Self-organising processes of task allocation

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Chapter 1
Introduction

> *The group escaped from the crash site after nearly three months. But the group that came down from Andes was not the same group that began the chartered flight; the pattern of relationships among the group members, or the group's structure, had been altered.*

(cited from Forsyth, 1983)

This quote describes some of the dramatic consequences of the air crash of a rugby team in the Andes in 1972. Many were severely injured, many were dead. The survivors had no radio, only some candy bars, wearing only ruby equipment. From the twenty six survivors only sixteen finally survived. The story of all the horrible things the survivors had to endure (Read, 1974) serves as an important example that describes different aspects of group dynamical processes and structures (see Forsyth, 1983). For instance, it describes how people organise without the context of an organisation. Although the rugby-team already had some organised structure, the horrible circumstances in the Andes forced them to coordinate their actions in a whole different manner than what they were used to do on the field. Without the daily structure of an organisation, in circumstances that differ largely from normal life, people must create new structures by organising their own behaviour. But how do they do that? Cases such as the Andes group describe that roles, status patterns, and communication networks emerge, but how do the underlying processes take place? How do people organise their own behaviour?

Unlike other animal behaviour, human behaviour is embedded in an institutionalised context (Zoethout, Jager, and Molleman, 2004). This implies that human behaviour in organisations is not only determined by individual characteristics and interactions emerging from it, but mostly by the organisational structure this behaviour is embedded in. In this way, components that determine human behaviour can be split up in top-down processes that indicate how our behaviour is enforced by the institutionalised context that we are working in and in bottom-up processes, that describe how we organise ourselves. The first question as stated above can be answered just by studying human behaviour in organisations. The second question however, cannot be answered by just looking at the daily world around us. By definition societal structures hinder the study of bottom-up processes. It is just because of that that scientists use cases such as the Andes group for building theories: only without the cover of institutions the human ability to organise becomes visible. Thus it is important to know how human beings organise their own behaviour because we could only be able to answer the question to what extent we need these institutions if we would know what our behaviour is like without them. Therefore, the main question I would like to answer is:

How does a group of human beings organises its own behaviour?

Another fundamental question that precedes this question is why human beings organise themselves. With regards to the Andes case the answer would be quite easy to give: in order to survive. In other cases the answer might be less easy to give and refers to 'improving performance' or 'to accomplish something that cannot be done without organising'. However, in this thesis I will not focus on this. To answer the question that I stated above, in this chapter first I will focus on the concept of self-organisation and relate this to a socio-managerial context. On the basis of this, I will describe a basic self-organising principle by means of a comparison between organisations and the brain. I further will clarify some concepts from General Systems Theory (GST) that are related to the different aggregation levels of the study of self-organising social systems. Then I will restrict the broad question as stated above down to the study of self-organising processes of task allocation. Next, I will describe the research method that I used and position this thesis within the tradition of this method. I will finish this chapter by giving an overview of the different chapter this thesis consists of.

1.1 Self-organisation in a Socio-Managerial Context

Self-organisation refers to the process in a system leading to the emergence of global order within this system without the presence of another system dictating this order (e.g. Dalenoort, 1989; 1995; Heylighen, 1997). Self-organising systems have been object of study in a wide variety of disciplines, such as chemistry (Prigogine & Stengers, 1984), biology (Maturana & Varela, 1980) and cognitive psychology (Dalenoort, 1982; 1995). Self-organising principles of social systems have been formulated as well (for an overview, see Ulrich & Probst, 1984) but those principles are formulated in an abstract system-theoretical way and are not related to behavioural theory.

The aforementioned definition of self-organisation is the most widely used definition that I will use in this thesis as well. However, some scholars in management literature use the concept of self-organisation to refer to local autonomy instead of an emergent ordering process (e.g. Kuipers, 1989; Molleman & Van der Zwaan, 1994; Molleman, 1998; 2000). As the title of the paper 'self-organisation as design principle'(Kuipers, 1989) demonstrates, here the concept refers to the result of an externally dictated design-approach. But according to the first definition, self-organisation cannot be designed, nor externally dictated: 'self-organisation as design principle' is a contradiction in terms (see also Zoethout & Molleman, 2000).

It looks as if the different use of the concept of self-organisation in management science seems to express a difference between top-down design and bottom-up development. In a sense, this difference can be related to two contrasting views: The classic view states that there must be some kind of entity that brings order into chaos, a

God that creates life and structures nature. In contrast to this, nowadays we know that the emergence of life as well as the ordering principles of nature can be described by using self-organising mechanisms (e.g. Kauffmann, 1995). Therefore, it can be questioned whether or not an organisation needs a designer to bring order out of chaos at all! (Zoethout, 2002; see also Rutges, 2002). For instance, social insects such as bees and ants, that are both simple creatures compared to us, are able to form complex organisations that are able to adapt flexibly to a changing environment (Hemelrijk, 2005; Gordon, 2001; Camazine, Deneubourg, Franks, Sneyd, Theraulaz, & Bonabeau, 2001; Hemelrijk, 2002; see also Rutges, 2002). If they do not need an organisational design or managers, why do we?

But human beings are not bees, for instance because we have the cognitive capacity of self-consciousness which enables us to anticipate all kinds of possible future scenarios. And although by principle we cannot know whether our self-consciousness really manages our actions or makes us just an observer of it, it is a necessary condition to create functions related to management and organisation design. Furthermore, because human beings have a need for leadership or control (De Vries, Roe, & Taillieu, 1999), a manager could very well function as someone to fulfil this need. Moreover, as the empirical studies of Burns & Stalker (1961) have indicated, in stable environments a top-down approach, which they call a mechanistic approach, may function the best, whereas a bottom-up organic approach fits best in dynamic environments (Burns & Stalker, 1961).

Nevertheless, nature shows that highly complex adaptive organisations survive without any top-down management or design, but just by means of self-organisation. This evokes the question whether or not management science uses principles of self-organisation to describe organisational processes. But, as we stated, the confusion of concepts related to self-organisation and design makes it difficult to describe how the concept of self-organisation is integrated into management science. For instance Morgan (1986) formulated four principles of holographic design[1] that must facilitate the process of self-organisation. These principles indicate under which conditions self-organisation may or may not occur. Therefore, I would rather speak of conditions instead of principles. These conditions are: requisite variety, minimum critical specification, double loop learning, and the redundancy of functions (see also Zoethout & Molleman, 2000). To describe the integration of the concept of self-organisation in management science I will shortly discuss each of these conditions.

The first condition, 'requisite variety', is often referred to as 'Ashby's law' (1956). This condition describes that the internal diversity of any self-organising system should match at least the diversity of its environment. This condition implies that a stable

[1] The notion of holographic design is based on the false assumption that the brain is somehow structured as a hologram, i.e. information about the whole is stored in every part. For instance, if you could break a hologram of a brain in 1000 pieces, you would end up with 1000 little holograms of a complete brain. Unfortunately, a real brain is organised differently (e.g. Rumelhart, 1998).

environment matches the best with a mechanistic centralised organisation, a turbulent environment demands an organic organisation with high individual autonomy, and somewhere in between, autonomous teams would match the demands of the environment the best (Molleman, 1998). The empirical studies of Burns & Stalker (1961) indicated this condition to be valid. The implications of this condition are worked out further in chapter five of this thesis.

In addition to the first condition, the second condition of minimal critical specification states that only critical issues should be fixed (Herbst, 1974). This condition is related to the tension between top-down structures and bottom-up processes. Too much structure leads to a rigid system with no self-organising processes at all but not enough structure may lead to performance loss (Burns & Stalker, 1961). Some consequences of this condition, such as the relation between the freedom to self-organise and performance are described in chapter four of this thesis.

Whereas the first and second condition describe the relation of a self-organising system with its environment, the other two conditions describe the consequences within the system (Zoethout & Molleman, 2000). The third condition, double loop learning is also referred to as learning to learn (Argyris & Schön, 1978). Whereas single loop learning implies to skill improvement, double loop learning refers to monitoring the tasks (including its goal) itself and constantly looking for better alternatives. In all the studies I describe in this thesis, I use the concept of task as an independent variable. This means that a group cannot choose or change its own task. Therefore, the concept of double loop learning does not apply to the self-organising processes I describe in this thesis.

The last condition is aimed at the redundancy of functions, which refers to the multi-availability of team members, with regards to knowledge, skills and abilities (Morgan, 1984; Kuipers, 1989). Without redundancy of functions a team lacks the flexibility to re-organise itself in case of external changes or personnel loss. In theory redundancy of functions does not necessarily imply multi-functionality of team members: two team members, one with function A and B and one with function B and C have as much redundancy of functions as four team members, one with A, two with B and one with C. However, in organisational practice, workers are not hired to just sit and wait. Therefore, redundancy of functions does refer to multi-functionality. Although not used as a variable or parameter, all chapters in this thesis refer to it.

Although these conditions are necessary for the process of self-organisation to take place in the first place, they do not offer a description of the process itself. For describing self-organising social process, some scholars compare a human organisation with the human brain (e.g. Beer, 1981; Morgan, 1986; Minsky, 1986; Zoethout, 1994) because the human brain is self-organising, able to learn, and a complex system that can be described by means of simple interconnecting element, i.e. neurons. To understand why such a comparison is useful and to create a framework to describe self-organising processes, I will now shortly describe this comparison.

1.2 A Comparison with the Brain

Varela (1981;1984) states that the autonomy of a system is defined by its organisation. Autonomous systems are characterised by organisational closure which is defined by two properties that are based on the assumption that a system can be described as a network of interactions. These properties hold that: a) the interactions regenerate the system i.e. the system is able to maintain itself. b) by means of these interactions, the system distinguishes itself from its environment. The definition of Beer (1981), i.e. a system that is responsible for its own regulation, agrees with this.

Since a self-organising system is able to regulate itself by definition, every self-organising system functions autonomously. To describe the internal processes that maintains the autonomy of the system, some scholars used a cybernetic description with the help of operators, feedback loops and the like (e.g. Beer, 1981; Von Foerster, 1984; Geyer & Van der Zouwen, 2001) and relate this to human behaviour. However, a description of self-organising social processes that is based on psychological theory has - as far as I know- never been made.

As I stated, a comparison with the brain could be useful to describe self-organising social processes. To do so, we must know first how to describe self-organising processes in the brain. These processes are described by making use of neural network models (see Rumelhart, Hinton, and Williams, 1986). They are based on the notion that the brain consists of a large network of interconnected neurons. Self-organisation is described in terms of changes of the connections between the neurons (e.g. Dalenoort, 1982). The only principle that describes these changes, i.e. Hebb's learning rule, states that simultaneous activity of two elements increases the likelihood for the emergence of an new - or strengthening of an existing- connection between those elements (Hebb, 1949). The application of Hebb's learning rule as a general principle to describe social processes is first formulated by Zoethout (1994) and is worked out later by Nowak, Vallacher, & Burnstein (1998) and Kitts, Macy & Flache (1999). With respect to this, Kitt's et al. (1999) refer to structural learning that refers to changes in the structure of the social network. This type of learning exists next to individual learning in the classic sense, i.e. individual changes such as skill improvement. An elaborate description of this can be found in chapter two. The distinction between structural learning and individual learning must not be confused with the distinction between single loop and double loop learning. The first refers to the difference between learning at the individual and the social aggregation level whereas the second refers to the difference between improving skills and improving tasks. This means for instance that a single individual has the capability for double loop learning but not for structural learning. Furthermore, within a group that cannot change its own task (as in the experiments in my thesis) there is both individual learning and structural learning but only single loop learning.

Thus, a comparison with the brain brought us to the application of Hebb's learning rule to describe self-organising social processes. This rule enables the possibility for describing self-organising social processes in terms of individual interactions by means of a network metaphor. In chapter two I relate these processes to behavioural theory.

On the basis of these interactions, a social structure, i.e. a group, may emerge. This may imply that individual behaviour cannot only be described in terms of local interactions, but is also as a function of the group as a whole. For instance, the influence of reputation (Conte & Paolucci, 2002) describes how a group influences its members. In the next section I will discuss the reciprocal action between individual and group in relation to the concepts of emergence, i.e. the influence of the lower individual level to the higher group level and downward causation, the influence of the higher group level to the lower individual level.

1.3 The Whole and its Parts

When a group is formed as a result of self-organising processes, some properties of the group can be considered as emergent. Emergent properties refer to higher level properties, i.e. from the group, that cannot be reduced to lower level properties, i.e. the individuals (Heylighen, 1997; Klein & Kozlowski, 2000a). The notion of emergence originates from the GST approach that states, using Aristotle's words, that the whole is more than the sum of its parts. This approach contradicts with a reductionist approach that states that the whole equals the sum of its parts. According to the latter approach, the whole could be studied just by studying its parts. For instance, a crowd could be studied just by describing the properties of each individual, the brain of an individual could be understood just by studying each neuron separately, etc. However, it seems to be equally impossible to know the parts without knowing the whole than to know the whole without knowing the parts in detail (cited from Pascal, 1995b). Therefore, according to GST, we must study our subjects of research on different aggregation levels and relate these levels to another. This implies that, by studying a crowd, we must focus at the behaviour of both the individual and the crowd level, and by studying the brain, we must relate a description of the brain to the properties of a neuron.

Whereas the notion of emergence describes how lower level properties influence higher level properties, the notion of downward causation describes the opposite. Originally formulated by Campbell (Campbell, 1974; see also Heylighen, 1995), downward causation refers to the notion that all processes at a the lower level of a hierarchy are restrained by and act in conformity to the laws of the higher level. In shorten this means that a group determines the behaviour of its members (e.g. Zeggelink, 1993). The condition of minimal critical specifications of Herbst (1974) that I stated in the former section addresses to this notion because it states that there should only be minimal restriction from the higher level to the lower level.

On the basis of this I may state that self-organising processes in a social system, i.e. a group, can be described as a combination of horizontal and vertical processes. The horizontal processes refer to the interactions between the members of the group that can be described with the use of a network analogy. Vertical processes indicate to processes between the higher (group) and the lower (individual) aggregation level. The horizontal processes affect the higher level properties and, therefore, the vertical processes. At the same time the vertical processes influence the horizontal processes. Therefore, to answer the question: 'What makes the whole more than the sum of its parts', from a Systems Theoretical point of view one could answer that the difference between the whole and its parts is determined by the relations among the parts (see also Klein & Kozlowski, 2000a; 2000b).

1.4 Self-Managing Teams and Task Allocation

Now that I have described some general properties and principles of a self-organising system, I will focus on the research subject of this thesis: self-managing teams. A self-managing team can be defined as a group of workers being responsible for the performance of a task, whereas each worker possesses a variety of skills relevant to that task (e.g. Manz, 1992). In theory, a self-managing team has the freedom to allocate and perform the task any way the team likes. Therefore, apart from all difficulties of implementing and maintaining them, within self-managing teams, there must be self-organising processes. Moreover, since the start of the popularity of the concept of self-managing teams, there has not been given a description of the self-organising processes within these teams yet.

Since a self-managing team consists of a group of people that must perform a task, it is likely that we study the processes of task allocation. Self-organising processes of task allocation have been studied within biology, for instance how ants allocate tasks on the basis of local interactions (e.g. Gordon, 2001). However, they have not been studied within the area of management science. Although there has been research on the behavioural and motivational consequences of task characteristics, primarily based on the Job Characteristics Model (Hackman & Oldham, 1980), the behavioural and motivational consequences of self-organising processes of task allocation have not been studied so far.

Components that determine the process of task allocation can be divided in task components and team components. Task components refer to the complexity of the task, i.e. the number of skills that are necessary to perform the task (skill variety), the interdependence between the different parts of the task, and the way in which the task changes over time (task variety) (Wood, 1986). Team components can be divided in attributes of the individual team members such as expertise and motivation (Wilke & Meertens, 1994) and social components, such as power, attraction (Leary, 1957; Kiesler, 1983) and coordination (Wilke & Meertens, 1994). These components influence the performance of the team (e.g. Wilke & Meertens, 1994). Figure A describes all these components:

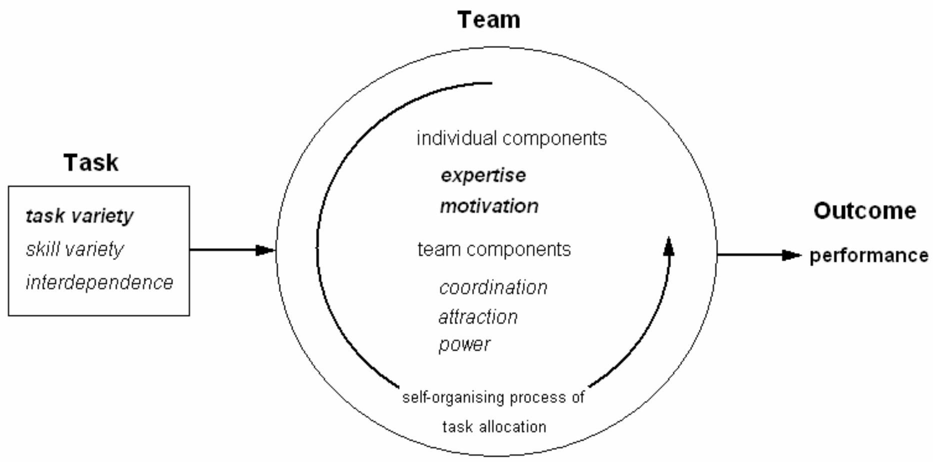

Figure A The model

An elaborate description of this model is given in chapter two, which forms the basis of the study this thesis is about.

A systematic study that includes all these components would easily lead to incomprehensible results. As Bonini's Paradox states: The more realistic and detailed one's model, the more the model resembles the modelled organisation, including resemblance in the directions of incomprehensibility and indescribability' (Starbuck, 1976, p. 1101, cited in Weick, 1979). Therefore choose to study these components in a stepwise manner. I started studying the influence of task variety, and the individual components on the task allocation process in relation to performance (see the bold components in Figure A). I will describe this in chapter two. On the basis of these findings, I explore the group dynamical processes in more detail, especially by focusing on the conditions under which task rotation emerges, the process in which workers mutually changed what they were doing. This will be described in chapter three. On the basis of this study I am able to describe the processes within the system as a function of the variables that are marked bold in Figure A. However, these processes are only tested in stable conditions. A description of self-organising processes should certainly incorporate processes related to the flexibility of the system in case the conditions change. On the one hand, the work to be done might change ('the demand side'). On the other, changes may come from the human resource side of the system ('supply side') Therefore, I will conduct two series of experiments. The first series focuses on the behaviour of the system as a function of task changes. Starting from the basis I formulate in chapter two, using a design that incorporates groups of generalists and groups of specialists, I conduct experiments about the relation between team performance and task dynamics. This will be described in chapter four. Whereas these experiments focus on the demand side, the second series describe how the system would adapt to changes in the supply side of the system, or, more specifically, adapt to the entrance of newcomers in the team. This will be described in chapter five.

Simply due to a limited time horizon for writing this thesis, I primarily focus on task variety as a factor that affects the task allocation process. I do not study the social components of power and attraction, although these may lead to fascinating dynamics regarding group and subgroup formation and possible leadership dynamics. However, I do study the related component of coordination, but only in some pilot experiments (see Chapter 3).

1.5 Multi Agent Simulation

Now that I have described what I study, I will proceed with specifying how I am going to study it. I have stated that the study of self-organising behaviour is hard because humans mainly operate in an institutionalised context. We can only answer the question to what extent we need organisational structures if we know what our behaviour would be like without them. Moreover, in theory, self-organising processes occur in self-managing teams, while in practice such self-managing teams are not purely self-managing because of management practice and organisational constraints (Manz, 1992). Therefore, a study of self-organising processes of task allocation should take place in an artificially context, such as team building sessions or experimental settings. However, for a number of reasons these real-life-contexts will not be sufficient.

First, experimentation with human beings is limited because of its limited possibilities to control for the large number of variables involved and its possible threats to the internal validity (Arrow, McGrath, & Berdahl, 2000). Within a laboratory setting, it is almost impossible to control for variables related to age, sex and gender, status, or social abilities. In field settings there are even less possibilities to control, because of the institutional environment of the research subject. Furthermore, is impossible to elaborately manipulate all kinds of relevant variables and parameters, just to describe their relation. Cook & Campbell (1979) mention a number of threats to the internal validity. For instance, human beings learn or get bored during the experiments which may affect their performance in the next task. This effect is called maturation. The effect of testing, i.e., familiarity of a test which may increase performance, is related to this. All such threats make it difficult to study self-organising processes.

Second, social psychological observations or experiments are not sufficient to describe the complexity and dynamics of social systems (Arrow et al. 2000; Vallacher & Nowak, 1994; Jager & Mosler, subm.). The relation between the different aggregation levels involves variables and parameters that interact in a complex way. Because of this, slight variation in initial conditions may cause large outcome differences. For instance, a dispute of two team members just before they start with a task could easily affect the allocation process.

Third, the study of many intra team processes would need such a time span that experiments with real subjects would be unrealistic (Jager, 2000) or unethical. Furthermore, sometimes it is hard to know in advance what valid time periods would be (Arrow et al. 2000; Vallacher & Nowak, 1994). How much time does it takes before workers are adjusted to each other? An hour? A day? A month? A year?

Thus, since a real-life context is not sufficient to study self-organising processes of task allocation, another method is necessary. Due to the advent of advanced information systems and the use of computational models, the last decade the bottom-up approach, which makes use of computer simulation, has become increasingly popular (Carley, Prietula, and Lin, 1998; Gilbert & Troitzsch, 1999; Axelrod & Cohen, 2000; For an historical overview of the development of different simulation approaches, see Gilbert & Troitzsch, 1999). For instance when guided by empirically validated theory or empirical observations, simulation seems to be a scientifically sound method to study self-organising processes. In particular situations computer simulation is even the only way of studying a certain phenomenon (Vallacher & Nowak, 1994; Harrison, 2002). The methodology of computer simulation introduces the possibility of a new way of studying social processes, based on ideas about the emergence of complex behaviour from relatively simple activities (Gilbert & Troitzsch, 1999).

Besides the benefits of experimentation without the validity threats I mentioned above, and the possibility to cope with the complexity and the time horizon of social systems, computer simulation yields at least three other profits (see Arrow et al. 2000). First, it does not tolerate vague ambiguous theories because it forces the researcher to explicitly formalise theory into computational algorithms. Second, it offers a possibility to integrate all kinds of theories and models related to the same phenomenon (see also Vallacher & Nowak, 1994). Third, because of the possibility to generate systematic descriptions of process variables and parameters, it may help to build and evaluate theories for empirical studies.

A specific way of using computer simulation is by means of multi-agent simulation (MAS). MAS can describe complex behaviour at the macro level by using a set of simple interacting agents at the micro-level (see also Gilbert & Troitzsch, 1999). In general, multi agent models are based on formalised descriptions of empirical phenomena (e.g. Edmonds & Hales, 2004), with or without the help of empirically validated theories. Holland (1995) defines agents as rule-based input-output elements where rules can be based either on simple economic rationality or complex psychological processes. With regards to my study, agents refer to psychological models of humans beings. The behaviour at the macro level refers to the group they are a member of.

With regards to this study, MAS offers a number of advantages that real-life studies lack It enables the possibility to model interaction processes within a social group, and to conduct a variety of experiments with elaborate designs. In this way it offers a method to systematically describe the relevant variables and parameters with regards to the processes I want to study.

By looking at studies that simulate social phenomena, I see a number of theories that are formalised into simulation programs (e.g. Troitzsch, 2005; see also the journals JASSS, SIMPAT, CMOT or AAMAS). Within the field of social simulation studies we can distinguish two different approaches. The first approach involves the study of sociological systems, social networks, and social interaction (Axelrod, 1984; Zeggelink, 1993; Kitts et al, 1999; Back & Flache, 2006). The second approach involves the study of the behaviour of cognitive plausible agents (Carley & Prietula, 1994a; Van den Broek, 2001; Helmhout, Gazendam & Jorna, 2004). Whereas the first approach does not concern about a plausible description of the cognitive properties of the agents, the second approach does not apply sociological or social-psychological theories to its models. Only a very few scholars focus on both the individual and the social level (e.g. Conte & Paolucci, 2001). Therefore, for me this thesis was a challenge to develop a model that links both approaches.

Simulation studies concerning organisational processes encompass a wide range of topics, including organisational learning (Carley, 1992), computation organisational theory (Carley & Prietula, 1994b), organisational semiotics (Helmhout et al. 2004), the co-evolution of social networks and behavioural norms (Kitts, 2005), and teams (Pynadath & Tambe, 2002; Coen, 2006). Up to now, studies of self-organising processes of task allocation have not been conducted. Furthermore, most studies focus only on cognitive or network components, while neglecting the influence of motivation on the internal processes and performance. Therefore, my study may contribute to this line of research.

1.6 The Chapters

All experiments that I will describe in this thesis are based on the same model. The chapters of this thesis consist of papers that either have been published or have been submitted to journals within the field of computer simulation. This implies that in each paper, although adapted to the specific experiments described in that chapter, I shortly highlight the general model on which the experiments are based.

In chapter two of this thesis I describe the basics of my conceptual model on which my simulation experiments are based. This conceptual model is partly based on a comparison of self-organising teams with the brain. I combine general self-organising principles and mechanism with psychological theory of task performance and organising behaviour. The conceptual model describes self-organising processes of task allocation both at the individual level, i.e. changes of skills, and at the social level, i.e. changes of power and attraction. This conceptual model is partly formalised into a computer simulation program, called WORKMATE. Chapter three focuses on this formalisation. I only formalised the individual level of the model, being only a first step but already leading to interesting behaviour. In this chapter I describe the results of three experiments: First, I describe how differences in expertise affect the duration of the task-allocation process. Second I describe how task variety and coordination time are related. Finally, I describe the relation between boredom, performance and task allocation. By conduction these experiments, I was able to simulate the phenomenon of the emergence of task rotation. In chapter four, I describe when task rotation may or may not emerge under different conditions of organisational constraints, which is called ‘level of self-organisation’. This chapter can be related to the condition of ‘minimal critical specification’. Further, I conducted experiments that focus on the flexibility of work groups. I have made a distinction between external and internal changes that force a work group to adapt to a changing situation. In chapter five, I focus on external changes. I describe a series of experiments to test the influence of task dynamics (variety in demand) on groups of specialists and generalists. Chapter six focuses on internal changes of the team, i.e. the influence of turnover (variety in supply) on performance. I especially indicate the adaptation processes concerning different kinds of newcomers (specialists and generalists with various levels of expertise) in teams. The internal and external changes that these two chapters describe can be related to the condition of 'requisite variety'. The influence of the differences between specialists and generalists on the adaptation process can be related to the condition of 'redundancy of functions'. In all experiments I focus on individual processes related to expertise and motivation. In chapter seven I propose the conclusions based on all the previous chapters in relation to the conditions for self-organisation. Finally, in chapter eight I reflect on the research itself, by discussion the validity of the model and the experiments, by proposing some suggestions for future applications and further research.