead do work in their own best interest. (Sonnenwald and Pierce, 2000)

2.4.1 The overall model of AMSIDO-1

The overall model contains four entities, namely Arena, Information point, Information and Automata/Agent. These entities still feel relevant, but it is obvious that Agent is the most important entity. Arena is merely some sort of framework for the environment and its only purpose is to limit different rooms and areas.

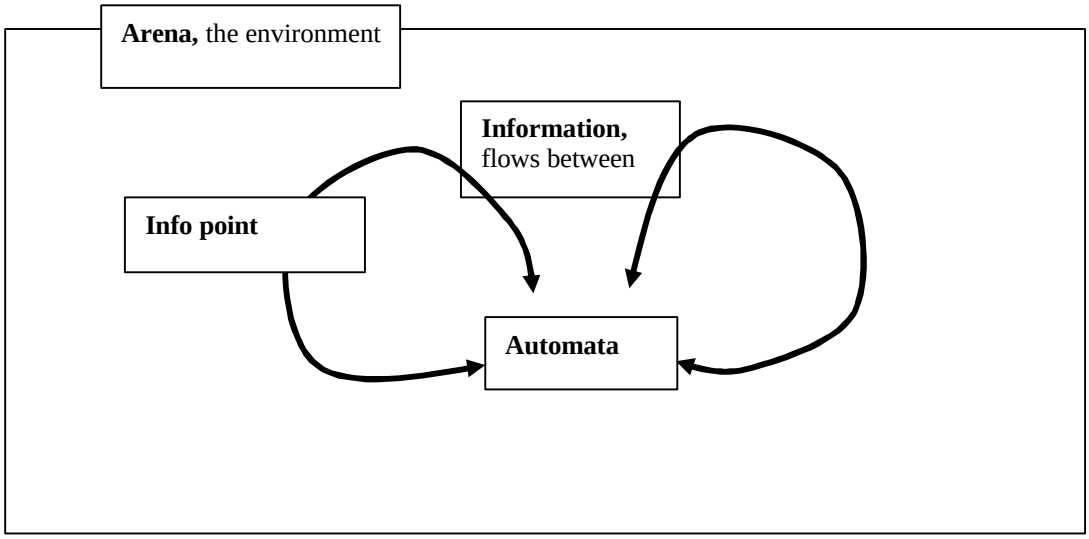

Figure no.3 : Modified model for the overall hierarchy. (from AMSIDO-2, Validation and data collection)

Information points can be seen as the technical network that agents use for distributing information to other agents. Information points are a kind of carrier for information between agents and have no value without the agents. The purpose with the simulation is to study the whole information system, both the technological and the social networks. Therefore the information point is important, but just in its quality as information carrier. Because of this, the interaction between agent and information point is fundamental. It is necessary to know about the information point, in order to study the interaction between agent and information point, in the sense of how the agent can receive or transmit information to another agent through an information point. The information points in our model could be described as kind of a non-mobile agent.

In Bergkvist's and Kristoferson's study (see “Information Node Characteristics for Model Construction”) one can read about information points and their qualities. Not all of the qualities described by the authors are necessary to implement if the focus is on the information point as a carrier of information.

Information, however, is a much more abstract concept to define and handle in this simulation. Information represents the interaction between the agents and is also a base for the knowledge the agent has. The agent needs this knowledge in order to reach its goal. This goal is, in the exercise, a goal of problem solving and making decisions. This goal is part in generating new message and new information flows.

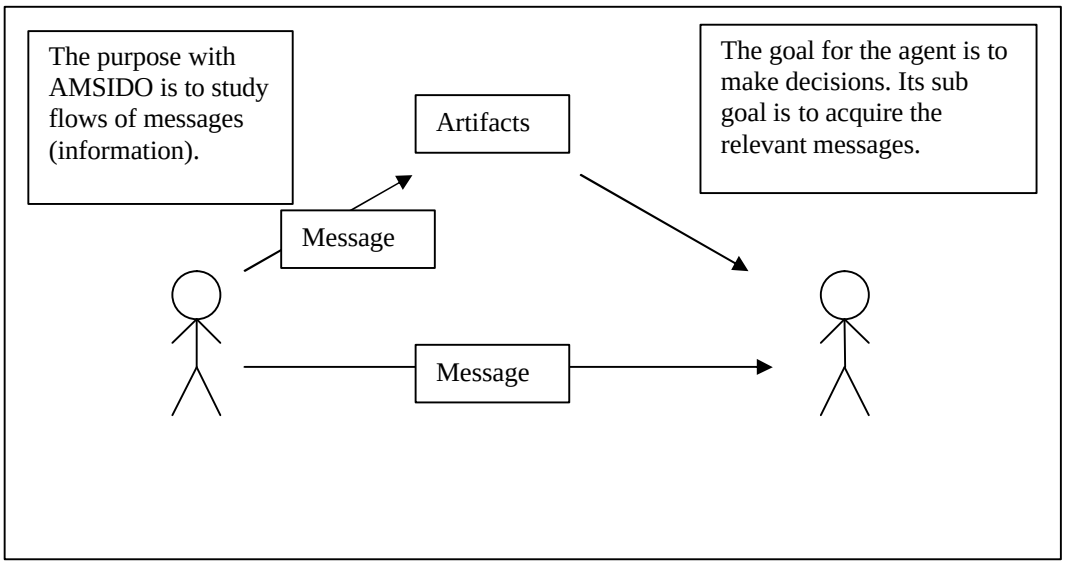

Figure no.4: Goals and information flows

In the first description of information, it was seen as representing interaction as a “take and give relation” with no intrinsic meaning. It was thought that it would be possible to handlele information a kind of "token" without any specific properties (See AMSIDO-1 models). When the information is something more than just representing a “take and give relation” it cannot be just a “token”. When information is representing some sort of knowledge or knowledge base, it must contain some language or symbolic representation. The message which carries the information can have some sort of qualities like the ones described by Holmström and Koli, especially in order to fit together within the technical network. (see "Making the Concept of Information Operational")

2.5 Social interaction in simulation

When studying sociology and social science, is it obvious that these science fields contain a lot of different theories and perspectives. Some concepts in social science are recurring, in the form of base concepts. From this point of view we try to construct a theoretical model of the interaction and group activity taking when two or more people meet.

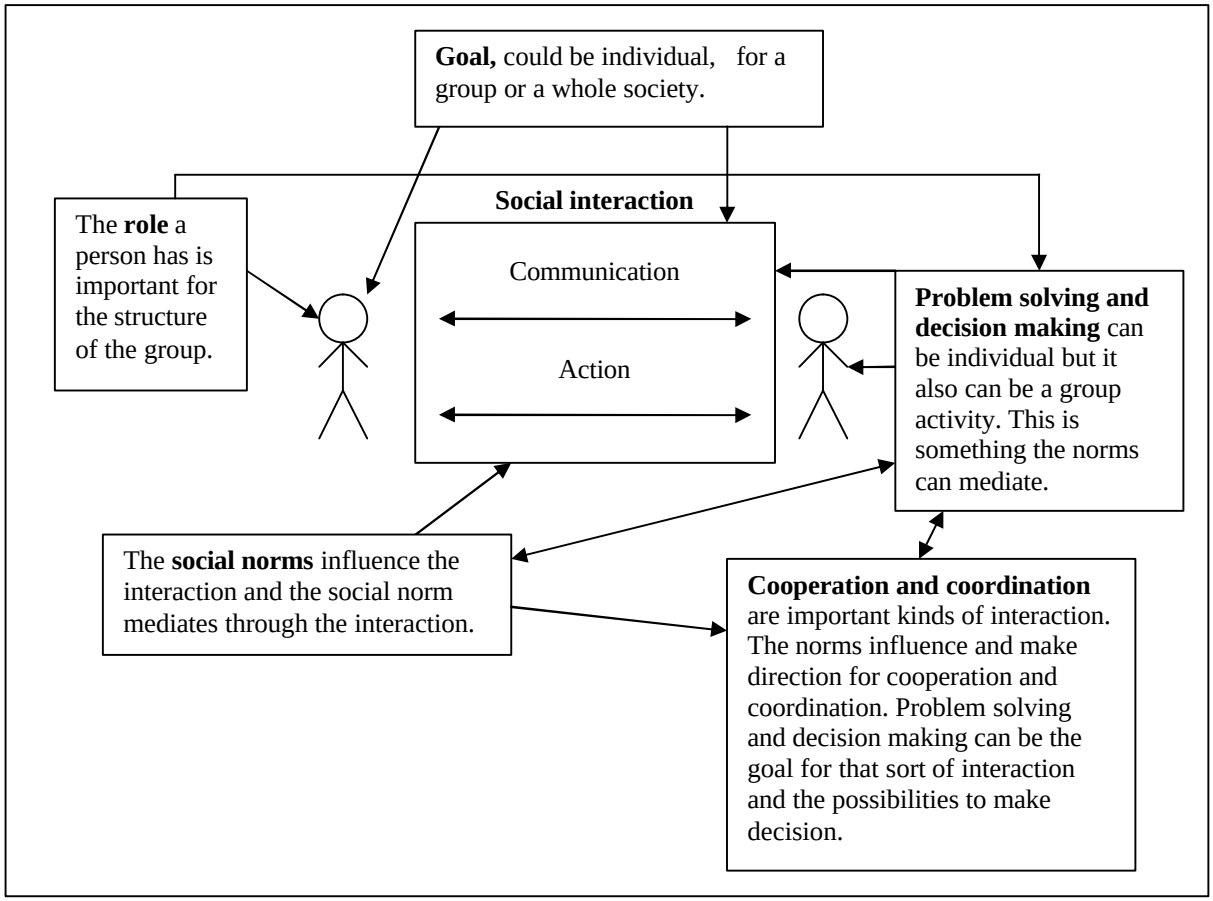

Figure no.5: Social interaction.

Social interaction is a major concept in this study, and it is handled here in the same sense as by Brent and Thompson (1999): "*the process by which two or more people communicate and act in ways having consequences for one another.*" Therefore the heart in the figure is interaction and it includes both action and communication.

Winograd and Flores (1997) explain communication as two components: to transfer information but also to create commitment. They also maintain that language is a form of human social action.

Conte and Gilbert (1995) maintain that social action is often seen as a choice between cooperation and conflict. They claim that this is not always true and that it does not work that way in reality. Not all interaction can be described as co-operation or conflict, as an example communication.

The interaction between autonomous agents in a simulation is based on motivation and goal for the agent. The goal is formulated as a state or sub state to be reached in the environment. It is important that the goal is distinct. When the goal is defined the purpose of the interaction is apparent. (d'Iverno and Luck, 1996)

2.5.1 Role

The definition and importance of the "role" concept in sociology has been the same for many years. In the social interaction between people it is classical to study social structures. Role is one important concept for describe the structure of a group, another is "status". Status involves a couple of roles. For example a man can get the status to be military and he can get different roles according to his commander and colleagues. (Merton, 1957)

Roles include the complete expectations from other people on the one who owns the role. (Kaufmann and Kaufmann, 1998)

Parson (1951) made more distinct definition of role:

“.,that of what the actor does in his relations with others seen in the context of its functional significance for the system”

He also maintains that role is not the same as a person’s status, even if these two concepts are often similar. He means that the difference is that role includes action and status just is an orientation for the person and other people.

Hayes- and Roth et al (1999) describes role competence in their simulation as "*the knowledge and skills the character needs to perform his or her job*"

2.5.2 Social norms

Social norms are important in sociology, as well as the phenomena that are the consequences of norms. If people do not follow the norms the reaction is punishment in different kinds from the society. The different sanctions could be positive or negative but the reprimands always work for conformity. (Giddens, 1993)

Of course these norms and their functions could be a problem in a group, like in the case of the phenomenon "groupthinking". The social pressure and conformity make the group dysfunctional. (Janis, 1989)

Norm Function

The functions for norms are many in organizations and group structures. Some of the most important are:

- Norms work like a sort of reference for the group and therefore give a feeling of safety in new situations.
- Norms give a hint of acceptable behaviour.
- The group identity will be stronger if the members follow the norms and it creates the group identity.
- Norms work for stabilizing the group.

(Kaufmann and Kaufmann, 1998)

Social norms in simulation

One significant aspect that has been the study of a couple of simulations is social norms and their importance.(Findler and Malyankar, 1995; Müller-Benedict, 2002; Staller and Petta, 2001).

Findler and Malyankar (1995) describe, with an Artificial Intelligence approach, the possibilities to study alliances. They use norms and goals to create alliances. According to them, the difference between alliance and cooperation is that alliances make it possible to share goal with others, not only to be interested in one's own goal.

In Artificial Intelligence, norms are often treated as a behavioural constraint, which is unacceptable because of what is known about norms. In Game theory, norm is seen as a sort of convention which is not acceptable either. Because that is "*behavioural conformities that do not presupposed explicit agreement among agents and emerge from individual interest.*" Instead it could be interesting of study the function of the norm. It is interesting to develop more sophisticated agent architectures, instead of simulating large populations, more dynamics or more marginal useful functions. (Conte and Castelfranchi, 1995)

Saam and Harrer (1999) have done a comparison between conceptualization of norms in a sociological and computational point of view. They also create a simulation that shows norms in a more sociological way. They show that it is possible to integrate "power" into computational models of norms.

2.5.3 Goal

Goal in the sociological sense could be the culturally defined goals that are more or less integrated in the human. This sort of goal is fundamental and very important in the social structure. Some of these goals are related to the biological drives for human. (Merton, 1949)

Goal is one important part of socially autonomous agents. The agent has its own goals and it could make decisions between a few conflicting goals. The agent could also adopt goals from other agents. When agents adopt goals from other agents it gives them not full autonomy as a paradox. Castelfranchi (1995)

2.5.4 Problem solving and decision making

In figure no.4 problem solving and decision making depend on cooperation and coordination. They are also a result of the current norms and roles in the group.

"*Almost every decision involves a series of activities and choices nested in choices of wider scope, rather than a single simple choice*."

From this point of view decision making in groups is depending on communication. Factors like group size, group composition and type of task also influence the decisions. Other groups of factors are group polarization and leadership. (Poole and Hirokawa, 1996)

Decision making is a central task for management. It could be seen as a process of information gathering and processing. There is a lot of research in this field from different disciplines like game theory, operations research and simulation.

"*Rational behavior is seen as a consequence of choosing among alternatives according o an evaluation of outcomes."* (Winograd and Flores 1997)

The process of problem solving could be seen as consisting of several steps. The first step is to select or find the actual problem. Next step is to analyze and structure the defined problem. Third step is an inventory of different methods to solve the problem. The two last steps are to resolve the problem and present the resolution and evolution of the resolution. (Banathy, 1996)

Different sorts of expert system is typically for the decision-making field. Expert systems often contain only one agent, but Karsenty and Brézillon (1995) did a study with more agents and introduced cooperation and joint cognitive systems. They study the human –human cooperative dialogues. Their conclusion was that such a system gives features as:

1. *Bilateral explanation;*
2. *The explanation process as part of problem solving;*
3. *Relation between problem solving and knowledge acquisition mediated by explanation process;*
4. *An explanation process driven by acceptance goals related to the task at hand;*
5. *Significance of spontaneous explanations, caused by mutual dependency between agents; and*
6. *The explainer and the explainee must cooperate to achieve an explanation goal.*

According to Sen (1997) there is research going on about problem-solving in the context of a group of agents. The technique is Distributed Artificial Intelligence, or like he calls it, Multiagent systems. Sen (1997) describes how cooperative agents work jointly on achieving a common goal. According to him the most important parts are:

- How agents decompose goals into sub goals.
- How to solve the organization of the agents and the agents' problem solving protocol which enables agents to share results and knowledge.
- How do agents keep coherence and problem solving focus?

Sen (1997) did not have the solution but claims that the way forward is promising, but also a challenge. The foundation for his optimism is clear when he describes research issues, applications and forefront of following field: Distributed search the economics of negotiation, social reasoning, mulitagent learning. Example of this is: How agents structure shared intentions (Singh, 1994) or shared collaborative plans (Grosz and Kraus, 1996).

2.5.5 Cooperation and coordination

Cooperation and coordination is important when studying a group or in an organization. These two phenomena have been studied a lot. The two phenomena also have central positions in the military concept.

Bissey and Ortona (2002) made a simulation through the SWARM simulation language to study the robustness of cooperative conventions. They do not try to create something like the real world: instead they use a specific game-theoretical model. There is just two parts in the simulation, natives and their neighbors; they are using the “prisoner’s dilemma” for the play. They use just a few parameters, group size and “intelligence” of the member. This is something they want to develop in their further research. The first result shows that the

"intelligence" had a crucial role. With "intelligence" the author means the members' ability to remember information during the game.

Another simulation in this field is done by Müller-Benedict (2002). He describes cooperation with the basis from an article done by Coleman. He uses three parameters in his study: group size, memory length and xenophobia. According to Müller-Benedict the combination of group size and memory length determines the level of social closure in a social structure. This combination is an important part of study because if the memory length is short and the group size large the people would seldom meet somebody they remember having met before. In the opposite a small group and a big memory length they would never meet anybody they did not know.

Lara and Alfonseca (2002) present in their paper the importance of the forgetting process and memory length in a multiagent simulation. In their experiment they study individuals trying to reach homogeneous vocabulary to name spatial movements.

2.5.6 Social network analysis

A rather new approach in sociology is social network analysis. This theory has focus on relationships between social entities. It also focuses on the pattern of these relationships. Instead of studying individual behavior, attitudes and beliefs, social network analysis studies the interaction between different individuals. The interactions constitute a structure that is possible to study itself. The focus of this theory is to create a connection between micro and macro social orders. (Galaskiewicz and Wasserman, 1994)

Anderson (2002) shows how social network analysis can be used to analyze relationships in an organization. The result of the application can be used to understand changes in communication patterns or interactions.

Stocker et al (2001) assume that: "*Social structures depends on connectivity and information exchange*". They also created a simulation over social network using transmission rate, number of neighbors and group size as parameters.

2.5.7 Information technology and information exchange

One sort of interaction between human is with some sort of technological aid as support, like a computer or phone. If the group makes a choice and uses technology, it also gives signals about the interaction in the group. (McLeod, 1996)

"*From a symbolic interactionist perspective, each message carries with it information not only about the group's task but also information on the legitimacy of particular actions, the meaning of actions for the organization, or the nature of types of information are carried in symbols such as the communication medium chosen or the specific source of message*."(McLeod, 1996)

The technical network during an exercise is large and it includes a lot of different types of aid (see the Report AMSIDO 2 and Validation). When we ask people; email is the most important technology aid during the exercise. Figure no.5 is one way to describe the interaction between the different parts; agent, information point and message. The figure also contains the different qualities for the entities. These qualities will be a ground for implementation of the model.

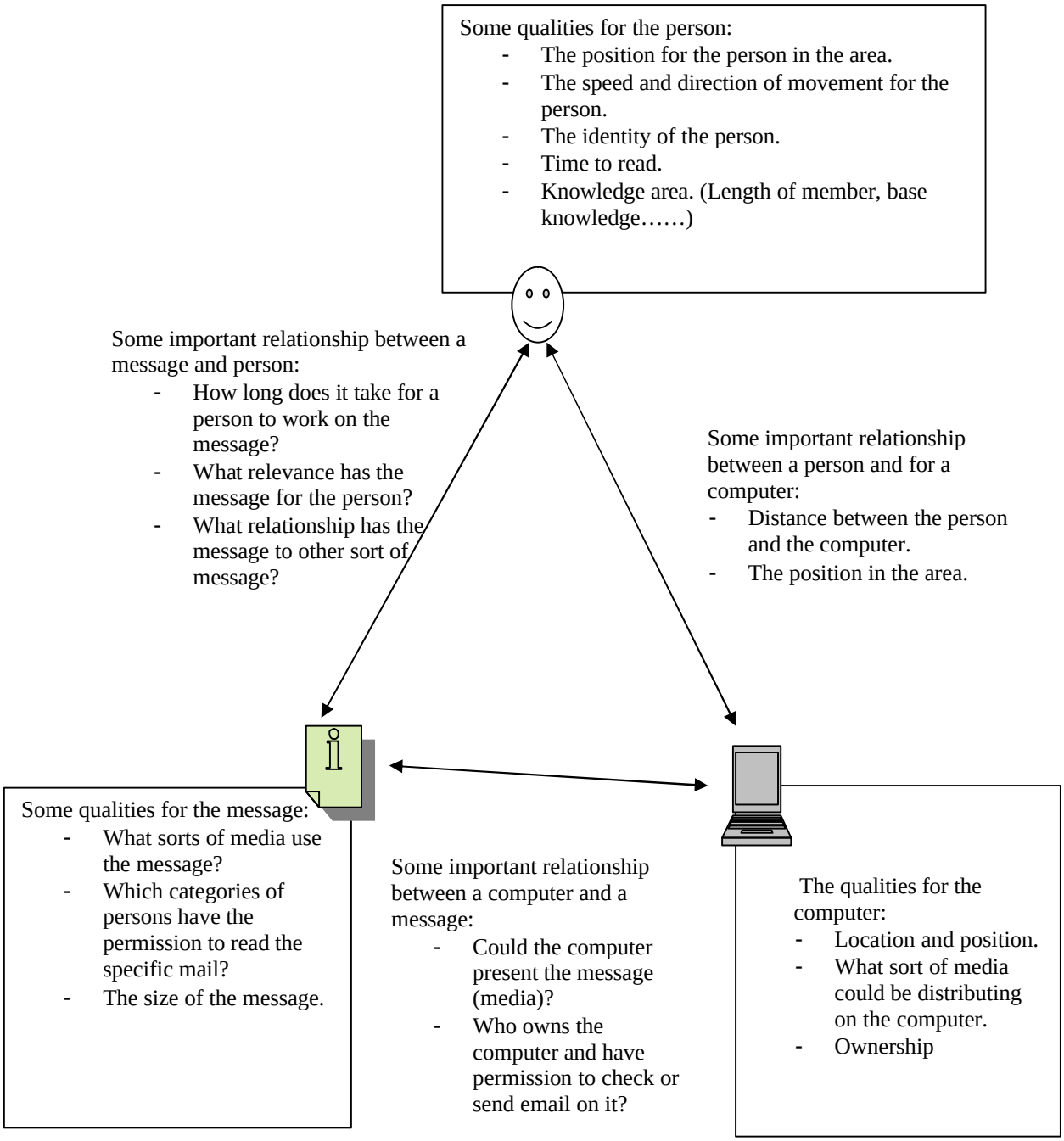

Figure no.6 : Interaction with e-mail.

2.6 AMSIDO as a social simulation?

Even if simulation is a rather new method in social science, a lot of research and work has been done in the field. This indicated that simulation is a promising method even if there are limits today.

It is not possible today to create a replica of a human being and it is not the intention of the project. The purpose of the project is to create a simulation of the information flow in an organization, and then to use the simulation to propose, evaluate, describe and visualize different possible information systems on different organization levels.

It is important to take a closer look at the critique of social simulation. Through a description of the theories that is underlying the models and entities for the simulation it is easier evaluate the result of the simulation. I also think it is hard to maintain that a deep modeling of the social phenomenon as the base for social interaction, since social science does not agree upon how this model should look. In this report I try to create a model for social interaction in information distributing according to several theories in social science.

The project intends to simulate information distribution and include human interaction such as meetings; therefore I think social simulation is a possible way for creating such a simulation. The material that is presented so far in this report is a support for that assumption.

2.6.1 What techniques are useful in AMSIDO?

Quality	Spatial, no limit	Two level	Agent, high complexity	Communication between agents
System Dynamics	**x**			
Cellular Automata		**x**		**x**
Genetic Algorithms	**x**	**x**	**x**	**x**
Distributed Artificial Intelligence	**x**	**x**	**x**	**x**
Micro simulation	**x**	**x**	**x**	
Multi level simulation	**x**	**x**		**(x)**

Table no.1: Technique matrix

The agents in AMSIDO need high complexity and the ability to communicate. It also is important that the agent can move around and interact with every other agent in the simulation. The simulation is a simulation at two levels. My recommendation according to the table and result in this report is to use Distributed Artificial Intelligence as a base for the simulation.

Simulations of sociological concepts show the importance of starting with few parameters and then develop with further parameters. That is also something that Goldspink (2002) identify. Gilbert (1999) also mentions the importance to not make the model more complex than necessary, one reason is the problem to verification and validity if the model is to complex.

During this inventory it has been obvious that it is not possible to implement all knowledge in social science about group interaction and group processes. So far two possible concepts to start implementation with are:

1. Cooperation and coordination
2. Decision making

This choice is a result from the validation and it is possible to read about it in that report.

During this inventory it was clear that a possible way to go forward is through an agent model. To produce what we want to do, we need different types of agents in the same environment. The agents that will represent the human must have some sort of learning capacity and memory. The memory length for the agents is an important issue for coordination and cooperation.

Agents in social simulations have a key position in our project and therefore need a closer study.

3 The agent

Agents will replace the word Automata, mostly because Automata give association to Cellular Automata. The project has made a decision earlier that Cellular Automata is not the right approach in this sort of simulation. This decision is confirmed in this report. Another example of the advantage of an agent approach is given by Davidsson (2002). He illustrates how agent based computing, social science and computer simulation fit together and could give synergy effects.

Wooldridge and Jennings (1995) describe an agent as hardware or software- based computer system with this properties:

- *"autonomy: agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state;*
- *social ability: agents interact with other agents(and possibly humans) via some kind of agent-communication language;*
- *reactivity: agents perceive their environment, (which may be the physical world, a user via a graphical user interface, a collection of other agents, the INTERNET, or perhaps all of these combined), and respond in a timely fashion to changes that occurs in it;*
- *pro-activeness: agents do not simply act in response to their environment; they are able to exhibit goal-directed behaviour by taking the initiative."*

Wooldridge and Jennings (1995) points out that there are researchers who include more in the agent term. Especially researchers within the field Artificial Intelligence use concepts that are more applied to humans, such as knowledge, beliefs, intention obligation and emotion.

3.1 Agent typology

One basic idea is that the world consists of entities in this case called agents. The agent framework include of four basic elements.

? Attribute; describe the qualities of the agent.
? Actions; means the fundamental capabilities of the agent.
? Goal; the goal for the agent.
? Agency: a couple of internal non- derivable motivations that give the agent its autonomy.
(d'Iverno and Luck, 1996)

Agents could be divided into different kinds and in different ways. The following approach is one way to describe agents.

3.1.1 Passive agents

This type of agent is inactive in the sense that they do not interact by themselves. They could interact with others but only with help from an active agent. How they interact depends on their properties. Passive agent can have properties like for example surface or color. (Goldspink, 2002)

3.1.2 Active agents
Active agent can interact with other agent and how much it can interact depends on their properties. A very simple agent is called “reactive” agent which can only receive a “message” and transmit a standard response. More qualified agents can process input before they show the behavior which is a result of the process. These agents have their limits even if they can be used for several kinds of simulation. (Goldspink, 2002)

3.1.3 Adaptive agents
Adaptive agents have the ability to modify some of their parameters or variables states and in some case even their rule set. This directed agent is often used in social simulation. Simulation with this type of agent could present macro- outcome that are unanticipated result of their behavior. (Goldspink, 2002)

3.1.4 Cognitive agents
Every agent that could adjust their own structure to compensate for perturbation could be called cognitive and is a neutral and flexible agent. This type of agent could belong to the class biological agents but does not necessarily do so. (Goldspink, 2002)

3.1.5 Biological agents
A “Biological” agent is important in simulations of social theory. This agent is designed with essential characteristics of a real biological entity. It is always autonomous and self-producing. (Goldspink, 2002)

3.2 Multi agents models
There are a couple of attributes which are common in agent model:

- **Knowledge** includes knowledge about the environment and other agents.
- **Beliefs** are information about the environment that could be false.
- **Inference** is a sort of assumption based on the beliefs about the environment.
- When the agents compile a picture of interrelationships with other agents they build a sort of **social models**.
- **Knowledge representation** to represent the beliefs of an agent.
- The agent needs internal **goals** to be autonomous and purposive.
- The agent requires some sort of **planning** to reach the goal.
- Some sort of **language** is an important part in an agent for the possibility to interact with other agents.
- **Emotion** is another part in the agent for the possibilities to create agents like human beings.

This is the characteristics of an autonomous agent but there are a lot of unsolved problems, one example is the relationship between goals and emotion. (Gilbert and Troitzsch, 1999)

3.2.1 Rule system
It is common that agents have some kind of rule system and the simplest is a ‘product system’. This system include three components; a set of rules, working memory and a rule interpreter. Every rule consists of a condition part and an action part. The condition part specifies the triggers for the role and the action part what is going to happen. In the working

memory is such information as location in the room. The interpreter is deciding what is when the condition part for more than one rule is satisfied. One of the advantages with a 'product system' is that the designer do not have do decide in what order the rules are to be executed. (Gilbert and Troitzsch, 1999)

3.3 Modeling human behavior, what is done?

It is commonly known that there is an enormous quantity of material available about agents. You only have to look at the Internet. There is a lot done about agents in the field Artificial Intelligence. The purpose is not to make an overview over that gigantic area in this report, even if there is a lot of interesting research that can be important in the AMSIDO project. The sphere about personalities for "Synthetic Actors" has influenced this part of the report.

There is an exciting challenge to model human behavior. A lot of researchers aim to do such models, like Schmidt (2000); Moffat (1997); Sloman (1997).

In the discussion if it is possible to model human behavior is it important to distinguish between model and replica. *"A replica is an identical copy of an original. A replica is completely indistinguishable from the original. It appears to be impossible, at least for the foreseeable future, to produce an artificial replica of a human being."* Schmidt (2000)

It is not necessary to build a model of human behavior that includes everything in the human nature. Even a quite simple model with focus on the dominant facts in relation to the problem could give interesting results (Schmidt 2000)

3.3.1 The PECS reference Model by Schmidt

"PECS stands for:
***P**hysical conditions*
Emotional state
Cognitive Capabilities
Social Status" Schmidt (2000)

This model is a sort of reference model and the structure consist of three fundamental components: environment, connector and agents. The environment component is the external events and influences that are important to the agent's behavior. This can include other agents. Connector is a sort of "switchboard" to make the communication possible between the agents (Schmidt, 2000)

The PECS model has its roots in system theory and it contains input, internal state and output. Sensor and perception is the input in model. The internal status is changed and held by social status, cognition, emotion and physis. Output in the model is the part called behavior and actor. The different parts in the model interact with each other all the time. (Schmidt, 2000)

The model has not been implemented and tested but Schmidt (2000) demonstrate how the reference model could be used in three case; "The Adams model", "The Learning Group Model" and "The Role Play Model".

3.3.2 Model of a Will by Moffat

This model is an attempt to design an artificial personality. The author is from the faculty of Psychology and the study has its roots in Cognitive Science and Artificial Intelligence. The model will include emotion as well as personality. (Moffat, 1997)

The model is made as simple as possible and includes just a few symbolic modules and some concerns. There are four basic modules like the cognitive elements of emotion. The modules are called perceiver, planner, predictor and executor. The perceiver module handles perception and the executer module executes actions. Predictor and planner do the prediction and plans for the agent. The agent also needs a symbolic world model which is called memory. The memory is an episodic memory and it stores facts about the environment. There module called emotor, which is responsible for secondary appraisal and action tendency. (Moffat, 1997)

There are some obvious limitations in this model is according to Moffat (1997). The most serious one is the lack of social awareness, the agents' abilities to relate to each other. Another disadvantage is the lack of learning capacity.

3.3.3 Control system by Blumberg and Galyean

Blumberg and Galyean (1997) present their architecture of external control into autonomous agent in interactive story systems. They maintain that it must be possible for the director to control the character at different levels of abstraction. Therefore they specify four different levels of control in that architecture:

- Motor skill (go ahead –forward)
- Behavioral level (Find the steak in the users hand, do something dependent on a goal)
- Motivational level (You are very hungry)
- Environmental level (The Jones town dam just broke, the environment influence the behavior)

3.3.4 Social nature in agents

Panzarasa et. al (1999) has created a conceptual model for social behavior in agents. They show how the behavior can be constructed through a Belief-Desire-Intention (BDI) architecture. Roles and social relationships are the base for social mental shaping. Roles provide the agent with goal, beliefs, desires and intentions.

3.4 Agents in AMSIDO

Figure no.7 is a conceptual model of information flows in the organization, and it is a further development of figure no.4. It should not be seen as complete but it is my assumption that contains it the most important parts.

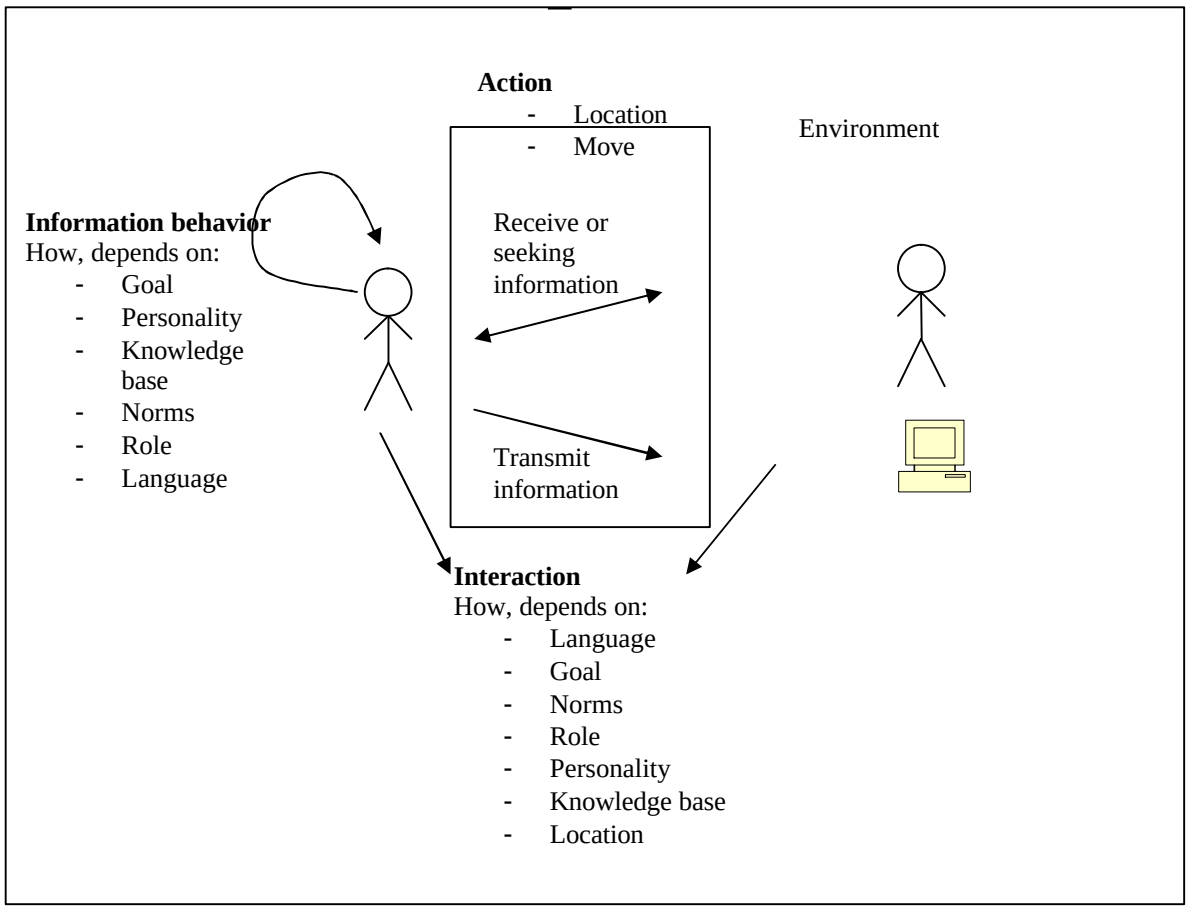

Figure no.7 : Interaction and information flow

3.4.1 Information behavior

According to Wilson (1997) there is a much research about human information behavior, conducted within various disciplines. His assumption is that all information behavior and problems regarding it, depend on information need. He creates an interdisciplinary general model of human information behavior. His model includes the following components: character or context for information need; activating mechanism, including stress and coping theory; intervening variables (he also calls it barriers to seeking information); activating mechanism (decision to engage in information seeking behavior), the last part describe information seeking behavior.

The steps in information seeking behavior are illustrated in his model as passive attention, passive search, active search and ongoing search. Passive attention is all type of information acquisition that does not include especially seeking information. Example of passive attention is listening on a radio. Passive search is those occasion when the information happens to be right for the right person. Active search is when a person actively seeks specific information. The last is ongoing search which is when a person has the framework but need to expand it. (Wilson, 1997)

Vickery and Vickery (1987) maintain that the recipient of information can be described as a chain of influence: social position- activities – information uses – information wants – communication behavior.

"*In any social situation, whether communication takes place and what information is assimilated may depend upon the information want of the recipient, his willingness too seek or accept information, his access to a channel, and his ability to assimilate the information from a message."*

Information processing by humans can be illustrated in several steps:

1. *Perception itself*
2. *Formation of concept from perceptions,*
3. *Storage in memory*
4. *Recall from memory*
5. *Matching perceptions against memory,*
6. *Matching stored attributes against the environment.*" (Vickery and Vickery, 1987)

3.4.2 Personality

A definition of the word personality is done by Moffat (1997) *"Personality is consistent reactive bias within the fringe of functionality."*

Hayes-Roth et al (1997) explain that it is easier to create actors with a character than agents like real human beings with all aspects. They have created a simulation which illustrates the servant and master problem. The model consists of three parts:

- Plot (The scenario, example a boy fall in love with a girl)
- Role (the expected role, in this example the boy who falls in love)
- Character (personality)

In the simulation for master and servant there are three variables for characterizing a specific role:

- Relationship
- Demeanor
- Space

They run the simulation with different values on the variables and their conclusion from this simulation is that what happens is exclusively dependent on the character.

3.4.3 Personality theory

Different types of personality theory can be found in psychology. It is not a simple concept with only one answer. Some theories will be discussed here.

Personality: Psychologists have formalized characterization by traits called the "big five". This technique has led to a fairly large agreement about five major traits that explains most of the variation of personality.

- Intellect or Imagination
- Conscientiousness
- Surgency or Extraversion
- Agreeableness
- Emotional stability

A person will theoretically be in the five-dimensional space. The criticism for this theory is that it is based only on factor analysis.

Another aspect on traits theory is that it only is descriptive not explanatory. Moffat maintain that it is possible to use traits theories in artificial agents of some kind but that it will not give the deep mechanism in human nature. (Moffat, 1997)

Theories by Freud, Skinner and Maslow are not useful for creating artificial actors. The reason is that they are not related to the every day notion of what personality is. (Moffat, 1997)

Personality according to social learning theories includes behavior, feelings and thoughts. Moffat (1997) maintain that using these theories is a promising way to model human behavior.

Emotion: If we think that thought and feeling is involved with behavior in types of reaction, the emotion is an important part to study. One difference between personality and emotion is that personality is stable over lifetime but emotions are short-lived. (Moffat, 1997)

"*Emotions influence beliefs. This is a classical assumption. People's emotions, according to this assumption, determine what they think, and what they think is true."(*Fridja and Mesquita, 2000)

Clore and Gasper (2000) define emotion as being one part feelings and one part mood. The difference between mood and feeling is that moods often begin as an emotional reaction on a specific event. Moods are also generally just positive or negative. The authors conclude that emotion is informative and believable.

Knowledge base: "*Knowledge is always a result of interpretation*" All knowledge can be seen in a perspective of pre-understanding. Pre-understanding includes all experience and tradition of a person. (Winnograd and Flores, 1997)

In the Artificial Intelligence and cognitive science field it is maintained that every knowledge representation scheme contains two parts: "*a knowledge base and an interpreter that manipulates it.*" (Stillings et.al. 1995 pp. 152)

They also discuss ten important questions that are useful for evaluating knowledge representation schemes. Some of the most relevant for this project is: possibilities for modify old knowledge and acquisition new knowledge. (Stillings et.al. 1995)

According to Thalmann mfl (1997) there are two main problems when simulating behavior for synthetic actors:

- To give the actor knowledge about the environment.
- To make him react on that knowledge.

Their conclusion is that virtual individuals need knowledge, and that they therefore require visual, tactile and auditory sensors.

There are some standard techniques for knowledge representation; one is a sort of semantic net. Semantic nets can also be used to represent aspects of natural language. The simplest and most used type of net in Artificial Intelligence is called "is-a" or "a-kind-of".
Another technique is the production system described earlier in the report, including three parts:

- A rule base representing the knowledge.
- A context of the current state of the system.
- An interpreter which know how to interpret knowledge with context.

(Stillings et.al. 1995)

Anticipation: If the agent in a simulation has the ability to anticipate and choose between different actions it would make the simulation realistic. An agent could notice that the level of energy is quite low and it is soon time for food. In this case the agent could do some priorities. There is some work done in the direction of anticipatory agents by Ekdahl et.al (1995).

3.4.4 Language

The meaning of language is clarified by Winograd and Flores (1997):

"We create and give meaning to the world we live in and share with others (and the social and technological networks in which our lives have meaning) in language."

Models include some sort of interaction between agents or at least some form of interaction between the agent and his environment. This interaction could involve some sort of passing information to each other like in the case of negotiation of contracts. Agents representing humans also need some sort of 'language' to be able to communicate. There is a considerable amount of literature in the field computer languages for communication between agents but it is also obvious that it is a very difficult and problematic area. One way to avoid this problem is to take for granted that messages pass straight between agents. This could be a possible way to solve the problem dependent on the object of the simulation (Gilbert and Troitzsch 1999).

Loyall (1997) has earlier built simulations and created agents that could both act and generate language. This is an ongoing work for development of what he thinks is a key question for creating believable agents.

"*Human language provides, among other things, a mechanism for distinguishing between relevant objects in the natural environment. This mechanism is made up of two components – forms and meanings- which must be shared by the community of language users."* (Hutchins and Hazlehurst, 1995)

Hutchins and Hazlehurst (1995) have developed a sort of language for interaction between agents. They use a model based on interacting artificial neural networks. This language consists of shared symbols of form and meaning pairs.

According to Brent and Thompson (1999) there are differences between believable and deep modeling models and they think it is necessary to make deep models of social phenomena.

Even if we do not make a deep modeling for the simulation, it is important to have the agents talk and understand each other.

Conversational system: Another way to implement the ability for communication or real conversation is an agent architecture including three core modules: interpretation manager, generation manager and behavior agent. This model is a general model of collaborative problem solving with a complement of an abstract level for practical dialogues. The behavior agent has the overall responsibility for problem solving. (Allen et. al., 2001)

3.4.5 Problem solving by individuals

Problem solving contains a number of elements according to Artificial Intelligence research. The first element is to specify the "Task environment". What action can change the state and what goal is the base for this action. "Internal representation" is the second element. The representation is a collection of "symbol structures" of the task environment. It interacts with the task environment. Next step is "Search" and it is a sort of information process to analyze possible courses of action to get to the goal. The last element is called "Choice" when the agent choice one way to action to reach the desired goal. (Winnograd and Flores, 1997)

3.4.6 Goal

Goal could have more than one implication in this report. In one way "goal" is a part of the agent architecture (see 3.2), but it could also be an important part in the problem solving concept. These two types of goal could be integrated. The agent's goal could be to solve problems.

Findler and Malyankar (1995) have made a work about goal structure with an Artificial Intelligence approach. They describe the structure as: *A goal structure is the hierarchy of goals and subgoals that compose the root goal"* With root goal they mean the original goal of the agent. Subgoal and goal is the hierarchy of goals that composes the root goal.

3.4.7 Norms and Roles

The definition of norms is described in 2.5.2 Social norms.

Findler and Malyankar (1995) handle the problem with norms in their simulation through a "norm database". They put the norms in a "database for norms" and explain how norms are generated. There is an agent cycle and a norm generation cycle. Through interruptions in these cycles is an evolution of "current norms". The "current norms" in the system are stored in a database and distributed to the agents.

Decision making in groups: Eisle (1999) describe different types of group decisions and various aspects of group behavior like persuasion, conformity and negotiation. He maintains that "*communication and influence are two interrelated processes that affect group decision making"*.

"System of Multiple Level Observation of Groups" (SYMLOG) by Bales (1980) is a rating form for measurement of general social interaction. It makes it possible to study different types of group members. The axes in the model are socially/task oriented, dominance/submission and friendly/unfriendly.

3.4.8 Location and motion

It is necessary for the agent to know where it is and how it can move to another place. How it can move must also include speed. The motivation for this is found in the Figure no.6 : Interaction with e-mail.

In the research field of modeling behavioral animation there are examples of navigational systems with global or local navigation. One approach is when the local navigation system has no model of the environment but get that information from the global system. Another approach is when the local system uses the input from the environment directly. That gives possibilities to imitate how human move in different environments and it is an approach to pass necessary information from environment to an actor. (Thalmann et.al., 1997)

4 Conceptual model

This conceptual model of an agent which will be the base for a simulation of information distribution is influenced both from Artificial Intelligence and the social simulation field. The purpose is to identify the underlying theories that bring the pattern in social behavior and at the same time give every individual a personality that influence the behavior.

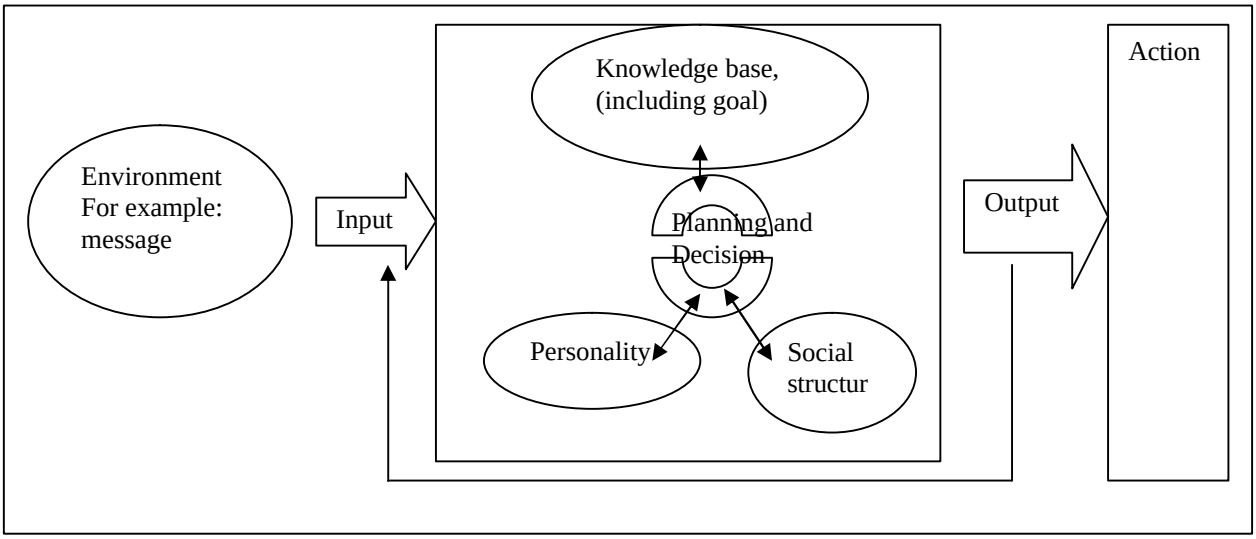

Figure no.8 : Conceptual model of an agent

Some sort of language or shared symbols is necessary in this type of simulation, since information has a fundamental position in many ways. It is central for the interaction between agents and it also is essential for some sort of knowledge base. My suggestion is to use some approach influence by Hutchins and Hazlehurst (1995).

An agent in a simulation like this needs a lot of knowledge, include memory and anticipatory. [hur kan du betrakta "anticipatory" som en "kunskap"?]

Everything mentioned above is not possible or necessary to implement at once. Therefore it is important to prioritize the list. The three first are necessary to start with as a general base for the agent:

- Knowledge of its own internal state, like energy and hunger.
- Knowledge about the environment, possibilities to move and get an email.
- Knowledge of goal and group goal, for example to collect information.

The next four are important to make a realistic picture of the specific work the agent conducting. This knowledge is specific for the work in a specific organization and it would be necessary to modify in the simulation. Even if the language is some sort of symbols and therefore quite general, the work schema are different even between two similar exercises.

- Knowledge about the organization and different positions, for example who is commander in J2.
- Base knowledge about the game that is simulated in the exercise, for example how big is the navy.
- Work skill
- Knowledge about work activity, like the battle rhythm.

The last knowledge is of the social structure and personality it is also important and need to be modified.

- Knowledge about norm and roles in the organization, for example the organization want you to cooperate.
- Knowledge of the personality.

The main goal for the agents is to get information in order to make decisions. When this goal is reached for an agent depends mostly on the position in the organization. The main goal needs to be broken down into a goal hierarchy. The contents of the hierarchy differ depending on who the agent represents in the organization. The behavior group in AMSIDO-1 is some sort of group with different work activities and that could be a base for development of different groups with different goals.

Even if “The big five” personality traits do not give a deep modeling of human personality in Moffat's (1997) sense, it is my assumption that it is a possible way to see what personality can do for the information distribution in an organization. One possibility is to use a graph like figure no. 8 and modify the agent. This profile would of course be connected to the action behavior of the agent. As an example, how much information or message do the agent distribute, and how much does it keep for himself?

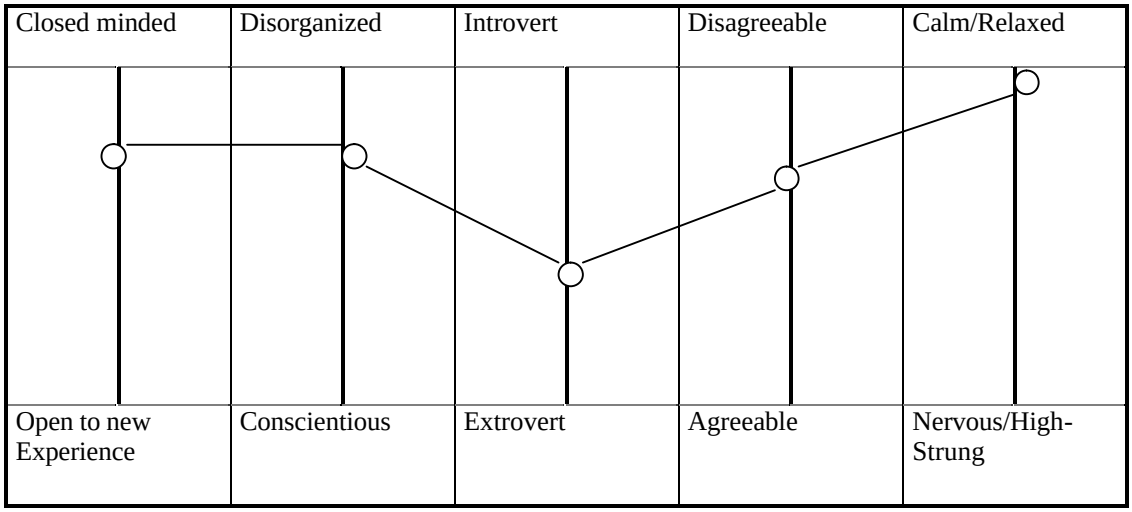

Figure no.9 : Personality

Roles and norms are important concepts for the social structure and how people live together. The role can be both formal and informal. In the first step to construct roles in the simulation, the suggestion is to implement formal roles. How humans use the different tools like email

and meetings depends partly on their personality. The suggestion is to start the implementation with one formal role, for example commander and try that role with different personalities. When that result seems to be stable it is time to expand the role gallery.

Norms in our society could include many different phenomena. It is also well known that it takes time to evolve new norms in a group or a society. Today the simulation only is planned to contain a couple of days in simulation time. Therefore it is not necessary to implement norm development. Instead it is usefully to specify the norm or norms initially.

5 Conclusions

During the study for this report it has become obvious that social simulations is an accepted method in the social sciences. There is a lot of research in the field from different disciplines and it has been influenced by the artificial intelligence area. Simulation as a method has lately been receiving more and more interest within the social sciences.

The different simulation examples discussed in this report only study one limited phenomenon, for example how norms are developed and change over time, or how language can be created in intelligent agents.

In the AMSIDO project we want to create a holistic simulation of information distribution. The project wants to study the patterns of information distribution with a sociotechnological perspective, and would include both human and technology artifacts. Therefore the study has to focus on the different entities in the simulation but also what happens during the interaction between the entities.

One important conclusion is the confirmation that CA is not a suitable approach for the kind of simulations we are about. Rather, an agent approach feel more relevant.

In AMSIDO we want to integrate many different qualities in the agent and we want the agent to imitate a person who is working in an organization with goals for work activity.

A lot of research has been summarized in this report. The intention is not to use all this research in the next phase of AMSIDO, but it is a base for what could be possible and what is important to think about during the development of the project. This base also provides the possibility to create a more general model for agent architectures in a system for illustrating information distribution in general.

- My suggestions is that the next phase of AMSIDO will evolve and implement the base for interaction, a language, sensors and the ability to move.

- Evolve and implement the knowledge base and create editors for designing the agents in the simulation.

- Evolve and implement personality and social norms in the simulation. It is also necessary to construct editors for designing this part of the agent.

All these steps need to be integrated to reach a holistic view of an agent during the simulation.

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