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Main Report

Contents

Figures

1. Background

In the society of today there is a variety of information systems supporting information distribution in organizations. This brings possibilities and benefits but also problems. One of the problems is to predict whether the information distribution will be "better" with one information system as compared to another. Because of this, many organizations would find it useful to be able to make some sort of theoretical experiments with different plausible solutions. These experiments could give the organization the opportunity to study different kinds of information systems before actually buying all the expensive technical equipment or doing time-consuming reorganizations. The experiments would also give the organizations opportunities to see what could be improved in existing information systems. To make this sort of experiment feasible, the AMSIDO project means to create a simulation of the information distribution in organizations.

During the spring and summer 2002 the second phase ("AMSIDO-2") of the AMSIDO ("**A**gent based **M**icro world **S**imulation of **I**nformation **D**istribution in **O**rganizations") was conducted. The report collection, of which this document is a part, summarizes and discusses the research that was done during AMSIDO-2. AMSIDO-2 has been conducted from 2002-04-01 and is expected to conclude 2002-09-04.

1.1 AMSIDO in General

The following describes the purpose and structure of the AMSIDO project as a whole. Note that the below is the current formulation, which differs somewhat from what was written during AMSIDO-1. The current formulation was made at the shift between AMSIDO-1 and AMSIDO-2, that is to say around february 2002.

The main purpose of the project AMSIDO could be summarized: *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.*

The focus of the project has been different during its different phases. The below is an explanation of the different terms used to describe the various parts of AMSIDO.

AMSIDO (**A**gent-based **M**icro world **S**imulation of **I**nformation **D**istribution in **O**rganizations) is the general label applied to the project producing this (and a number of earlier reports) concerning simulations of information distribution. More formally, it is a label on a joint project between the Swedish National Defense College (SwNDC) and Mid Sweden University. So far it has also been implicit that a specific case scenario with exercises at SwNDC has been the main focus of the study.

CASID (**C**ellular **A**utomata **S**imulation of **I**nformation **D**istribution) is synonymous with AMSIDO-1, but the term was dropped since it was discovered that it was not feasible to use

Cellular Automata as base technology in the simulations. More information about this can be found in the end report from AMSIDO-1[1].

AMSIDO-1 was the first phase of AMSIDO. It was conducted from 2001-08-01 to 2002-02-01 and mainly focused on constructing a crude model of information distribution, and on testing whether it was technologically feasible to implement this model in a simulation.

AMSIDO-2 is the second phase of AMSIDO, and it is the phase which has produced this document and the other sub reports in the collection. AMSIDO-2 has been conducted from 2002-04-01 and is expected to conclude 2002-09-04. The main focus on AMSIDO-2 has been to do an inventory of literature within the field concerning simulations of the mentioned kind, but has also included elaborations of the entities from AMSIDO-1, and both theoretical and empirical evaluations of AMSIDO-1.

1.1.1 The Case

The case scenario for AMSIDO is currently the OBS/OPS exercises (see below) conducted annually at SwNDC. SwNDC is a part of the Swedish government, and on the web it is possible to read following about it: *"The task of the Swedish National Defense College today is to contribute to national and international security through research and education. We do this by training officers and civilians for staff, commander and specialist positions for the Total Defense or for international missions. The research is mainly directed at supporting the study programmes and is to a large extent interdisciplinary. International conflict solving, politico-security evaluations, crisis management and the art of war presuppose that knowledge from various different areas can be analysed and consolidated into a whole."* (http://www.fhs.mil.se/about/en/frame.html)

OBS 02 (Operative Strategic Decision game) is a course in applied war science at SwNDC. It is a decision game for students at the school for experts in political science and students in strategic command, and is a part of the Program for Advanced Command.

The purpose of the decision game exercise is that two "states" (North and South) are confronted in a conflict situation. The decision-making within the "states" are organized in three levels: the political, the military strategic and the operative. Different decisions have to be made by the participants depending on the information they receive. The calculated intention of the opponent has to be taken into account and compared to the own "state's" goals and resources in every specific situation.

This sort of exercise is organized is arranged annually, although the framework for every exercise differs slightly. This specific case scenario exercise was smaller than previous years; it consisted of around 90 participants, as compared to about 150 participants the year before.

[1] This report is available on the project homepage: http://gathering.itm.mh.se/amsido

1.2 AMSIDO-2 in Specific

After the first prototyping phase in AMSIDO-1 it became obvious that it was important to do an inventory and deeper study of different possible theories underlying the simulation. Therefore AMSIDO-2 focuses on several research fields:

1. Literature inventory of simulations
2. Study of the concept agents in simulations
3. Study of the concept information
4. Study of the concept technical aid
5. Theoretical evaluation of the models from AMSIDO-1
6. Empirical validation of models form AMSIDO-1
7. Data collection for further development of the AMSIDO models

1.3 Report Disposition

The full report from AMSIDO-2 reaches a full size of between 100 and 200 pages. In order to ease reading, the report has therefore been decentralized into several component parts.

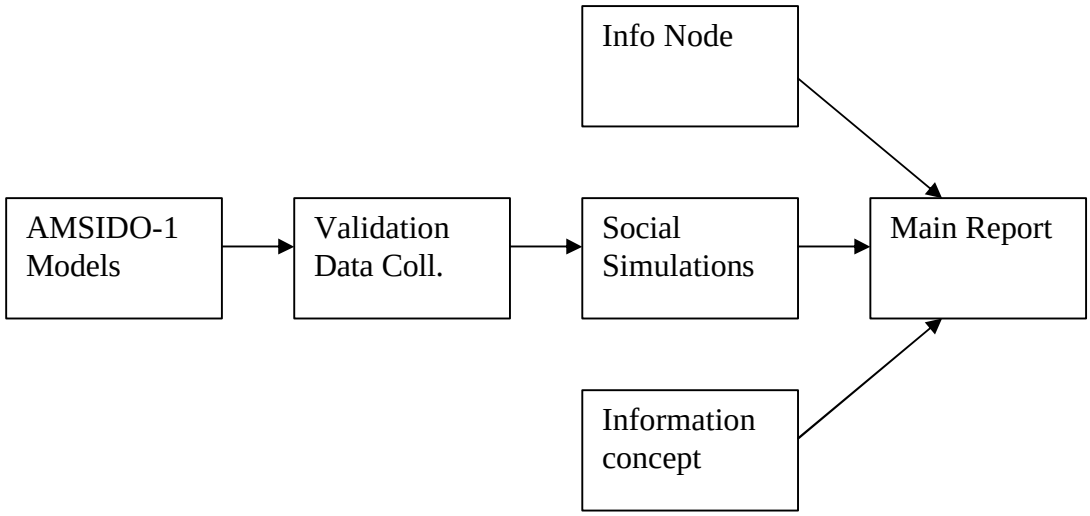


Figure no.1: Report disposition

The current document, the **Main Report**, ties in and discusses the sub reports, in order to propose ways for future research. Thus, for details and a more full view of what is discusses in this document, the reader should turn to the sub reports. A more full discussion about the purpose and disposition of this document can be found below.

The bulk and focus of the AMSIDO-2 project has been the literature inventory of existing research within the general area of the simulations of the kind we are about. The results of this inventory are collected in the **Social Simulations** document. The more detailed purpose with this report is to propose a conceptual model for human behavior in information distribution based on theories from areas, such as social simulations and agent theories, surveyed in the

literature inventory. The document partly built on material from the Validation and Data Collection.

The empirical findings of AMSIDO-2 consist of an evaluation of the models constructed during AMSIDO-1, and of data collected during the last exercise. These findings are collected into a sub report called **Validation and Data Collection**. It includes observations, interviews and seminars conducted during the exercise OBS 02 (see background below). The report should be seen as both a "validation" of the models from AMSIDO-1, but it is also a data collection for the AMSIDO 2. This document was partly based on the findings in the theoretical specification/evaluation of the AMSIDO-1 Models.

A complete reference and a *theoretical* evaluation of the models from AMSIDO-1 can be found in the sub report called **AMSIDO-1 Models**. The main purpose of this document was and is to function as a background for the Validation report.

Apart from the formal reports, the project team also had the honor of advising two master theses within the frame of the project. These two theses contributed important elaborations of two separate entities studied within AMSIDO. The first, "**Making the Concept of Information Operational**", contains a study of information as a concept and proposes a definition and a model of that concept. The second, "**Information Node Characteristics for Model Construction**", studies information-spreading technological artifacts and proposes a hierarchical/object-oriented model of these.

1.3.1 This Document in Specific

The intent with this document is to tie together some of the most interesting parts of the sub reports, and combine that with a theoretical discussion and analysis of those parts. This document should therefore not be seen as a summary of those other reports, but rather as a "discussion layer" tying in and discussing the conclusions from those other reports.

The main sections in the document could be said to be a evaluation of the background beliefs and world view we have, a discussion about (some of) the results from the AMSIDO-2 project as a whole, and finally a section with suggestions for the future.

These sections can of course be read separately, but at least the results discussion and the suggestions lean upon the existence of the sub reports. It may therefore come in handy to have these sub reports readily available when reading these sections.

2. World View and Background Beliefs

A common critique of attempts at social science simulations is that they fail to make explicit what the underlying world view is which, as an example, may lead to problems with identifying which phenomena to study (Goldspink 2002). The common approach is to model a very small part of a complex whole and present that small model as something uncontroversial which does not need any elaboration. The critics attack this since a worldview is always there even when it is not expressed.

Since we are aware that we have been using an implicit world view in our work so far, the below is an attempt to make that world view explicit. The formulation of the world view is partly based on the issues discussed later in this document.

It should be noted here that when we use the term "world view", we use it in the SSM sense of the world. Rather than being a grand theory of everything, it should be seen as the background philosophies which make the things we do sensible. The world view for a plumber is that tubes which do not leak will transport water more efficiently than tubes which do leak.

2.1 A World View

As an attempt at summarizing the world view underlying AMSIDO, the following could suffice.

The world is composed of a network of system hierarchies, which can be described on a large number of different levels. A phenomenon to be studied must first be examined on its own level, immediately within its supra-system, in order to identify its interactions within that supra-system.

At the level of analysis being conducted, all component parts are viewed as black boxes: They have an input with a given format, and an output with a given format. The internal processes are not known.

For each of the black boxes a decision then has to be made for whether the box should be opened and analyzed on a deeper level, or if the box should be emulated. In the latter case, a model producing reasonably similar I/O patterns has to be constructed, with the idea that many different internal structures can produce the same the same overt pattern, and that the "real" internal structure therefore does not necessarily have to be copied.

2.2 A Self-Critique of Existing Beliefs

The following is a theoretical evaluation of some of the views and beliefs we have entertained during the AMSIDO project.

2.2.1 Implicit Beliefs

Without discussing the specific detail issues with method, what beliefs have we implicitly accepted? It is our experience that we have taken a few points for granted so far in the project:

1. The best way to measure/approximate how information propagates in a complex organization is to construct a simulation of the situation we want to study.
2. Since the situation is highly complex, too reductionist simulation models are likely to fail.
3. The way to avoid being too reductionist is to adopt an object/agent-oriented approach within a micro world.
4. The method for constructing an object/agent functioning in this micro world is to study the real world and try to copy it as closely as possible.

Now, can we really accept this reasoning as being self-evident and the only way to reach our goal? Is there a need to challenge it? In the following, we will suggest that the first three beliefs are reasonable to retain, while there are good reasons for abandoning, or at least modifying, the last.

2.2.2 Do We Really Need a Simulation?

This is a rather important question: Do we really need a simulation to measure, or at least approximate, how efficient an information system is?

2.2.2.1 Reasons for Using a Simulation

While not being entirely common, and while sometimes being frowned upon, using simulations in social sciences is an established method (see the "social simulations" sub report). Thus, it can not be said that the use of simulations is an obscure and invalid approach. This said we do not yet know anything speaking in favor of it.

To be able to determine why simulation is a good approach, we would need to consider the alternatives. As we see it, there could be two main alternatives: The statistical and the mathematical measurements.

Using a statistical approach, we could measure how well a number of existing base types of information systems work, in order to acquire statistics about the speed of which information distributes given some basic parameters. Then we could add empirics about probability numbers of how likely it is that information arrives in time given the number of information points separating the source and the destination, and expand the model with probabilities for transmission noise in the channels. In the end we might arrive with a set of probability constants that we could combine for each new information system. The way to predict how well a new system would perform would be to consult statistics about how similar systems had performed, and number about how the known component parts had performed in other situations.

The mathematical approach would include constructing score constants to include in a concrete formula. The constants could include scores for how well the information distributes based on the number of people, machines, transmission steps and interactions required to distribute the information from source to destination. As an example, with two persons talking directly to each other with no intervening machines, the calculated efficiency score would be higher than if there was a whole organization and several machines in the channel between the to persons.

So why should we not use one of these approaches? The simple answer is "because of complexity". In an organization with, say, 40 people and 200 information points, the number of possible interactions are so great that it is likely not feasible to calculate a concrete score using a mathematical approach. Because of the complexity, it is also not very likely that it is possible to find general enough base types of information systems: They would be too many to be practical to handle.

The problem we have with the complexity is that we simply do not know about all the possible interactions at the time when we model the situation. Since we do not know about the interactions, we cannot take them into account using a calculation. As an example, how could we take into account that two people meet when one is on his way to the coffee room, and the other to the fax machine?

With a simulation, we can avoid this problem by letting all those interactions happen in the way they would happen in the "real world". We do not need to know about them in advance, as long as we have included functionality for encounters in general.

As a summary, the reason for using a simulation (of the type discussed below), is that we can handle a lot of complexity without removing it. The complexity is inherent in the situation, and if we remove it, we are not likely to have constructed a good view of the modeled situation.

2.2.2.2 Reasons for not Using a Simulation

This said it is not entirely uncommon to argue that in order to ensure validity in computer models, those models must be simple and not contain too many variables, but that such a model is to reductionist to be usable in social science. Or, to use Troitzsch's diagnosis of the historical problems with social science simulations:

> *Either models are simple enough to be linked to the empirical data that are at hand but […] may fail to be appropriately complex to explain reality […] or the model is so complex that any empirical analysis must fail due to the enormous number of parameter that have to be estimated from the empirical data.* (Troitzsch K, 1998)

We tend to disagree with the view that simulations necessarily have to be simple, partly because of the difference between "copy" and "emulate" (see discussion below), but primarily because of the object-orientation concept of encapsulation.

The idea with encapsulation is that each object has a simple interface protecting its internal complexity from the surrounding environment. The interface defines how it receives input, and which format the output has, but not the actual contents of those. How the process of transforming input to output is constructed is not for the *environment* to handle.

In a well-structured computer program, all component parts are modeled this way: Each component hides its internal complexity, and only defines an interface for communication externally. What we do when we model the components, is to study the format of the input and the output of each component part in order to emulate those. At the time of modeling the large-scale simulation, it is not necessary to know the state variables included in the physical navigation of an agent in the modeled arena. Those variables do not exist at the level of the simulation as a whole, as they are encapsulated within the agent, or possibly within a navigational subcomponent of the agent. Those state variables are only interesting at the time of modeling that subcomponent.

The object orientation philosophy and technology is mature and has been established for some time within the computer science field as a whole. In social science simulations, the wording may be a bit different, but ideas similar to object orientation can be found in thoughts concerning multi-level process modeling (see as an example Troitzsch (1998)).

Of course, the above presupposes that we have already decided that a simulation is a good thing. It does not discuss the social reasons for not constructing a simulation, such as issues with power balances between leaders and led within the organization. The above is simply a discussion about whether a complex simulation is technologically feasible and scientifically possible. Whether the simulation is, to use SSM wording, systemically desirable and culturally feasible, is an issue which we do not address here.

2.2.3 Model Families

Flood and Jackson (1993, p153-154) presents a list of basic model families: The sentential, diagrammatical, mathematical, statistical and logical model families. While we might not agree with all their conclusions about the appropriateness of each (as an example, they seem to have a bias in favor of strictly mathematical models), this seems like a good summary. We may further feel that, while we certainly have utilized these base models in the various parts of the AMSIDO-project, they do not correctly describe what we have done as a whole.

So far, the bases of most of the models underlying our simulations have been formulated in a diagrammatical manner. However, when moving them from conceptual model to implementation, they have usually been reformulated in a mathematical/logical manner. That is to say, they have been reformulated along the lines of *"When agent A meets agent B, they exchange C packets of info if criterion D is true"*. When programming, it is somewhat difficult to directly map a sentential or diagrammatical model into code, hence the reformulation.

So is the model we use logical or mathematical in the modeling sense? The answer may be somewhere between yes and no. The answer may also be that the question is wrongly put, and

that the modeling approaches we use do not easily fit into the above five somewhat "barebone" models.

Perhaps a bit drastic, we nevertheless presume to claim that those five base models all presuppose a strictly determinist and clockwork phenomenon. They do not take into account that the phenomena we try to model may be dynamically changing and not possible (or at least not feasible) to describe as one sequence of events nor even hierarchy of events.

We will therefore here suggest a new model family, the "black-box container" modeling approach. In this approach, the model is broken down into black box objects, which are supposed to have enough intelligence themselves to realize what their behavior should be in each situation they find themselves in. The model itself is the container (in our case the "Arena"), the black box objects placed within the container, and the (logical, statistical or mathematical) rule applying to the container itself.

Now, in this view, the black box objects are all modeled in a strictly deterministic way. They all implement an input-process-output form of model, which may be any of (or possibly combination of) a logical, statistical or mathematical model.

The basic proposition here is that when asked if we are following a statistical or mathematical approach for describing the phenomenon we are trying to simulate, we cannot answer, since we follow neither. The basic objects do, yes, but the *simulation as a whole* does not. The whole idea with the micro world approach is that the phenomena modeled are too complex to simply calculate in a probabilistic or determinist manner.

2.2.4 Is the Agent-based/Micro-world Approach Preferable?

With the black box approach to the modeling, we can begin to ask ourselves about the best way to implement this. We must also ask ourselves if there is a feasible alternative. Clearly we need at least some correspondence between the underlying model and the simulation we construct.

Given the literature inventory presented in the subreport "Social Simulation", we think that there is good reason to retain this belief. In social simulations, the wording we have used may not be the same, but what we are aiming at seem to be reasonably similar to DAI and multilevel simulations.

2.2.5 Copy, Represent or Emulate?

We feel that we during the modeling phases sometimes have been a bit vague about the approach for the process of moving the reality into the simulation. Sometimes we have implicitly claimed that what we do is to study the reality in order to find the algorithms underlying it, and then implement those algorithms in code. This is something which could be called "copying" reality, or in the wording of social simulation "deep modeling".

Other times what we seem to have claimed that what we do is to study the reality in order to see the general patterns. These patterns are then something we have tried to reformulate in

abstract terms, and within models. The idea here was that while we do not try to copy the world, we try to *represent* the phenomena we study, a bit like in an impressionist painting where no part resembles reality but where the wholeness is a good representation of it. With this view, we are still trying to find some sort of correspondence between the internals of the "real" objects and our models of these. The correspondence might not be a copy of the internal algorithms, but rather like a psychologist's model, such as in the information-processing paradigm, of thought processes.

A third approach we sometimes seem to have been adopting is to study the objects in the reality, with focus on their input and output. In this approach we drop the notion of internal correspondence of the entities in focus. Rather, we try to *emulate* the objects, with the idea that as long as the important I/O patterns are reasonably similar, there is no harm in viewing the entities as black boxes on the simulation level.

We will here claim that that the last approach is preferable. The goal is to study the overall effect of the cooperation and interaction of the objects. Our goal *is not* to study the internal state of the objects as consequences of this interaction. The internal state is simply there to produce a believable output based on the inputs. It is not only conceivable but even probable, that there could be large numbers of different internal models that would produce the same results.

Now, with this approach, can we still be said to model reality? If there is no internal correspondence, can we still be said to have done a simulation of the reality we study? We will here lean on the words on Schmidt, where he discusses the differences between a model and a replica:

> *A model of the human being is always fundamentally different from the human being himself. Nevertheless, a model is useful and meaningful. Many critics [...] confuse a model with a replica and because of this become engaged in incomprehensible polemics.* (Schmidt B, 2000, p20).

In our situation, we claim that this approach is valid for all the entities we model, and not only for the representations of the humans.

3. Some Words about Method

The literature inventory in this report collection was necessary. The focus of the sub report was (as can be concluded from its title) "social simulation", or more closely on the merge between social science and simulations. However, it could have had another focus, like as an example, technology. We do believe that the social science perspective must come before the technological perspective though.

The purpose for which we use the tool is more important that the structure of the tool. This is something which has been the focus of fair critique of the first phase of AMSIDO: That we started with having a method, and not until after that formulation began to examine what we were going to use the method for.

Concerning the validation of the models developed during that phase it can be said that such a validation was, and still is, necessary. Before continuing with software development, it would be good to have at least some input indicating whether the underlying models are reasonable.

Our expectation was to be able have a seminar with people who knew the exercise activity, and who at the same time were interested in our project. That seminar was unfortunately not possible to conduct, since only one person was interested in participating. In the end we had to be satisfied with have a discussion about our model with that person. Even if the discussion was very good, we think a seminar with more participants would have given more and more relevant feedback.

However, the validation also consisted of a more general data collection, since this was the first opportunity to study a real exercise. Our opinion is that it had been useful if the data collection had concerned more exercises, because the result would then have been more general. The details of the validation can be studied in the sub report "Validation and Data Collection":

The more theoretical evaluation (contained in the sub report "AMSIDO-1 Models"), was conducted through discussions between the project participants. As this report just lists the state of the models and some critique of them, it should not be seen as something final, but rather as a complement to the other material in the report collection.

4. A Synthesis of AMSIDO-2

During AMSIDO-1, most of the effort was aimed at developing a software prototype. The study of the reality was mostly directed at understanding the background of the organization, in order to model the entities (humans, information points, information and arenas).

The focus during AMSIDO-2 has been to study different theories and do a survey of what has been done so far within the field. This has been combined with theoretical and empirical evaluations of the work so far, some data collection, and some remodeling of existing entities.

AMSIDO-2 is presented here as a synthesis of the sub reports in the project. Only those results interesting for the discussion here are included below, while other results may be excluded. For a more detailed view of the result as a whole, please refer to the sub reports.

To reiterate, the focus of AMSIDO-2 has been on a theoretical inventory and on evaluations of the work so far. In short, the findings of the "validation and data collection" were that overall model was acceptable, but that it should be refocused. The findings from the "social simulations" were that an agent approach is preferable to more limited models. These findings will be discussed in more detail below.

4.1 The Model Hierarchy of AMSIDO-1

The first question is of course if the AMSIDO-1 model can be said to be valid.

The model we discuss here is the overall model that contains four entities: Arena, Information point, Information and Automata/Agent. Given the discussion in the sub reports "social simulation" and "validation and data collection", we feel that the entities as such are still valid to use as a base. However, we feel that focus has to be shifted somewhat towards the agent entity.

Concerning the specific entities, the *information points* can be seen as the technical network that the agents use for distributing information to other agents. Information points are, for the purpose of the simulation, just a sort of carrier of information between agents. The purpose of the simulation is to study the whole information system, both the technological and the social networks; therefore information points are important, but only in their quality as information carriers.

In Bergkvist's and Kristoferson's study (see report "Information Node Characteristics for Model Construction") one can read more about information points and their qualities. All the proposed qualities are not necessary to implement if the focus is to describe the information points as only carriers of information.

The *information* entity is a much more abstract concept to define and handle in this simulation. The information represents all the interactions between the agents and it is also a base for the knowledge inside the agent. This knowledge is necessary in order to reach the goal the agent has: the goal of problem solving and in the case of the exercise, making decision.

When information only represents interaction, it is possible to handle it *"as a kind of token without any intrinsic properties"* (See AMSIDO-1 models). When the information is something more than just a representation of interaction 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 carry the information may also have some sort of qualities like the ones Holmström and Koli describe in the report "Making the Concept of Information Operational", especially in order to fit together within the technological network.

The *arena* is what it is, and we have not found much to comment upon concerning it. It is the least complex and most easily observed part of the simulation.

The *agent* representing the human in the organization is the most important and complex entity within the model. Therefore it is described in more detail below. It should be noted that the name for this entity so far has been "automaton", a term which has been dropped in favor of "agent".

4.2 The Agent Entity

The "agent" entity represents the human in the simulation. This entity is supposed to contain everything from simple navigation to decision making concerning human behavior.

4.2.1 The Focus of the Simulation

Earlier during AMSIDO, the focus of the study has not been entirely clear. It has sometimes been implicit that the focus is the information points, and sometimes that the focus is some relation between automaton and information point.

We feel that the focus need be made explicit, and our proposal is that the agents become the central focus. The result from the validation is unambiguous; the agents are the most important parts of the information system. This could of course be said to be obvious: An information system (at least following the definition we have, see the glossary) can exist without information points, but it cannot exist without humans.

4.2.2 Modeling the Agent

The "social simulation" sub report describes a lot of research concerning social simulation. Not all of this, or even a very minor part of it, is relevant to reuse. However, it is useful as an input for which parts to focus on when developing the agent model.

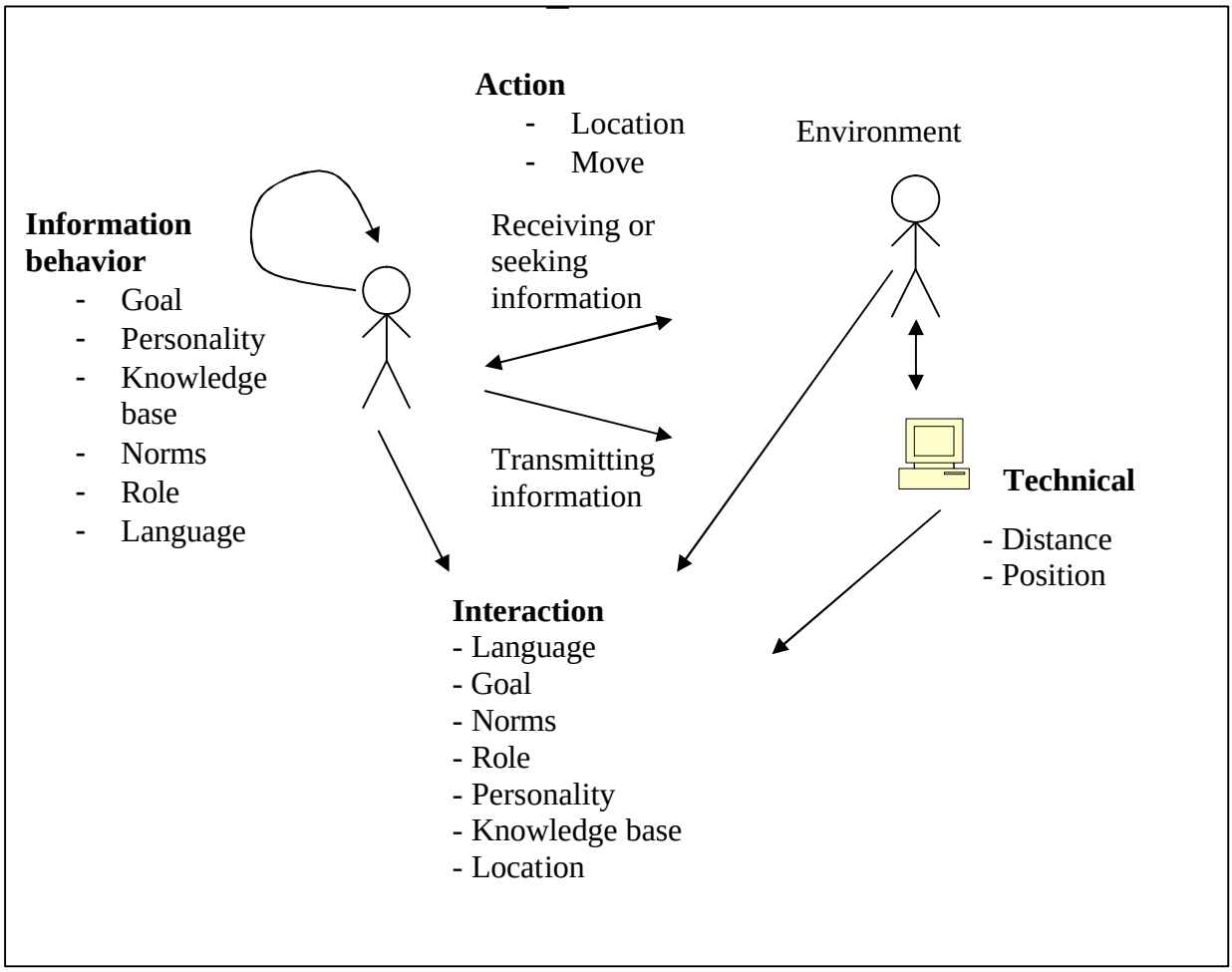


Figure no.2: Modeling the agents

Given the black box model approach described above, the modeling of the agent must be described on different levels. On the level of the simulation as such, the agent is a black box,

which accepts an input formatted according to certain rules, and which outputs a behavior formatted to other certain rules. However, in order to make a believable emulation of the agent (indeed of all the entities), the agent black box has to be opened and studied on a lower system level. This system level does, in its turn, contain several other black boxes representing subsystems of the agent. Some of these black boxes are mentioned in the figure above.

The decision about which boxes to actually include, and which theories or models these boxes should build on is a later question, to which we do not have a good answer yet. However, it could preliminarily be mentioned that the agent/agent and agent/technology interaction is the kernel of the project, and that thus the subsystems influencing this are the most interesting. As an example, the navigation subsystem of the agent could be said to be a prerequisite in order to get any interaction at all.

Even though it may be a bit early to decide upon model components yet, there is a further discussion about possible parts to include to be read in the "What needs to be done" section.

4.2.3 Delimitation of the Agent Model

If the current case scenario is dropped, we will have to consider the delimitation made previously in the project. The most limiting aspect is that the case scenario only spans over one or a few days, something which by necessity exclude factors like the development of norms over time.

5. What is it that we are doing actually?

The main incitement for the work done during the AMSIDO-2 phase was the completely justified critique that we were not basing our work in earlier research, that we did not even know about the possible existence about such research, and that we therefore were likely to reinvent the wheel.

The literature inventory of the social simulations field has of course been enriching and has given many useful inputs. However, still after having done this inventory, we do not feel that what we are doing is to be found in existing research. We believe that the inventory we have made is as encompassing as could be possibly expected, what with a reference list taking up five pages in the social simulation document. Still, after having read all this literature, we still have not found anyone having approached some of the most important problems we perceive.

The thing is that social simulations so far mainly have been aiming at studying *simple and reduced phenomena*. Many examples of this can be found in the sub report. However, we have so far not seen anyone trying to construct a simulation of a *complex macro phenomenon while retaining the necessary complexity*, which is what we are aiming at here.

Why is this so? Models, at least diagrammatical models, describing such phenomena exist within both informatics and other social sciences. We could speculate about compartmentalization of science, or lack of necessary computing power, but will refrain from

doing that. We will only state what we have found: For better or worse, we simply do not have much to lean on for the construction of a simulation of the kind we intend.

On the *macro level* in the simulation we are working within a field with little or no previous research. This should, however, not be confused with the lower system levels though: there is a plentitude of models and implementations describing the various *micro* phenomena which we want to include in our macro model.

Because we need some sort of label when discussing the field, we would like to call this field HCSS - Highly Complex Social Simulations. This field would be defined along the lines of aiming at encapsulating necessary complexity on different system levels rather than handling it through reduction. This is by no means something which replaces existing methods and models; rather it should be seen as an added layer for combining several micro-models into aggregations and larger models.

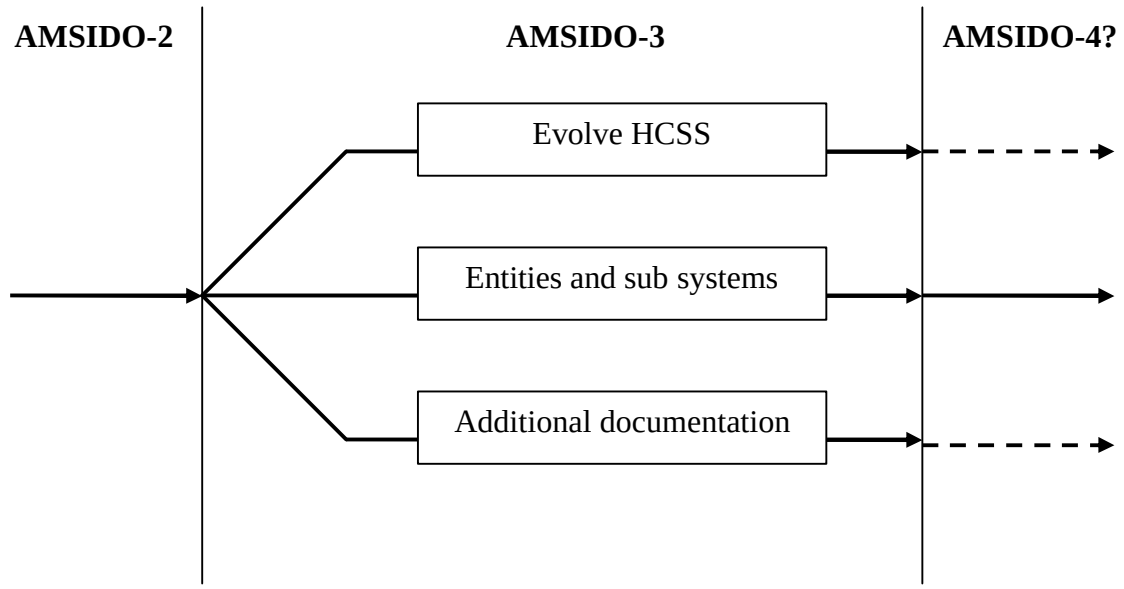
Now, there are of course at least two obvious comments or alternative interpretations that may be suggested after having read the above.

The first is that we may have missed the existing research within the field, that there may be a lot written about it, only just not within the literature we have found. Well, this is an "unknown unknown", and there is not much we can do about it.

The second is a bit worse: That the reason no-one has done this is because it is a stupid idea which is unnecessary to even contemplate. We are of course aware of several authors claiming that simulations should be kept simple because of reasons mentioned in the section about world view above. We disagree both because we think it is not necessary (also because of the discussion above), and because we believe that any attempt to describe a social system in general, or an information system following its full definition in specific, in such simplistic terms would need such a reduction as to render the resulting simulation useless.

6. What needs to be Done?

The following is what we suggest for the immediate continuation of AMSIDO. The specifics of the continuation need to be discussed further, as there could be several ways of focusing and prioritizing the project parts.



6.1 HCSS

The HCSS approach will require some work if it is to be usable. First the view, its merits, its assumptions and its method should be made explicit in order to properly define it. It seems reasonable that this program statement could be contained with one article or similar. The writing of this is not something which should be expected to be very difficult. The difficult part is to make probable that the approach is valid.

The HCSS approach (or rather "meta-model") will evolve dynamically over time. The development and specification of it should be conducted in parallel with the more practical parts of the project.

6.2 Entities and Sub Systems

The agent entity needs an overhaul. A basic conceptual model has been proposed in the "social simulation" sub report, but the specific parts of the model still need to be identified and properly defined. Some suggested areas for further investigation could be:

- ? The important bases for interaction: Navigation, language (for interaction), sensors
- ? Bases for organization-controlled behavior: Norms, organization, identification, locations

- ? Bases for drive-controlled behavior: Needs such as hunger and tiredness
- ? Bases for teleological behavior: Goal, memory
- ? Individual bases for behavior: Knowledge base, personality category
- ? Multi-level analyses of group behavior: meetings and group-specific behavior

The first step of the agent overhaul would be to complete this list. For each of the subsystems, an inventory of relevant psychological and sociological models should be made before actual modeling. As an example, a combination of social network analysis and actor network theories, with Bales three-dimensional model of group member's social interaction style, could be investigated as a base for the group behavior. Another example could be Winograd's and Flores' research about language and cognition when looking for approaches in the agent/agent interaction.

The other entities in the model (primarily "information" and "information point") need to be studied further and adapted according to the changes done in the agent entity. As an example, if a "language" is implemented in the agent, this needs to be reflected within "information" too.

6.3 Additional Documentation

Alongside with the other work, the documentation of the AMSIDO project should be complemented with a number of documents which have so far been missing. One of these documents is a complete specification of the case scenario, something which we have felt is lacking currently. Today we include pieces of this description in every new document, which is not optimal.

Further, the social simulations overview should eventually be complemented with a technological counterpart: a discussion about the implementation aspects of the social simulations techniques.

7. Glossary

This glossary is a limited list with definitions of terms used in this document.

Information
Information is an abstract concept which is not easily to define. The closest (short) definition fitting the way we use it in AMSIDO, is "message". A longer definition and discussion about the concept can be found in the sub report "Making the Concept of Information Operational".

Social system
The specific meaning of the concept in this report is: A social system consists of acting individuals and the interaction between these.

Information system
An information system is all that, within an organization, that participates in distributing information between humans, such as the humans themselves, routines, policies and technological artifacts.

Information point (or "technical aid")
In AMSIDO-1, the information points were defined as "physical objects with the ability to receive, store and transmit information packets". "Information points" and "technical aid" will be used in this sense in this report. In Bergqvist's and Kristofersson's paper the word "node" is used rather than "point", but it has basically the same meaning.

8. References

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