Self-organising processes of task allocation

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Chapter 8
Discussion

The papers that are part of this thesis describe simulation studies of self-organising processes of task allocation. I described the model, its formalisation, and some pilot experiments to verify the model and WORKMATE, the program. On the basis of this I conducted experiments about the emergence of task rotation under diverse conditions. These experiments have brought us further insight in the processes within self-organising systems, which led to two more advanced experiments in which I tested the flexibility of the system by manipulating external and internal variables. The external variables concerned the influence of task variety on the performance of specialists and generalists. The internal variables dealt with the influence of two types of newcomers entering two kinds of task groups. In each chapter I ended with a discussion part that reflected on the particular study. In this final chapter I will discuss the most important subjects of the preceding chapters in a more comprehensive way. I will discuss four topics, the scientific contribution of this thesis, its contribution to practice, the validation of the studies that I have conducted, and suggestions for further research.

8.1 Scientific Contribution

In this section I propose five ways in which my research contributes to science. First, my approach can be used as a platform to integrate various psychological theories and models. My research focuses on two different aggregation levels, involves principles and theories from different fields and is therefore multi-disciplinary by nature. In this sense, my model is an example of an integrative approach that may contribute to social and organisational psychology.

Second, the model I used indicates a psychologically more realistic description than most existing multi-agents models. As I stated in the introduction, within the area of social simulations two approaches may be distinguished, the social approach and the cognitive approach, whereas both approaches lack the benefit of the other. My research tries to encompass both by combining a cognitive architecture with social realism. Although some scholars from both disciplines could claim that I emphasise their part to little, I would argue that this criticism may yield for multi-disciplinary research in general. Further, my model is not based on cognitive properties only but uses variable motivational states as well. Although this does not necessarily mean that the results of this study can easily be related to real life events, the components that the model incorporates are relevant in relation to the outcome variables of the experiments.

Because I used a formalised description of psychological theories, my model can relatively easy be related to other formalised disciplines within management science such as Operations Management. Since these disciplines in general lack the attendance of psychological plausible models but yet pose propositions related to human behaviour, a formalised description such as my model may contribute to this field.

Third, my studies offer a systematic description of underlying processes. One of the advantages of multi-agent simulation is the systematic description of processes leading to a certain result. In daily life these processes are difficult to study for reasons I mentioned in the introduction. My research has not only highlighted the outcomes of experiments, but has especially focused on the importance of the processes leading to those outcomes. In this way my research not only shows what happens, but systematically describes how this happens as well.

Fourth, the results indicate that self-organising processes of task allocation are highly relevant processes to study. In chapter five I stated that self-organising processes of task allocation may explain how differences between groups of specialists and generalists lead to performance differences. In chapter six I indicated how these processes describe the mutual adaptation of newcomers and work teams. In general, the concept of self-organising processes of task allocation describes how people organise without an external instance dictating order. Therefore, the study of this concept elucidates some fundamental organising principles. As I stated in the introduction, we can only indicate the benefit of organisations if we know what our behaviour would be without them.

Fifth, I not only studied some relevant aspects of group processes, but developed a new research instrument as well. WORKMATE is able to describe processes of task allocation on the basis of task and team characteristics. It was used for the simulation of various experimental designs, it was able to generate emergent behaviour such as task rotation, and it generated process descriptions of expertise, motivation, performance, and task allocation, at the agent level as well as at the group level. With some adaptations it can be used for simulation experiments concerning group dynamics in general. In the section about future research I will elaborate on this.

8.2 Managerial Contribution

To phrase Kurt Lewin that there is nothing so practical as a good theory, the most important managerial contribution my research has to offer refers to one of the benefits of computer simulation that I stated in the introduction, i.e. the possibility to build theories. Regarding my thesis, these theories describe processes in organisations in a way that contributes to improving practical management issues in daily life. In this section I will elaborate on this. Furthermore, the method of computer simulation that I used, has been a part of a much broader development concerning the use of complexity theory and advanced information systems. Nowadays, this development has lead to a growing need for computer simulation instruments, for instance within the area of business consultancy. Therefore, the second contribution to practice of my research will be related to the connection to this area.

With regards to the contribution to theory building, as I have stated in the former section, my research offered a description how processes take place instead of just describing what their result are. Further, I indicated that the concept of self-organising processes of task allocation elucidates some fundamental organising principles. Although at this stage the descriptions of these processes are rather abstract and far away from real life events, they may give rise to new perspectives on team issues. I will elaborate on this by means of the conditions for self-organisation that Morgan has described.

The condition of requisite variety focuses on the relation between organisation and environment. This condition can be used to indicate the benefit of teams in organisations under certain environmental circumstances (e.g. Molleman, 1998). As chapter five indicates, the condition can also be used to describe the relation between a team and its environment, i.e. the task. Although the results of the experiments do not indicate a clear relation between the condition and its related processes, it shows the relative importance of team design. In general, in the introductory chapter I questioned the use of organisational design because if bees and ants do not need such, why do we? Of course, the discussion about design and development involves a lot more issues than dealt with in the present study. However, as chapter five states, my study indicates that the difference between design and self-organisation does not lead to spectacular performance differences. On the basis of that I may conclude that in some cases self-organising processes may replace top-down management. Furthermore, the study offers a systematic description that not only concerns traditional variables such as performance and expertise, but involves motivational processes as well. The condition of minimal critical specification indicates the space that is needed for self-organising processes. The experiments -especially in chapter four- not only confirm the importance of this condition, i.e. the proper balance between structure and freedom related to group performance, they also clearly show the underlying self-organising processes related to this. The condition of redundancy of functions is related to the flexibility of the workers. Limited flexibility may lead to performance loss, especially in turbulent environments or in the case of turnover. In my experiments, this condition is not only related to expertise but also to motivation. The motivational effects concerning (the lack of) redundancy that my research shows, offers insight in real life processes, for instance because it shows a balance between the benefit of specialisation, i.e. high expertise, and the disadvantage of it, i.e. boredom.

Thus, my studies describe a first outline for the balance between team and task, the balance between organisational constraints and self-organising processes, and a balance between expertise and motivation. This outline can be considered as a the beginning of a theory about the balance of self-organising processes within teams with respect to their performance.

Whereas the systematic description concerns the theory building part of my research, another contribution of this thesis may be the applicability of the model itself. As I stated, my research can be seen as a part of a larger development towards the use of computational models for business purposes. My model may serve two kinds of applications. First, it may serve as a tool to train and assess managers. I used WORKMATE to study team processes by manipulating different psychologically relevant variables and parameters. The underlying model may serve as a platform for gaming purposes. For instance it can be used by managers as a simulated team to practice their skills, for instance regarding performance components. WORKMATE simulates, by adjusting tasks, initiating relationships among workers, conducting on the job training, and motivating the virtual team. Second, WORKMATE may also be used as a platform for analysing organisational problems. By putting the self-organising processes that WORKMATE is able to generate into a organisational context with constraints related to structure, space, and time, WORKMATE will be able to analyse organisational processes and bottlenecks. It may answer questions like why a self-managing team is not self-managing. Is it because of the implementation or doesn't the organisation need such teams? These questions are not new, but WORKMATE may give a new perspective on the answer. Especially a combination of a behavioural model such as WORKMATE with traditional simulation models for organisational processes such as logistic models, is able to analyse an interesting and useful combination of variables.

8.3 Validation of the Model

To what extent does WORKMATE really describes what it clams to do? What is the validity of the model and, consequently, the results? Holland (1998) distinguishes three ways in which scientific models can be validated. The first and most traditional way states that models are validated through the correctness of their predictions about the world device (cited from Holland, 1998, p241). When looking at my study, I must conclude that my model is not validated in this sense. Although the theories and frameworks that served as input for the model were empirically validated, both the processes and the outcomes of the model were not. At the most I might conclude that my simulation processes and outcomes mimic real life phenomena, but I did not cross-validate my findings in real life settings. However, such a comparison could easily lead to a number of problems. For instance, both the simulation model and the empirical model could be based on stochastic factors or the simulation data is correct but the empirical data, being gathered with methods having their own validation difficulties, is not (for an overview of problems related to empirical validation, see Gilbert & Troitzsch, 1999, p. 22). This does not mean that we should not try to relate simulation experiments to empirical studies. On the contrary, although simulation studies are useful to comprehend the complex coherence of variables regarding organisational processes, ultimately, without being related to empirical studies, their scientific value will be limited.

The study of self-organising processes of task allocation can be empirical validated to some extent, for instance with experimental task groups. However, the study of complex social systems implies that simulated processes may develop in another direction as in empirical data because small effects at the micro level may result in large consequences at the macro level. This implies that outcome validation is only possible if the empirical data shows 'stylised facts' (e.g. Jager & Mosler, subm.). Stylised facts are robust empirical effects that have been identified in a number of examples. Validation of a simulation model consists of reproducing these effects. However, in more complex conditions empirical outcomes may vary too much to generate any stylised facts at all. Moreover, if a limited set of empirical outcomes is available, simulation outcomes are impossible to validate against such unstable outcomes. Nevertheless, it may very well be the case that the same underlying behavioural mechanisms are responsible for these outcomes. Hence we can imagine that process validation is possible.

But, as I stated before, this is not the only reason that cross validation of the outcomes of the experiments is more difficult to accomplish (see Gilbert & Troitzsch, 1999, p. 22). Therefore, although process validation would have been possible within the time horizon of a PhD-project, I choose to describe an overview of simulated self-organising processes under different conditions, generating different hypotheses about real life processes.

The second way to validate theoretical models serves as a demonstration that something is possible, as in Neumann's demonstration that a machine is able to reproduce itself. Here validation occurs when a dynamic model works as claimed, as when validates a patented device (cited from Holland, 1998, p241) This type of validation resembles the verification stage of simulation research that Gilbert & Troitzsch (1999) describe. Indeed, as I described in chapter 3, I checked whether or not WORKMATE did what it has supposed to do. With regards to this way of validating, I dare to conclude that my model serves as a demonstration that with respect to self-organising processes of task allocation, simple agents at the micro level are able to produce complex behaviour at the macro level. The emergence of task rotation, the role of motivation concerning the results of the task dynamics experiments, and the decrease of performance concerning the experiments with newcomers, are clear examples of this. Therefore, I demonstrated that WORKMATE is able to simulate self-organising processes of task allocation.

Third, models may generate ideas about a complex situation, suggesting where to look for critical phenomena. Here, validation is in the cogency and relevance of the ideas they produce (Holland, 1998, p241). This way of validation is related to the model suggesting ideas about the importance of task allocation processes. My experiments produced a systematic description of endogenous and exogenous variables involved. This description generates hypotheses concerning important variables of group dynamical processes and how they are related to each other.

8.4 Strength, Weaknesses and Future Research

In chapter one I discussed the discrepancy between the model as described in chapter two and the series of experiments I conducted as described in chapter three, four, five, and six. Whereas the model involved different components of task complexity, I only studied the effect of one, i.e. task variety. Furthermore, the model proposed both individual and social components that affect the task allocation process. However, I only studied the individual components. On the basis of this discrepancy I now formulate ideas for further research. Following the model, I mention task interdependence and social components such as power and attraction. Task interdependence refers to the way the parts of a task are related (e.g. Thompson, 1967) and its consequences for human behaviour. It is an important subject of empirical study within the area of group dynamics (e.g. Van der Vegt & Van der Vliert 2005). Moreover, it is an important component that determines the task allocation process. Because of this, computer simulation experiments may be used to systematically describe the underlying processes regarding the empirical data. Moreover, empirical data may validate the processes and outcomes of the computer simulation experiments. With respect to self-organising social processes of task allocation, the social components of power and attraction are needed to describe the dynamics concerning group formation. Only studies concerning these social components will justify the relation with Hebb's rule that I stated in the introduction. Especially the concept of 'structural learning', i.e. altering the social structure, can only be studied with the use of social components.

The future research issues that I mentioned above are a logical consequence of the model that I highlighted in chapter two, and its discrepancy with the experiments that I conducted and described in this thesis. Other future research that I mention here can be divided into two parts, a part that formulates research within the structure of the conditions of self-organisation that I used in the former sections and a part that focuses on the realism of the model.

As I stated in the conclusions section, the relation between requisite variety and group dynamical processes needs more research. The experiments on task dynamics and groups of specialists and generalists that I have described in chapter five indicated that especially the generalists did not behave according to the law of requisite variety. Because the generalists were only generalists with respect to their original task and not with respect to the new tasks, they were not flexible enough to cope with task dynamics. A logical continuation of these experiments would imply experiments with generalists having larger sets of skills. A second way of exploring the relation between conditions of self-organisation and group dynamical processes is to focus on the condition of minimal critical specifications. Although chapter three indicated interesting results, the use of 'real' critical specifications may help to relate the simulation results to empirical findings. These critical specifications can be related to structure, such as formal and informal networks, space, such as spatial distance to potential co-workers, or rooms and corridors, and time, such as deadlines, nine-to-five jobs, or shift-work. However, organisations do not only limit self-organising processes, but may facilitate them as well, for instance, by operating as an information buffer with respect to learning, especially in the case of turnover (e.g. Levine et al., 2005).

In general, in this thesis I have been given the concept of learning only little attention. In the introduction I stated the relevance concerning the distinction between individual learning and structural learning. However, I did not explore its consequences for, for instance, the transactive memory system (TMS). TMS is a collective memory system for encoding, storing, retrieving, and communicating group knowledge (e.g. Brandon & Hollingshead, 2004). Therefore, future research can elaborate on the relation between TMS and structural learning. Furthermore, I did not explore the relation between the condition of 'double loop learning' and self-organising processes because in my experiments the environment, i.e. the task, was an independent variable. What holds for the condition of minimal critical specification also applies for the condition of double loop learning: with a more advanced definition, the condition not only serves as an independent variable, but indicates more complex mutual interactions either between critical specifications and self-organising processes or task/environment and double loop learning.

With regards to the realism of the model, I will now shortly focus on three variables: motivation, the task itself, and time. In the model, these variables show weaknesses that I would like to discuss. In the original model, motivation is independent of the task. However, one might state that each task contains elements that everyone likes or dislikes. Therefore, motivation being a combined outcome of both agent and task characteristics may result in more realistic dynamics. Further, with regards to the task, in chapter six I stated that a division into for instance operational and control parts would influence the task allocation process (see also Rice, 1976). Finally, the way I implemented the component of time is rather primitive. Although the time the agents need to perform a single cycle determines their performance, no matter how big their differences are, they all start and finish together. It is merely evident that a more realistic description would generate more sophisticated results.

Certainly, it is not difficult to come up with more ideas to implement into a computer simulation model. It is far more difficult to keep the model simple. Yes, I could enhance the agents with personality characteristics (see Zoethout & Molleman, 2000) and it is possible to model some cognitive abilities to let task allocation rules emerge in order to facilitate the task rotation process. Social components such as team size (e.g. Molleman 2005), commitment, team cohesion and coordination costs (e.g. Cohen, Ledford & Spreitzer 1996) would indeed cause the model to resemble reality in greater detail, including - to phrase Bonini again – its incomprehensibility. All these ideas, including the importance of empirical validation, suggest that the studies that I described in this thesis may only form a first step for future simulation studies. I already mentioned different research lines. They vary from elaboration of the simulation model to empirical validation and adjustment. Furthermore, the further development of a formalised behavioural model may contribute to other management disciplines, for instance by creating an artificial organisation, either for scientific or for practical use.

8.5 Finally

I started this thesis with the question how humans organise themselves. Have I been able to answer this question in this thesis? By all means, no! The question that I started with is too fundamental to answer fully within the scope of a PhD-project. At the best I started with an introduction of describing some basic principles and mechanisms of self-organising behaviour related to task allocation and task performance. This introduction may only serve as a first step towards a better understanding of self-organising human behaviour. This means that I am not able to present definite conclusions. But does this mean that scientists in general should not try to comprehend fundamental issues in the first place? I think not. Every discipline, including management science, has its roots in its own fundamental questions. And what is the use of a question if nobody tries to answer it? Besides, fundamental issues serve as a shared bedrock that integrates the different perspectives within a study such as management science that is both multi-disciplinary and applied. This integration is needed as a counterpart for the logical specialisation that applied research brings about, because without it, a discipline would end up as an incoherent collection of various research topics. On the other hand, a discipline that only studies fundamental issues may loose its contact with reality. With respect to my study, this means that the development of applications, for instance as a described above, would be beneficial for both theory and practice.