The Process Model of Problem-Solving Difficulty

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Abstract

Groups and organizations, or in general multi-actor decision-making groups, frequently come across complex problems in which neither the problem definition nor the interrelations of parts that make up the problem are well defined. In these kinds of situations, members of a decision-making group have disagreements on what the problem is and/or how it should be solved. The study reported in this paper represents a causal loop diagram, which brings together different causes that lead the group members into disagreement. In this way features of individual and group decision-making can be integrated in a coherent framework. By analyzing the problem from a feedback point of view, we hope to clarify the self-perpetuating quality of these problems. The main feedback loops in this model were identified with the aim of pointing out key issues to keep in mind for interventions in complex problems. A small portion of this model was also quantified to show the possible creation of a sustained disagreement situation.

1. Introduction

Groups and organizations that need to solve a problem together, very frequently, have difficulty in solving their problems. According to March and Simon (1993), the necessary conditions for inter-group conflict are a felt need for joint decision-making, difference in goals and/or difference in perceptions of reality. March and Simon calls these interpersonal inconsistencies in preferences or identities: " different people want different things, and not everyone can have everything he or she desires. Different people have different identities, and their different definitions of appropriate behavior are mutually inconsistent". Moreover, groups also face various problems of communication and coordination which can affect the communication quality or decision-making groups, lead to stress and motivational problems, and create undesirable or no solutions.

The aim of this paper is to bring together the factors that are at play at multi-actor decision-making situations. We will relate the processes using a causal loop diagram, identify feedback loops that can lead to disagreements, and finally, point out key issues to keep in mind while intervening in groups. This causal loop diagram will form the basis for a formalized system dynamics model.

2. Disagreement

March and Simon (1993) state that differences in goals and perceptions of reality are the necessary conditions that lead groups or organizations to conflict. Taking this to a more general level, we can say that disagreement in a problem-solving group arises from differences in the mental models of individuals. Richardson et. al. (1994) classify types of mental models that are used by individuals to decide on which action to take into three groups: ends, means, and means/ends models. Ends models describe the goals people keep in mind when considering interventions in a problematic situation, while the means model represents the steering points in a problem. Means/ends models capture the relation between intervention points and goals and reflect assumptions on how a system functions. The three types of models jointly help people decide on what the problem is and how they can solve it. So, if people would hold differences in any of these three types, disagreement between the members of a problem-solving group can arise. We are going to classify disagreements broadly in two groups: (1) disagreement on problem definition and (2) disagreement on what to do. When the perceived reality deviates from the desired situation, a problem is said to exist. However, different people can hold different perceptions of reality as well as different goals/desired situations. Therefore, we can say that disagreement on a problem definition can arise due to differences in perceptions of reality and/or differences in what the desired situation (i.e. the ends in Richardson et. al.'s framework) is. The second type of disagreement is related to how people would like to solve the problem at hand, i.e. disagreement on what to do. By what to do, we mean the means and strategies that one would like to use to solve a problem. Strategies and solutions are derived by analyzing the problems we have by using the assumptions we have on how the world around us functions. Therefore, if people define the problem in different ways and/or have different cognitive models (i.e. assumptions) on how the system functions (means/ends model) then this can lead to differences in strategies and solutions they find.

So to summarize, differences in goals and perceptions can lead to different definitions of the problems. This disagreement, in turn, together with differences in assumptions people hold with regard to the structure of the system would lead to disagreement on how to solve the problem. Overall disagreement a group would have is then a function of the disagreements on the problem definition and what to do in order to solve the problem. Figure 1 shows how differences in perceptions, goals, and assumptions held by people can lead to disagreements on problems definitions and on what to do, which in turn jointly create the disagreement.
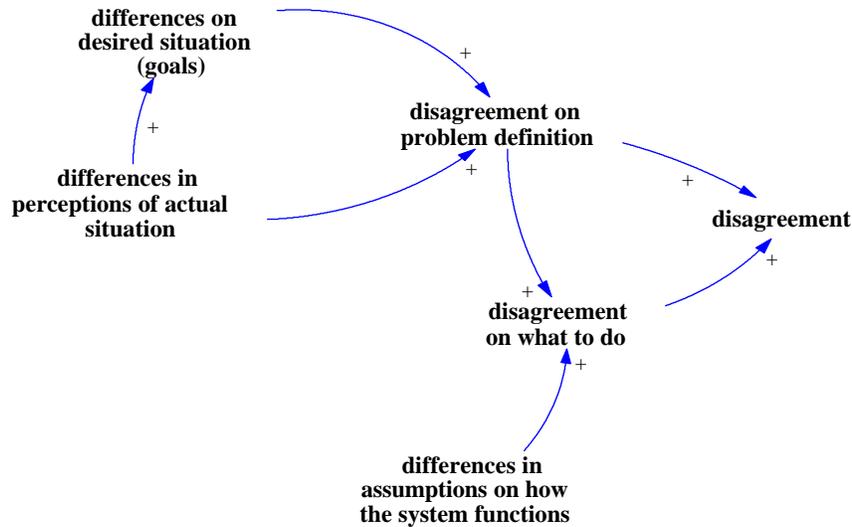
Figure 1: Main differences in mental models of individuals that lead to disagreement

What is important to examine is the reasons of the differences that lead to disagreements. If we know what the causes for the differences are then we can better focus our methodologies to alleviate these causes. There are basically three areas that lead to the divergence of opinions:

- Differences in the usage and interpretation of information leading to differences in perceptions (e.g. March and Simon 1993, Cartwright and Zander 1953);
- Poor communication quality leading to people talking past each other;
- Poor analysis quality (and differences in analysis done) leading to disagreements on what to do.

In the following subsections we will deal with each of these three areas separately.

2.1 Information

In this subsection, we will explain the effects of information usage on the differences that exist amongst the group members. As far as the information usage is of concern, the differences in the perceptions of people can be due to (a) _differences in information used_; different individuals attend to and collect different types of information while forming their perceptions of reality. For example, an production manager and financial manager would tend to be interested different sources of information and (b) _differences in the interpretation of information_; even though different individuals would be presented the same information, how they value this information would differ from one another based on the characteristics, past etc. of the person who is processing the information (Vennix 1996). Vennix gives the example of the interpretation of the level of an inventory. Some organization members interpret it as too high, since keeping a stock of inventory is costly, while others see it as too low since it ensures rapid delivery to customers. Below we will explain both differences in information used and interpretation in more detail and place them in the causal loop diagram.

Individuals routinely collect and process information. Perceptions of reality are based on this information. In the environment of organizations, there are many information flows. Neither available time nor the cognitive capacities of human beings is sufficient to attend to all these information flows. Complexity of the environment (time pressures, the vast amount of information sources, uncertainties) coupled with limited information handling capacity of individuals leads to the usage of filters and simplifying procedures (called heuristics or rules of thumb) in scanning the environment and processing information (Hogarth, 1987). As a result, only a few of the existing information flows

reach the decision-makers and influence their decision-making. So individuals selectively perceive their environment and this perception will be a function of the filters used. These filters are largely a function of individual experiences, mental models, and organizational functions and positions. Therefore, different individuals will tend to focus on different sources and types of information. Since information forms the basis of our perceptions of reality, the higher the extent of differences in information used, the larger will be the differences in perceived reality. Moreover, even if the same information sources would be used, different people can interpret them in different ways due to differences in their mental models. Since people hold different assumptions on how the system around them functions, they would attach different meanings to the same information.

We will now explain the effects of information scanning and processing in more detail (please refer to figure 2). The first factor that affects the differences in the perceptions is the differences in information used. As explained above, the differences in information used is largely due to different filters used by different people. This is called the selective bias. Our filters lead us to select information in a biased way. The different filters arise due to differences in the functions held by different individuals, differences in the perceptions[1], and differences in previous experience[2]. These three factors are shown in figure 2 as linked to differences in information used. There are three other factors that would affect the differences in information used. The first one is the potential number of information sources available (March and Simon, 1993). If there would be less information sources then there is a higher probability that the same sources will be picked. The number of available sources would, in turn, be dependent on the analytical complexity of the problem. If the problem becomes more in analytical complexity, then it would involve more variables and relationships. To have information on more factors and relationships, the decision-maker would be exposed to increased number of information sources. The last but not the least is the extent the information is channeled within the group. By channeling of information we mean the extent the information is shared amongst the member of the group. The more the information is shared; more will be amount of people who are exposed to the same information (March and Simon, 1993). How well the information is shared in the group is a function of the communication quality of the group. Communication quality will be discusses in section 3.

The second factor affecting the differences in perceptions is the differences in interpretation. These are the differences caused due to the way the information is processed. First of all, the way we interpret the information is a function of the information we have. Therefore, the more is the difference in the information people use, the more will be the differences in interpretations. Differences in interpretation is also a result of the differences people have with respect to the assumptions on how reality works and what people think the problem is. Individuals seem to manipulate the collected information to fit it into the way they perceive things (Hogarth, 1987).

If we look at figure 2, we can see that if the differences in information used and the way it is interpreted are not remedied then it can lead to increased differences in perceptions. If people keep on using and interpreting information based on the way they perceive the world then each will get more convinced in their perceptions and the extent of difference in their perceptions will increase. Therefore, the tools we design should aim at decreasing the differences in the way people use information.

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[1] Actually, the way we selectively scan for information is affected by the way we perceive the problem and how we perceive our environment. The model might therefore be extended by including a relation from disagreement to problem definition.
[2] Since individuals seem to search for information with already a solution in mind, a link from disagreement on what to do can be included in the model as well. A solution is based on the previously satisfying alternatives. This is the heuristic of "rules of thumb" or "representativeness". And people have the tendency to reject the information that is disconfirming with the solution they already have in mind (Hogarth, 1987).

Figure 2: The main causes of differences in perceived reality

2.2. Communication amongst the group members

Communication, or rather miscommunication, is an important reason why things go wrong in organizations. People holding different viewpoints do not pay attention to what the others in the group are saying. According to Schein (1987) we may at any time observe the content and the process of communication in a group. Over time, the recurrent patterns or communication structure may be identified. As a first start of characterizing communication, we will look at communication process quality and communication content quality.

Communication process quality represents how the well the process involves factors such as openness and willingness to listen to each other's ideas. It is defined by using the following dimensions[3]: open communication, clear and understandable communication, equal participation, opportunity to address issues about which opinions diverged, pragmatic and clear focus, attention to each other's ideas, and absence of dominance of the discussion by participants. These dimensions originated from a scale first used by McCartt and Rohrbaugh (1989) and later by Vennix, Scheper and Willems (1993) and Rouwette, Fokkema, Van Kuppevelt and Peters (1997). In order to keep the model as simple as possible, we will reduce these seven dimensions to three variables in the model. Open communication, clarity and understandability, equality of participation and absence of dominance are all captured under open communication. Pragmatic and clear focus is included as communication complexity. Third, there is the motivation to listen to others, which captures the attention to listen to other's ideas.

Openness of communication is an indicator for communication process quality and therefore has a positive influence on communication process quality. However, openness of communication will be hindered by biased communication, which is a result of lack of motivation to listen to others. If the communication in the group is not going well, then this would increase the feeling of frustration of group members leading to stress and less motivation to listen to others which would lead to decreased communication quality but also to biased communication which would hinder the openness of communication. Following the theory of procedural justice (Korsgaard, Schweiger and Sapienza, 1995), we can also say that openness of communication also has a positive influence on 'people feel

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[3] McCartt and Rohrbaugh include "absence of time pressure" which is omitted here because it seems more of an external factor. Even when there is time pressure there can still be a high quality communication. In addition, the variable 'stress' which is included in the model can be taken to represent the effect of time pressure on individual performance.

acknowledged', which increases their motivation to listen to others. Moreover, if the number of parties involved will increase the quality of communication will decrease.

Apart from communication process, communication content can be addressed as well (Schein, 1987). Janis and Mann (1977) describe the relevant aspects of communication content. In their view, communication is adequate to the extent it covers all relevant aspects of a decision: all options, goals, values, risks, and costs. In addition, all positive and negative consequences, conditions and contingencies should be addressed and all information for weighing options should be analyzed, resulting in an integration of all relevant information. If these dimensions of a decision are covered, Janis and Mann speak of vigilant information processing. It is clear that when a problem increases in analytical complexity (contains more variables, relations or loops) it grows more difficult to cover all options or goals etc.

Communication process quality and communication content quality are related, as described by Janis and Mann (1977). In the extreme of groupthink, the very low communication process quality leads to a low content quality. So it is reasonable to include a relation between quality of process and content. This is modeled as a direct relation. We also included complexity of communication in the model as a function of disagreement. Complexity of communication lowers communication quality. Lastly, there is the indirect effect of information processing quality, which changes under the influence of stress (included as an element of process quality) and influences communication content quality.

Increase in both communication process and content qualities leads to better results in terms of decreasing the existing differences between decision-makers. Communication content and process qualities together determine the overall communication quality. An increased communication quality enables the real differences of viewpoints to be addressed and would enable sharing of different aspects of mental models. Therefore, it generates alignment of perceptions and desired situation. Moreover, with the increase in communication quality the channeling of information in the group can increase.

Figure 3 includes the variables related to the communication sector in the model. The most important loop involved in this particular model is the loop that states that the higher the communication quality the lower will be the differences in perceptions and goals and thus lower will be the difficulty to solve the problem and as the difficulty to solve the problem decreases the complexity of communication will decrease leading to even higher quality communication.
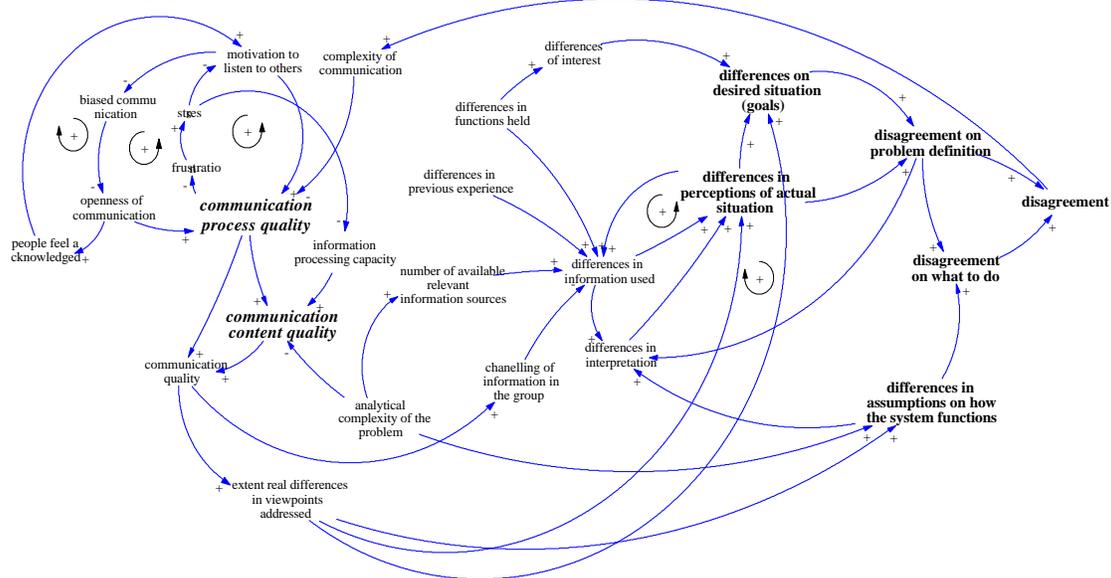

Figure 3: Effects of communication quality

2.3 Problem Analysis

In addition to the use of information and the communication process, the analysis of information also has an effect on disagreement within a decision making group. Different group members will have differences in assumptions on how the system functions because most of the time these assumptions are implicit and it is difficult to communicate assumptions when they stay implicit. Moreover since people use different analysis procedures to decide on what to do, there occurs a disagreement on what to do. We will call all these into one variable called the analysis quality. Analysis quality is determined by several factors such as time pressures, satisfying behavior of individuals. Analytical complexity is also a variable that would affect the analysis quality. If the problem is high on analytical complexity then the system can be defined in many different ways. It would be difficult to validate whose opinion is right. Last but not least, is the effect of communication quality on analysis quality. If the communication is well in the group, it would allow for easier analysis in terms of identifying the system structure.

As the analysis quality increases, the assumptions regarding how the system functions, variables and relationships existing in the real system are made explicit. This would decrease the differences in assumptions on how the system functions leading to more agreement on what to do (the means).

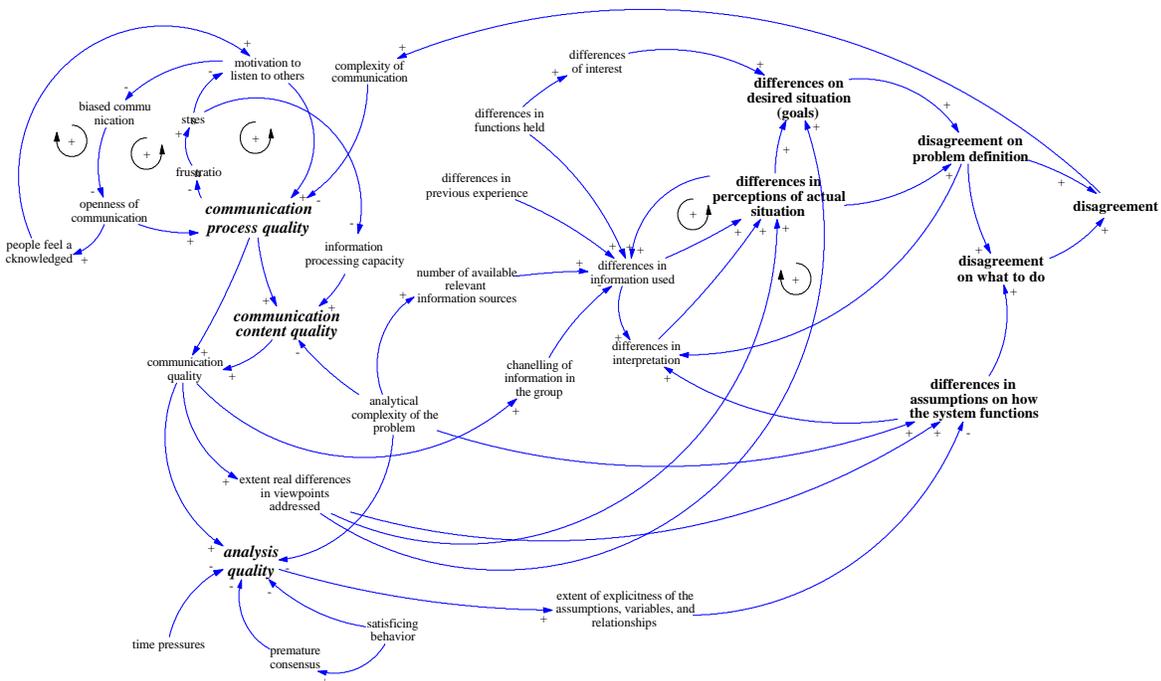This would bring us to the model shown in figure 4.

Figure 4: Overall model linking the effects of information usage, communication quality, and analysis quality to disagreement

The model in figure 4 integrates information, communication and analysis factors discussed in the previous sections. In the following section we will address the feedback loops included in the structure.

3. The main feedback loops

In Figure 5, you can see a simplified version of figure 4. It can be seen that there are three positive feedback loops that can create an ever-increasing disagreement. These loops go through differences in goals, perceptions, and assumptions. If no intervention is taken at an already existing disagreement situation then the increased complexity of communication can lead to low communication and analysis qualities catalyzing the differences in goals, perceptions, and assumptions. Moreover, if the disagreement on the problem definition is not addressed, this can lead individuals to focus on different information sources getting more and more convinced of their own point of view.
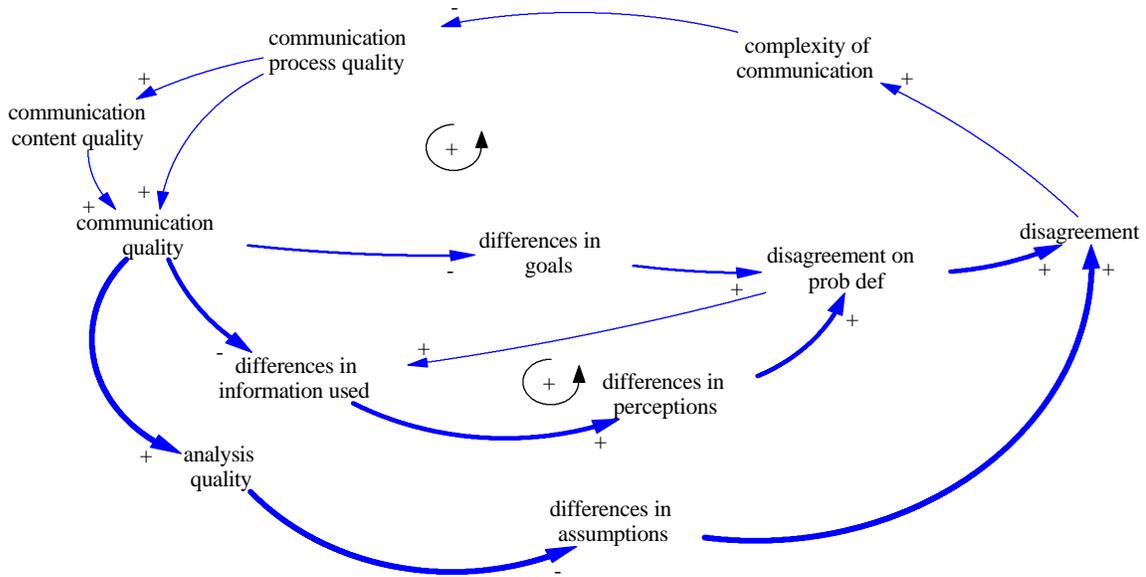
Figure 5: Positive feedback loops.

Other important loops can be seen at the communication process quality part of the model. Unless precautions are taken, quality of communication amongst individuals that have differences of opinions can degrade since people will be stressed and not be motivated to listen to each other. These processes can be seen in figure 6.
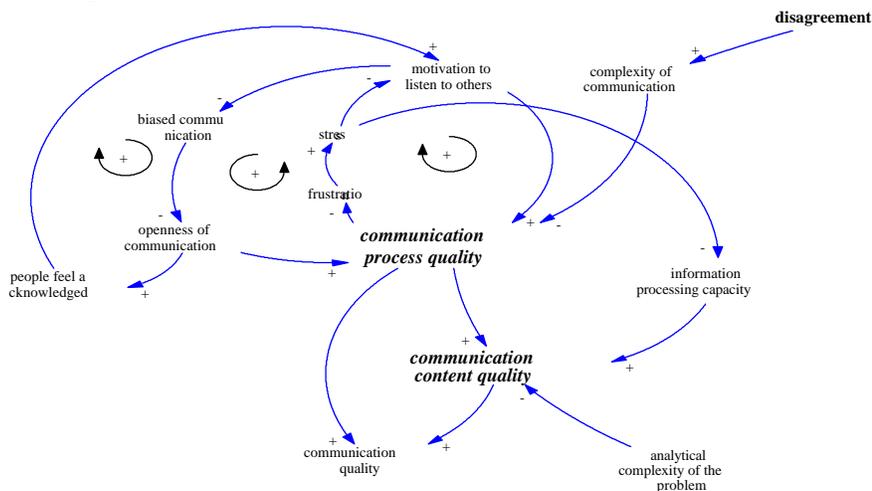

Figure 6: Positive feedback loops around communication quality

This means that when we intervene with groups to resolve disagreements, one has to pay attention to using

- Effective of communication procedures,
- Effective methods to clarify problem and share information, and
- Effective methods to elicit implicit assumptions and analyze the problem.

4. Initial quantification attempt

An initial attempt was made to start with the quantification. The portion modeled is related to the disagreement in problem definition. As can be seen in figure 7, the only portion that is included is the differences in information used, differences in interpretation, differences in goals, and differences in perceptions.
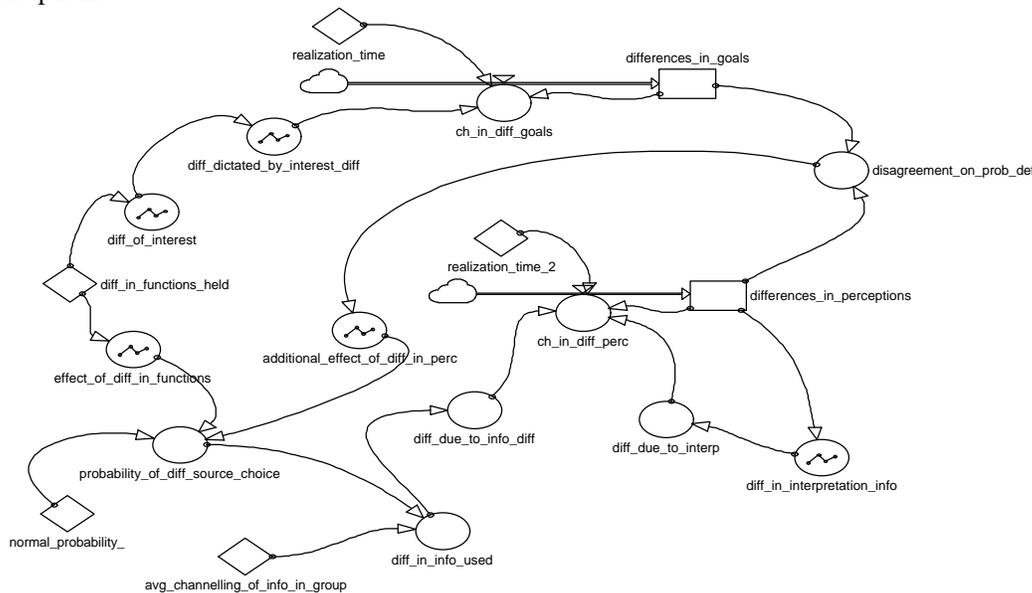
Figure 7: Initial formalized model

If we run the model, we see that without precautions, it is possible to end up with sustained disagreement on problem definitions. In figure 8, four runs are presented. The initial values of differences in goals and perceptions are assumed to be 0. This represents the assumption that initially within the group everybody share the same goals and perceptions and hence, the potential to define a possible problem in exactly the same way. This would mean that there would be no disagreement on the problem definition. Such a situation would represent 100% consistence within the group/organization.

The first two runs show the simulation of a hypothetical situation where everybody in the group assumed to have the same function[4]. In run 1, the average channeling of information in the group is assumed to be 100%, meaning that everybody gets to see all the information that is has been collected. In this case, the effect of having the same functions and seeing all the information available is no differences in terms of either the goals or the perceptions. Thus, the disagreement on problem definition will not exist. In run 2, the channeling of information is 0%, meaning that information that is collected by one member of the group is not available to others. In this case, there is a slight difference in perceptions leading to a slight increase in disagreement on problem definition.

The last two runs show a case where the differences in functions are at its maximum level. This would represent a situation in which all the members of the group have different functions. Runs 3 and 4 show situations where the channeling of information in the group is 100% and 0%, respectively. As

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[4] Differences in previous experiences which is in the CLD is assumed to be part of this variable.

can be seen the differences in functions lead to higher differences in goals. The channeling of information, on the other hand, moderates the effect of differences in functions on differences in goals. If the information is shared in the group to its fullest extent then the effects of having different functions disappears because everybody gets to see all the information collected. On the other hand, if the information is not shared then differences in perceptions increase to higher values. In either of the runs, we can see that disagreement on problem definition persist.
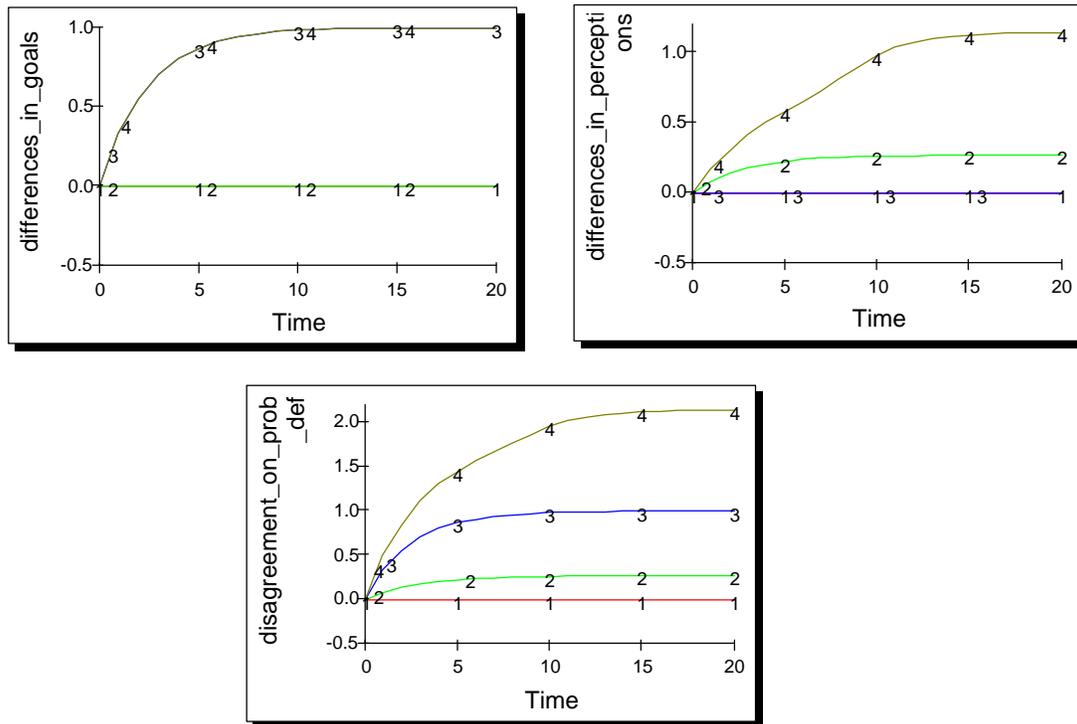

Figure 8: Model runs with the initial basic model

The quantification effort needs to include other sections of the model and be further validated before more definite conclusions be drawn.

4. Conclusions

In this paper, an attempt was made to formulate an integrated framework of decision-making in complex problems. Groups that need to come to joint-decision are often faced with disagreements. These disagreements can arise due to differences in perceptions of reality, differences in goals (desired conditions), and/or differences in assumptions held with respect to how the system functions. The main cause of differences in perceptions is related to how information is used and processed by the individuals of the group. The differences in the types or sources of information used by individuals and the differences in how people interpret information are the basic causes for differences in perceptions. Together with the differences in perceptions and goals, the communication problems are also crucial for the (non-)existence of disagreements.
We have put together all these factors in a causal loop diagram. The diagram sheds light onto crucial processes that are going on in multi-actor decision-making. First of all, if the differences in information use are not addressed, then the perceptions of reality can end up diverging from each other. The reason for this is that individuals will tend to look for information that will prove their point of view to be correct and they will (un)consciously avoid challenging information.

Communication plays a very important role in these kind of groups. If it is not paid attention to then increase stress and motivational problems can lead to further divergence and thus, the problem situation will not be resolved. During these processes, one should pay attention to making the implicit assumptions individuals hold explicit, so that the other team members can share them as well.

The next stage in this project will be building a quantified model of these processes.

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