Innovations in Conceptual Modelling

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Abstract

In this paper we describe the process of building a conceptual model of a guided missile base of the Royal Netherlands Air Force, a complex organisation in the middle of transformation. Based on this conceptual model we developed a policy exercise that is used by the Air Force to explore their future organisation, focusing especially on the communication structure.

We will describe the steps made in developing the model and explain the choices that lead to some methodological innovations in communicating complexity through a conceptual model. We will also describe this model, which consists of 28 actors or actor groups, and between them more than 350 relationships of nine different types, including five specified types of communication.

Furthermore we will look shortly into the possibilities of transforming our qualitative model of actors and relations between actors into a system dynamic model, thus broadening the scope of system dynamics by giving an input from the system analytical approach we use in developing policy exercises.

Innovations in Conceptual Modelling

The problem

The Royal Netherlands Air Force is a rapidly changing organisation. Due to the recent changes in the European military theatre the decision has been made to withdraw the two Dutch guided missile bases from Germany. These two will be combined into the new Guided Missile Base (GGW De Peel) in the Netherlands. The Air Force is also changing its military strategy from a 24 hour alert into the new NATO strategy of few Reaction Forces that can be in action anywhere in the world on a very short notice and Main Defence Forces for the times of war.

The withdrawal and joining of the two bases has prompted a number of other processes of change, mostly initiated by the Working group for the Operational and Logistical Philosophy (WOLF). According to the WOLF concept the base will change from a matrix organisation to an organisation based on a system of integral management. In the old management system the base had three hierarchical levels, in De Peel there will be two. Squadrons will be treated as business units, they will be responsible for achieving their own production targets, and they will have to negotiate with each other over potentially scarce resources. On top of this all production processes will be controlled by a system of process management and integral quality assurance.

The large number of processes of change have some significant consequences. For the people involved it leads to:

- loss of oversight,
- lack of knowledge, and
- feeling of uncertainty.

Therefore the development of the new organisation is accompanied by a lot of discussion in which stakeholders participate from:

- their specific backgrounds,
- their differing levels of knowledge, and
- their specific interests.

To reduce uncertainty about the communication structure and to come to a more fruitful development of the new organisation, the command of GGW De Peel and the Department of Behavioural Sciences of the Air Force Staff have chosen for an interactive and participative development of the communication structure in the new base. This process is facilitated by the Policy Advice Group (BAG) of the Institute for Applied Social Sciences (ITS).

The project

The main objective of the project was to develop an approach that leads to a clear and functional communication structure for GGW De Peel. The process consists of three different phases. Phase 1 started in September 1993 and ended in January 1994. Phase 2 started in January and ended in May. Phase 3 will end in November 1994.

Creating a shared vision (phase 1)

Objective • In this initial phase our objective was to create clarity in the discussion about the new organisation and to develop a shared vision among stakeholders on the way the new base is supposed to function.

Process • We therefore developed a structured process where key actors of the base and a number of officers from the Air Force Staff jointly defined the tasks and responsibilities of the main actors in the new base. They also defined the relations between these actors and they identified a number of potential problems in the structure they redesigned. They also developed several solution scenarios that could respond appropriately to these problems.

Result • The findings were reported in the 'Systeemanalyse GGW De Peel' report, and the conceptual model that is part of this report.

Testing the new communication structure (phase 2)

Objective • In this second phase our objective was to test the structure that was defined during the previous phase of the project.

Process • Based on the conceptual model that resulted from the previous phase we developed a policy exercise (Brewer 1986, Wenzler 1993) in which the communication structure of the new base could be tested. In May of this year 37 key persons of the new base experienced in a simulated environment the new communication structure they defined themselves. They were also able to experiment in a safe environment with their own responses to the potential problems in the new structure.

Result • Based on the experiences of this policy exercise the command of the new base was able to approve those parts of the new structure that proved to be adequate, and to change the communication structure where necessary.

Training the squadron management (phase 3)

Objective • Until now only the top management of the new base was involved in the development process. There is also a need to communicate the consequences of the decisions made in the two previous phases to the middle management levels in the organisation.

Process • For the above objective to be achieved we are currently developing a gaming/simulation exercise focusing on the communication structure of the new base, that will involve the middle management levels in the process.

Result • On the one hand the result is an inventory of problems that can be expected on the middle management level, and on the other hand it is an opportunity for middle management to experiment with potential solutions to those problems. Another result is the transfer of the communication

structure that was developed in phase 1 and 2 to the lower levels in the organisation. In this respect phase 3 is a logical follow up for the two previous phases.

In this paper we will elaborate on phase 1 of the WOLF project: the conceptual modelling and its result, and the visualisation of a shared mental model of the communication structure of GGW De Peel.

Conceptual modelling

Knowledge about the new structure

When phase 1 of our project started we had no specific knowledge about the army. So our first task was to learn what the Air Force did, what their language was, and what types of processes they have. We did this by making a *thematic inventory of policy documents (step 1)* that our client, the Air Force, designated as central for our project. This was done by grouping pieces of text per actor and per process on thematic cards, thus creating a database of everything that was stated in these documents about all the central elements of the WOLF concept and its relation to the new guided missile base.

We grouped all thematic cards on a large matrix on the wall, making distinction between different levels in the Air Force (NATO, Air Force, GGW De Peel, Squadrons). In doing so we were able to learn enough about WOLF, the Air Force and the base itself to be appropriate discussion partners on the issue. We were now able to ask the right questions during the *interviews with the key actors (step 2)* of the new base. The central theme of the interviews, and the subsequent discussion, was the communication structure of the base: how can the Commander and his staff communicate with 9 independently operating squadrons without losing control and without violating the WOLF-concept?

The following task was to translate our knowledge about the communication structure of the base into a conceptual model, described in terms of actors and relations between those actors.

Conceptual model

Together with our client we first decided on the *level of abstraction (step 3)* we would use in the conceptual model of the base. It was decided that squadrons and staff departments in the base would be regarded as unitary actors. In total we distinguished 9 squadrons and 19 staff actors.

As in most organisations, the Air Force uses hierarchical structures to visualise its own organisation: the organigram. However, in visualising an organisational problem it is much more useful to think in terms of a *functional structure (step 4)*. We started developing the functional structure around the primary process of the base, the production of air defence. Air defence is produced by four squadrons (Triads). Each TRIAD go through four different phases (status of alertness) in a cycle of two years: 1) ready to go, 2) maintenance, 3) nearly ready to go, and 4) training. By the nature of their status they have a special orientation towards other squadrons and staff departments. For example: if a Triad has a maintenance status, they have scheduled most of their equipment for maintenance within this period.

Of course their relationship with the logistical squadron is dominant, while their relationship with the staff department that monitors its operational performance is of minor importance.

This was an important aspect of the new military strategy that guided us in giving the conceptual model its shape. We grouped all squadrons and staff departments around the four TRIAD squadrons, using the functional orientation as a guide. After designing this initial structure, we proceeded as we were used to in our previous projects: we attached a 2*2 m sheet of paper to the wall, drew the *actors (step 5)* conform their functional orientation and started filling the actors in the model with literally all the information we had about them.

Of course this information is often formulated in terms of a *relations with other actors (step 6)*. If so, we connected actors with each other. Very soon we were no longer able to read our own model, because it contained more then 175 lines between the actors. Because it was not possible to follow the line itself, and to keep grip on the information, we wrote at the beginning of each line its destination. We no longer looked at the line itself, but the text at the beginning of the line told us at which actor to look. We then realised that this is an important concept to deal with large quantities of information. We developed this logic further: if you know the destination of a relationship line, you don't need the line itself, but you could use abstractions of this line. These abstractions, we call them highways, could be used to represent something else, for instance the communication structure of the base. More over: if we give information about the destination of a relationship line, we could also attach information about the content of that relationship. We regarded this as the **first innovation** in our process of conceptual modelling.

According to this concept we designed a pattern of 'relation highways' in the functional structure of the new base. From each actor relations enter this highway. The link to the highway is made of labels that contain information about the *destination of the relation and of the character of the relation (step 7)*. By giving each actor a logical number, we could make use of the number to identify the actor. By making use of icons, we were able to distinguish between as many types of relations as we wished, and moreover: the type of the relation is known at first sight. We regard this our **second innovation** in making use of visual language in a conceptual model. In figure (1) we show the basic structure of the conceptual model, and in figure (2) an example of one of the actors and its links to the relation highways.

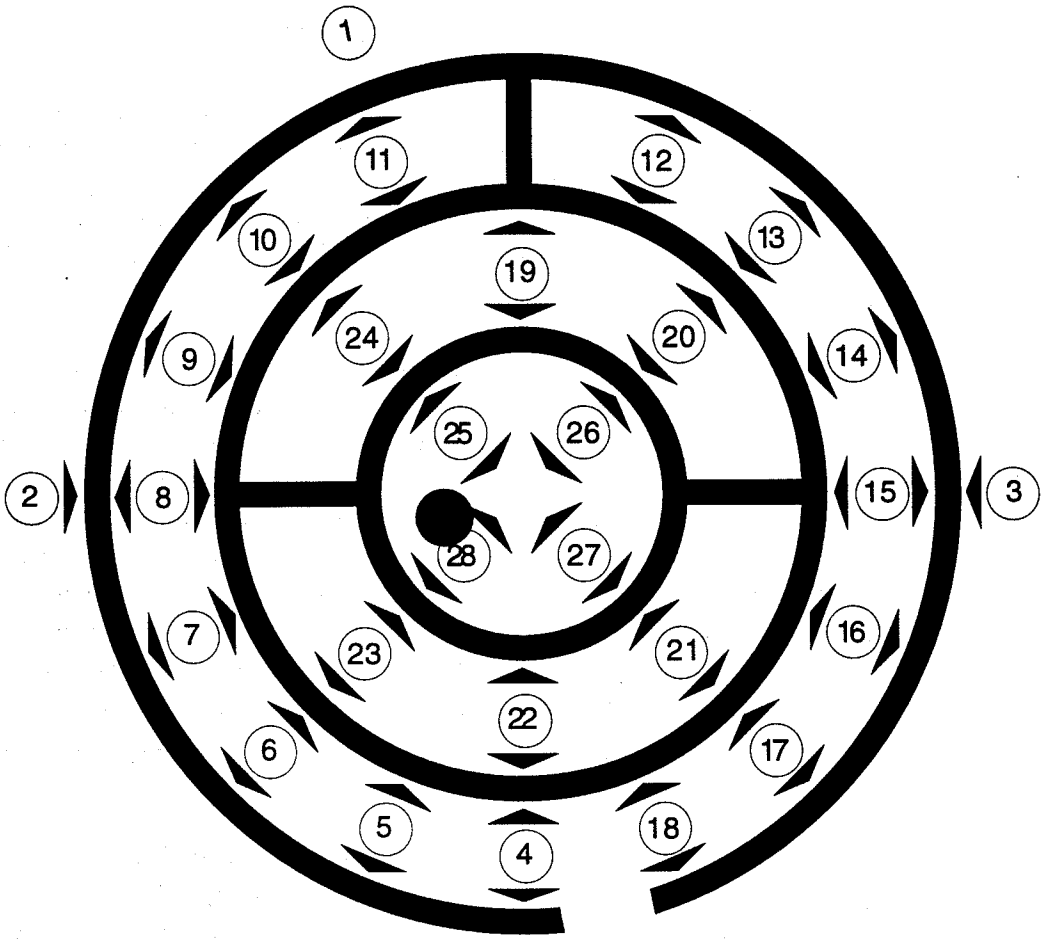

Figure 1 • The basic structure of the conceptual model of GGW De Peel

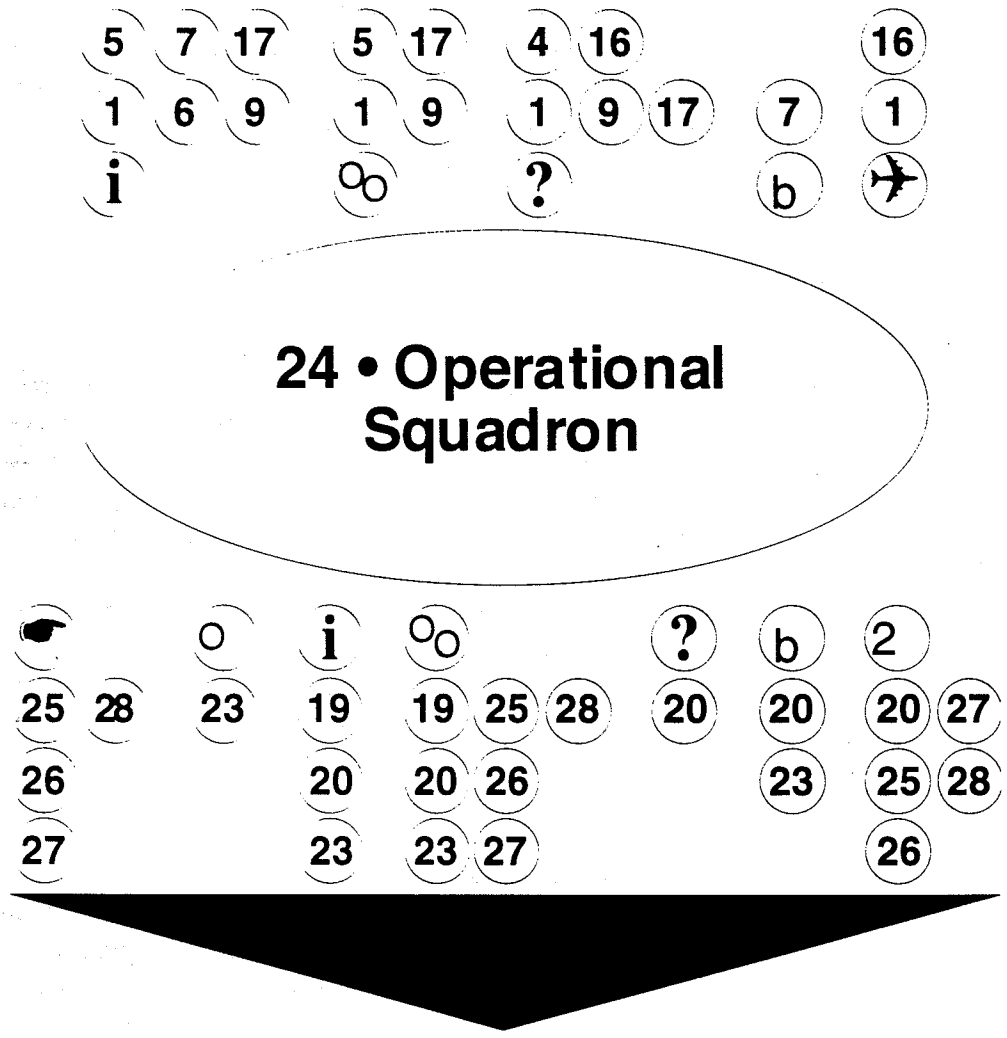

Figure 2 • Example of an actor
(different types of relationships are linked to a number of actors)

To represent the nature of a relations we used 9 different icons, 5 of them representing specific types of communication. We distinguished: an order, an advice, information, mutual adjustment or negotiation, a request, people, money, a product and monitoring. For each of the 9 types of relations we attached the destination by using the number of that actor. This concept made it possible to

incorporate on a very effective and easy identifiable way 28 actors and over 350 relations between them, while each relation can hold a maximum of 9 specific types of that relation. Although this was not our main objective, this way of representing a model proved to be also very elegant and visually attractive.

We also used 5 different colours in the conceptual model, each of them representing a different functional cluster in the organisation. Use of colour coding (our **third innovation**) made it easy to see where the destination of a relationship is. In a first glance you see the functional cluster by its colour, and you recognise the specific actor in that cluster by its number. This way of representing the relations with other actors in an organisation has an important benefit: it gives an immediate insight in the nature of the function of an actor. Some actors have contacts only in their own sector, which is indicated by the fact that almost all their relationships have their own colour. Other actors are real spiders in a web: their contacts are similar to a rainbow.

Developing a shared vision

All the information we gathered in our research would have had no extra value for the organisation if it would not be internalised by the stakeholders involved. Therefore it was of the utmost importance to rebuild this whole model with the actors that are represented in this conceptual model. We designed a structured two day workshop where in a first step the central tasks and responsibilities of every actor in the model were redefined and discussed. Thus all the participants in the workshop agreed on who was doing what in their new organisation. In a second step they split up in several functionally oriented groups and we asked them first to redefine all the relations between actors and then give a detailed description of each relation. These relations were also discussed in plenary sessions. All the information we gave them in these two days was thus reconsidered, discussed and agreed upon. Our model had become much richer, much more detailed and above all, it had become their model!

Beyond our own tradition

The conceptual modelling process, as described above, serves for our group primarily two purposes. The first purpose of the process is to provide us with a tool to help our clients in developing a shared vision of their reality. The second one is to provide us with a detailed conceptual model of our client's reality which is then used for developing a 'simulated reality'. Most of the times this 'simulated reality' we develop is a policy exercise or a gaming/simulation exercise.

In the recent tradition of system dynamics, the conceptual modelling process also basically serves the above mentioned purposes. Developing causal diagrams (conceptual modelling) with the client has been proven effective in helping them develop a shared vision of their reality (Vennix 1993). Causal diagrams are also used as a basis for developing 'simulated realities', which in the language of system dynamics means dynamic simulation models and micro-worlds.

Although these two approaches are more than significantly similar and complementary (Figure 3), there has been very little attempts to make a connection and learn from each other. Our belief is that our (qualitative) conceptual modelling process, which focus on actors and their relations, could be

very useful not only in developing the (qualitative) causal diagrams of complex problems, but also in the process of developing (quantitative) multi-dimensional dynamic simulation models. At the same time we also believe that we can benefit a great deal from the modelling tradition of system dynamics, especially for developing complex policy exercises which need to have sophisticated and dynamic decision-support systems as part of their design.

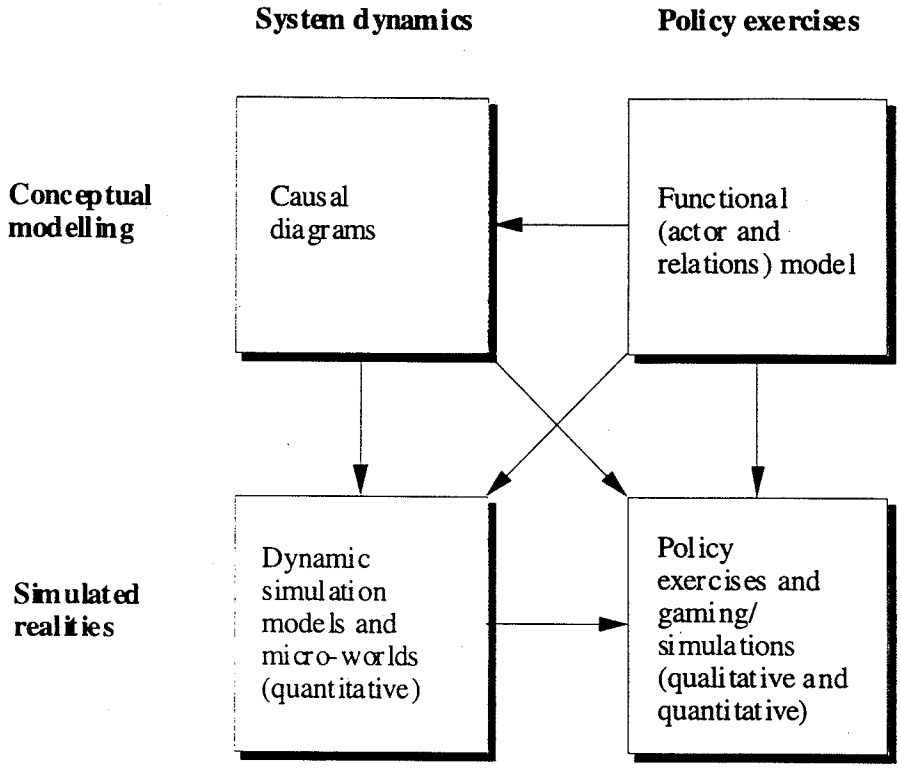

Figure 3 • System dynamics and policy exercise as complementary approaches

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