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Attitude formation
in organizations;
the ghost in the machine

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Voor mijn ouders, Joke en Gerard
The work presented in this thesis was carried out within the department of Organizational Sciences of the faculty of Social Sciences at the Free University of Amsterdam and was supported by the Radboudumc.

Title
The phrase “ghost in the machine” was first used by the British philosopher Gilbert Ryle’s in his critique on René Descartes’ mind-body dualism. Ryle referred to the idea of a fundamental distinction between mind and matter as “the ghost in the machine”. Later it has been used in various contexts. Arthur C. Clarke’s novel 2010: Odyssey Two, contains a chapter called “Ghost in the Machine”, referring to the virtual consciousness inside a computer also the X-Files-series named an episode involving a rogue AI computer system “Ghost in the Machine”.

In analogy to these this, I used the phrase “ghost in the machine” to express that, although the model presented in this thesis is built on a pure mathematical algorithm (the machine), its outcomes are nevertheless unpredictable as if it has a mind of its own (the ghost). In the perspective of the school of scientific management, organizations are often seen as machines, machines that can be adapted at will. However, as shown in this thesis, organizations seem to have a mind of their own explaining why organizational changes will rarely generate the outcomes as anticipated, and strategies may just, or are even more likely to emerge than to be planned by management.

Cover
The cover is a 3D stereogram and although it may look like a bunch of random colors, when you stare long enough and try not to focus on the details but try to look through the picture you will see a 3D donut emerge from the chaos.

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Attitude formation in organizations; the ghost in the machine

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1

General introduction, aims and outline of the thesis
1 General introduction, aims and outline of the thesis

1.1 Introduction
As a manager I am supposed to lead my department in line with the goals set by the board of executives. However, I know that I will not execute all that has been asked by the board. Their instructions may not work in the specific circumstances of our department, may have a negative effect on our performance, interfere with other objectives, or may be in conflict with our way of operating. In such cases, whether based on rational or irrational considerations, I will take a negative attitude towards these instructions, and will try to avoid them by bending them, persuading the board to change them, or simply ignore them. But also the people working under my supervision may bend, change, or ignore my instructions, depending on their attitude towards these instructions. It is obvious that whatever instructions or guidelines are given, they will never be executed in exactly as they were intended to when issued. Heading a team, group, or department, is thus never a straightforward process, and instructions will be constantly negotiated between their organizational members. These negotiations are the consequences of the different attitudes organizational members have towards the instructions they receive. Due to these constant negotiations, teams, groups or organizations develop their own way of doing things, which is generally well accepted and in the end supported by the majority of the employees. These constant negotiations between group members do not lead to chaos, but to stability. What fascinates me is how during all these negotiation processes between all these individuals in organizations, over time a shared attitudes emerges towards the instructions these individuals receive. What fascinates me even more is what the real influence of managers on these processes is. Based on my experience that only a small part of all the instructions given by managers is carried out in exactly the same way as was intended, my questions is whether managers can indeed lead and steer an organization, and can create a shared positive attitude towards desired behavior, or whether the outcomes of all the efforts to lead an organization are just a matter of coincidence, and outcomes emerge autonomously beyond the control of managers.

Besides the phenomenon that, due to the different personalities of individuals, managers' instructions are constantly negotiated during their flow through the organization, there is another phenomenon that seems to subvert the influence of leaders even further. At this moment, I am the general manager of two hospital departments. My knowledge of the technology used in these departments is less than that of a starting PhD student. My knowledge of the processes and systems involved in patient flows, data flows and sample flows is rudimental. Moreover, heading more than 400 people in both departments, I only have regular contact with less than 5% of the employees falling under my responsibility. For me, just as
for most other general managers, it is impossible to oversee the organization in detail. The consequences are that many decisions need to -and are made- lower in the organization, and that neither I, nor any of the staff members, may have any knowledge or direct influence on these decisions. Such decisions, however, can have major long-term effects on the performance of an organization.

A good example of a decision made lower in the organization is the development of Remeron at Organon, which was at that time part of AKZO Nobel. The history regarding the development of Remeron was told to me by one of my colleagues when I worked as a research coordinator at AKZO Nobel’s head office. In a very early phase of its development, the compound Mirtazapine –the active ingredient of Remeron– was only one of many potential leads to a new drug. In that period, potential drugs were tested on rats first. Whether a compound was attributed as a potential to go to a next phase depended on the behavioral effects of the potential drug on the rats. The compound now known as Mirtazapine failed all criteria! It was however only because of one stubborn scientist that, against the strong advice of all other people involved, this compound was taken to the next step of development. As it turned out, this drug eventually became the blockbuster that made Organon great. This example shows how a decision taken at the bottom of the organization against the guidelines and will of superiors had a major effect on the future performance of the organization.

Actions initiated at lower levels in the organization, can thus have a profound influence on the performance of an organization. With the growing complexity of organizations it becomes ever more unlikely that one person can oversee the complete organization and inevitably more decisions will be taken lower in the organization. These decisions, as in the above example, can have a huge effect on the long-term performance of organizations, and interfere with the assumed role of higher managers being the captains responsible for success and failure. Therefore, due to the growing complexity of our organizations, the features of such organizations will be determined less by rational design and will become more the result of emerging processes.

Emergence however, provides a problem for traditional views of leadership. It is generally presumed that organizations can be rationally steered, and many theories and schools in management science are based on this presumption. Given the high salaries for managers/leaders, there is a general agreement that organizations need to and can be steered by managers/leaders. Managers/leaders are supposed to effectively generate long-term strategies that will enable the organization to cope with the changes taking place in the environment, and ensure that positive results are generated by the organization. However, when we conclude that, for a significant part, organizations are shaped by emerging processes -which are by definition autonomous processes that cannot be managed- the role of
managers/leaders in directing an organization might be far less important than what is anticipated by many scholars and stakeholders in organizations.

With regard to managerial influence, March (2006) argues that along with the growing complexity of organizations a number of factors undermine the value of rational design, and thus limit the ability of managers to steer an organization. He argues that it is unlikely that main events and processes in history are caused by rational design, but that it is plausible that they are caused by wild ideas. However, wild ideas in general have a high probability to fail (March, 2006). His conclusion is that rational design may provide an important source for exploitation, but that foolishness may sometimes be desired (March, 2006). March thus recognizes that rational design as advocated by the various schools of management is required, but needs to be combined with less rational planning: foolishness. He concludes that only out-of-the-box ideas can create the innovations that can change the status-quo. However, the outcomes of such out-of-the-box ideas are far less predictable than those of rational design, and thus impose a larger risk of organizational failure as well.

In a similar vein, Burgelman and Grove (2007) investigated which factors added to corporate longevity (Burgelman & Grove, 2007). They showed that only nineteen of the top 100 Fortune companies in 1965 were also found in the 2005 Fortune top 100 list. It is thus clear that today’s success is no guarantee for tomorrow’s success. Based on their study on the antecedents for longevity, they concluded, in line with March’s conclusions, that the key to corporate longevity was to find the right balance between induced and autonomous (emerging) strategy processes (Burgelman & Grove, 2007).

However, autonomous emerging processes are no guarantee of success: autonomous processes can also generate undesirable results. With regard to autonomous processes, Henning (2008) recommended to look out for self-organized patterns of behavior, because such patterns can undermine the organization’s performance (Henning, 2008). Autonomous strategy processes are a form of self-organization. When, as a consequence of the interactions between individuals in an organization, a shared attitude emerges towards a behavior influencing how things are done within the organization, the organization has self-organized itself without the influence of management. The outcomes of such a process are not necessarily beneficial: they can also be devastating. In our example of Organon, the emergence process led to a better result than rational design, but the decision to proceed might have turned out disastrous as well. As we will demonstrate in chapter 5, self-organization can also lead to adhering to the same strategy and being unable to adopt a new way of doing things. Examples of previous successful companies that were unable to adjust in time to new circumstances are Nokia and Kodak. Both companies were once market leaders in their segments (cell phones...
and photography). Nokia, however, failed to keep up with the developments in the smartphone segment and saw its market share drop from 41% to 3.5%. Kodak was unable to adjust to the introduction of digital photography and went from a 1.3 billion profit in 1995 to a 687 million loss in 2010, this in contrast to its competitor Fuji which was able to make a switch to a new marked. As put forward by Henning (2008), recognition of self-organizing patterns creates awareness and the possibility to intervene when these patterns of behavior hinder organizational performance (Henning, 2008).

Based on these considerations it seems essential to find the right balance between rational design and emerging processes. As pointed out by Henning (2008), the outcomes of emerging processes are not always beneficial to the organization. However, as mentioned earlier, as a consequence of the growing complexity of our organizations, emerging processes will increasingly determine the way things are done in an organization therefore, there is a need to better understand emergent processes and to find means to influence them.

Influencing emergent processes provides us with a paradox: since emergence is by definition an autonomous process, it can hardly be controlled. This paradox is based on the assumption that rational design and emergence are two separate processes in organizations. Although it is recognized that both processes may strengthen or hinder each other, organizations are only steered by rational designed planned changes. In this thesis, I will challenge the assumption that planned changes and emergent changes are two separate processes, and try to close the gap between rational design and emergence. Also I will challenge that emergence is out of the control of management. By gaining more knowledge regarding emergence I will make an effort to make emergence more susceptible for the influence of managers. However, because of the nature of emergence, with its multiple interactions over time, it is hard or even impossible to study emergence empirically. The only way to obtain more insight in emerging processes is by computer simulations. By using computer simulation we are able to handle the complexity of the multiple effects of series of interactions taking place over time.

1.2 Self-organization in organizations

Based on the general consensus that organizations need to be steered, organizations are organized as hierarchies (Leavitt, 2003). In the classical view on organizations as hierarchies, the CEO or a board of executives steers the organization. In the simplest model, the CEO receives new information, which then triggers the need to reanalyze the current way of doing things. After a careful analysis of the facts the problem is defined and the various strategic alternatives are evaluated, then the best strategy is chosen. The CEO then communicates the chosen strategy to the lower hierarchical layer and assigns specific targets to them. These targets are then
transformed into strategies for the next hierarchical layer and this sequence is repeated until the lowest hierarchical level has been reached. From this perspective, the strategy of the CEO cascades through the organization and will finally arrive at the level of the workers, where the strategy is executed. The driving force behind this mechanism is the authority given to superiors. This is a highly simplified but basic description of the functioning of hierarchies. However, in my experience it has a number of fundamental flaws.

In the classical perspective of how organizations are managed some implicit, unrealistic presumptions are made. First, it is assumed that each person in the organization is equally bound to follow a superior’s instruction. However, some people will be strongly motivated to follow a superior’s instructions, whereas others will deliberately act against these instructions, and in between all variations of compliance will occur. Moreover, the classical perspective on leadership assumes purely rational behavior of all organizational members, which is an illusion. Based on my experience, people may act irrationally when they feel threatened, when they disagree with instructions, when their routines are distorted, or when they fear for the consequences of a measure etcetera. All these factors will undermine purely rational behavior, leading to a further differentiation in reactions to the instructions of superiors. It is also presumed that a superior’s influence will reach each subordinate, which is unlikely to happen. Even when managers and communication departments do their best, a large number of employees will not receive the relevant information, or will receive it incorrectly. Another assumption is that influence always goes top-down from superior to subordinate. However, influence also goes bottom-up, as well as horizontal. It is often presumed that superiors are the only people with authority and thus with the means to influence others, which is not true either. Some subordinates may even have more influence than their superiors in their roles as informal leaders, experts or friends. Therefore, in reality the nicely structured schema in which the ideas of the CEO cascade through the organization has to be abandoned, and replaced by an unpredictable pattern of interactions and outcomes of these interactions. In reality everybody –including the CEO- experiences various influences by various individuals during various periods in time. In addition these influences are interacting with various mixes of rational and irrational personal motives. Although the pattern of these mutual influences may seem to follow the main communication lines within the organization, a substantial part of the interactions will also be based on pure coincidence. The rationally and structured classical view on leadership in a hierarchy should better be replaced by an unpredictable pattern of multiple, highly random and diverse interactions over time, of which the outcomes are hard to predict. In broad lines, this is what the Garbage Can model describes, in which organizations are regarded as organized anarchies in which coincidence determines
the outcomes of organizations rather than rational design (Cohen, March, & Olsen, 1972).

Despite these considerations, most organizations are characterized by order and structure. This seems to contradict the conclusion of the previous paragraph. To understand how multiple random interactions can lead to stable systems, we can make use of the complexity theory. The complexity theory demonstrates that complex systems have the ability to self-organize into stable patterns (Kauffman, 1995). Complex systems are defined as systems consisting of many elements, interacting with each other over longer periods of time (Morel & Ramanujam, 1999). This definition perfectly fits the description of organizations as described in the previous paragraph, in which employees are portrayed as interacting and influencing each other. This definition is also in line with the observation that organizations should be regarded as social systems (Katz, 1964). Thus, if organizations are complex systems, they will also most likely be self-organizing, which explains why despite the presence of an unpredictable pattern of employees influencing each other organizations can still be quite stable.

In the next paragraphs I will further explore the concept of organizations as self-organizing complex systems. I will show how self-organization develops as a resultant of the interactions between the individual organizational members. And once due to self-organization a stable pattern of attitudes has emerged from these interactions also an organizational shared way of doing things emerges which then can be seen as part of the identity of the organization. First, I will elaborate on the concept of organizations as self-organizing systems in a literature overview. After I demonstrated that this perspective on organizations is valid, I will show how stable patterns of attitudes emerge in organizations. To study the emergence of a shared attitude, I will show that only by computer simulation it is possible to study emergence in sufficient detail and to make it possible to open the black box of emergence. My final aim is that, by opening the black box of emergence, managerial tools can be identified in order to be able to get a grip on emergence.

1.3 **Historical development in regarding organizations and organizational changes; from rationality to complexity**

In the previous paragraph I concluded that organizations can best be seen as self-organizing complex systems. This conclusion was based on both personal experiences and commonly accepted facts found in the literature. In this section the development in the thinking regarding the nature of organizations will be described in more detail. For this three perspectives on organizations will be described and the consequences of these perspectives for leading organizations. These three perspectives on organizations have succeeded each other in time and its categorization is based on the overview of organizational theory provided by W.
R. Scott (Scott, 2003). With respect to leading organizations I will focus on the role of management in organizational change and not on their role in maintaining the regular processes.

1.3.1 Organizations as rational systems
Organizations as rational systems is the perspective of the classical schools of management. The classical schools are characterized by the assumption that organizations are rational systems that can be designed at will to obtain specific goals. Schools that advocate this perspective are Fayol’s administrative theory, Taylor’s scientific management and Weber’s bureaucracy-theory (Scott, 2003). Depending on the school, no little attention is paid to personal motives of individuals in the organization, a strict rational behavior is assumed. The perspective of organizational change based on the perspective of organizations as rational systems is the structural theory of organizational change. In this perspective, organizational efficacy is achieved by a rational design of the organization. Organizations are steered by means of control and structure by which behavior can be coordinated and controlled. The leadership associated with these classical schools is that of the strategic architect who designs organizations (Scott, 2003). In this perspective organizations are fully controllable and predictable.

1.3.2 Organizations as natural systems
In reaction to the rational system perspective on organizations, the natural system perspective emerged. Schools associated with this perspective are characterized by the notion that organizations are regarded as collectives of individuals, i.e. social groups that need to adapt to survive. These schools recognize that an informal structure could exist beside the formal structure. Schools representing the natural systems theory are Mayo’s human relations school, Barnard’s cooperative system, Selznick’s institutional approach and Parson’s AGIL schema (Scott, 2003). In these schools it is recognized that individuals’ behavior is not only determined by the formal organizational goals but also by individual and group goals. Leading organizations from the natural systems perspective is seen as establishing social consensus regarding the organizational goals. With their emphasis on behavior and social consensus these schools endorse the importance of a positive attitude of individuals towards the organizational goals. The perspective of change linked to the natural systems perspective on organizations is the school of Organizational Development represented by scholars as Maslow, McGregor, Schein and Lewin (Scott, 2003). The basic definition of organizational development is provided by Beckhard (1969): “Organization development is an effort (1) planned, (2) organization wide, and (3) managed from the top, to (4) increase organization effectiveness and health through (5) planned interventions in the organization’s ‘processes,’ using.
behavioral-science knowledge” (Beckhard, 1969: 9). After this definition many followed. Egan (2001) counted 27 definitions containing 60 different variables (Egan, 2001). Central in all Organizational Development definitions however is the human resource focus of its approach to changes. The Organizational Development school however, still presumes that the change is a rational process that can be planned similar to the rational perspective on organizations as discussed above. In contrast to the rational perspective, in the Organizational Development perspective there is a clear awareness that not all information is available and learning is essential. The Organizational Development school with its emphasis on behavioral sciences also recognizes and emphasizes that also other than only rational motives will influence decision making and acceptance. The leadership style associated with Organizational Development is that of the logical incrementalism (Quinn, 1982). In this perspective it is explicitly recognized that the process of strategy formation is fragmented, evolutionary and largely intuitive (Quinn, 1978). Strategy requires testing new ideas in a circular process of personal and organizational learning. In the perspective of organizations as natural systems it is recognized that leading an organization is not a straightforward process and that intrinsic uncertainties are present. However, organizations are still regarded as being largely controllable by using the right instruments being organizational learning and human resource management.

1.3.3 Organizations as open systems
The perspective of organizations as natural systems does not sufficiently capture the complexity of our current organizations, and was followed by the perspective of organizations as open systems. This perspective on organizations emphasizes the complexity of organizations, and focuses on both the looseness of organizations and the connections between parts or individuals in organizations. In this perspective, organizations have no clear boundaries: materials, energy and information flow through the organizations. This movement is essential for the organization. Two processes operate simultaneously in organizations as open systems: processes that preserve the organization and processes that change the organization. In this perspective on organizations, organizations are complex systems capable of self-regulation. Schools representing the open system perspective are e.g., the Systems Designs school which emphasizes the nonlinear dynamics in organizations (Thietart & Forgues, 1995) and the school of the Contingency Theory stating that there is no uniform way to organize an organization, the way to organize depends on the environmental conditions (Lawrence & Lorsch, 1967). Another example of the perspective of organizations as open systems is Weick’s model of organizing. His model is based on the presumption that the primary reason of people to organize, is to reduce uncertainty and when organizations want to survive they
need to balance flexibility and stability (Weick, 1976). In general in the open systems schools there is a strong emphasis on processes and adaption.

Change in organizations as open systems can best be linked to the Critical Theory of Change (Grieves, 2010). In this perspective, the linear sequence of change cascading through the organization is abandoned. Change is seen as a nonlinear process in which people are active agents. However, it is also recognized that people have to accept changes and that the acceptance of these changes can be hindered by resistance, cynicism or reorganization fatigue. In this theory, the driving force for change are conflicts which are inevitably generated by the organization’s complexity. Change in this theory is caused by emerge rather than by planned actions (Grieves, 2010). This perception on organizational change fits with the view that attitudes are negotiated between the organizational members who will try to persuade others with a conflicting attitude in order to resolve this conflict. Although the Critical Theory of Change might best fit in with reality, it doesn’t provide lessons about how to manage an organization. As put forward by Grieves (2010) “Critical Theory should be considered as change theory without an intervention strategy” (Grieves, 2010: 33). This conclusion is not very helpful for managers who need tools and guidance to steer organizations.

The perspective of organizations as open systems may be the best description of our current -complex- organizations. As a consequence, it needs to be accepted that organizations are driven by nonlinear processes, which are almost by definition uncontrollable. Therefore, these perspective seems to deprive managers from means to steer an organization.

The perspective on organizations as open systems is the perspective used in this thesis. However, we will challenge Grieves’ statement that due to nonlinearity of the processes there are no intervention strategies possible, and as a consequence organizations displaying nonlinear processes cannot be steered. We will demonstrate that by obtaining more insight into the nonlinear process of attitude formation in organizations, it is possible to generate intervention strategies for managers that can enhance the influence of managers on these processes and make them more controllable.

1.4 The features of complex systems in relation to organizations
In the previous paragraphs it was concluded that there are good arguments to regard organizations as complex systems. In this paragraph we will explore the general characteristics of complex systems. From the complexity theory it is known that complex systems display a number of special characteristics and having defined organizations as complex systems, these characteristics will also apply to organizations. In this paragraph the specific characteristics of complex systems will be related to organizations.
1.4.1 General characteristics of complex systems

The first characteristic of a complex system is that it will self-organize (Stewart & Cohen, 1994). The concept of self-organization is demonstrated best by the work of Kaufmann (Kauffman, 1993). In his work Kaufmann modelled a large landscape of light bulbs in which each bulb was connected to four surrounding bulbs. Each bulb was given a decision schema, e.g., when 3 or 4 of the bulbs connected to it were on, the bulb itself went on, when only 1 or 2 connected bulbs were on, the bulb went off. Instinctively one might predict that based on the initial conditions, three end situations could occur: all bulbs are on, all bulbs are off, or a chaotic pattern of bulbs switching itself on and off. However, what was found was that there were always stable patches of bulbs that were either on or off, and patches of bulbs which kept switching on and off. The patches and the nature of these patches, however, remained stable, and the system thus self-organized (Kauffman, 1993). This type of self-organization is typical for complex systems.

The second characteristic of a complex system is that it will display nonlinear behavior. To understand nonlinearity, we need to explain linear behavior first. Linear behavior occurs when there is a clear relation between cause and effect. Note that this relation can be a line, in which an increase in one parameter results in a similar increase in the other parameter, or in an exponential increase or even a parabola. The key is that the relation between both parameters is predictable, and based on an equation. In linear systems, the initial parameters predict the outcome of the system. Vice versa, knowledge of the outcome can be used to determine the initial parameters. In nonlinear systems however, the initial parameters are not predictive for the outcome: the relation between cause and effect is lacking. As an example of how a system can change from a linear system into a complex system by expanding the number of interacting elements, one can imagine a pool table. If one pool ball is placed on a specific spot on the table, and targeted on a specific spot with a specific force and at a specific angle, it will obtain a specific speed and direction, and after bouncing against some pool table sides it will come to rest at a specific place. If this process is repeated and all initial conditions are held exactly the same, a ball will end at the same place, time after time. This is an example of a linear system: there is a clear relation between cause -hitting the ball- and effect -the place where the ball is found afterwards-. Now imagine a break in a game of pool in which 1 ball hits a rack of 15 balls. Even when we are able to perform this break under exactly the same conditions, the position of all balls after the break is uncertain. In this case there is no relation between cause and effect and from the end position of the balls it has become impossible to determine the starting conditions: the system has become nonlinear just by adding more components and thus more interactions.
The third characteristic of a complex system is that it will display non-proportional behavior. Non-proportional behavior was metaphorically explained by describing how the flap of the wings of a butterfly in Brazil might cause a tornado in Texas: the so-called butterfly effect. In nonlinear systems, a small change in one place may cause a disproportionally large change in another place, however, the opposite may happen as well: a large change in one place may leave no traces at all and may be completely absorbed by the system. The disproportional behavior of organizations is described in the punctuated equilibrium theory (Gersick, 1991). This theory states that organizations go through long periods of stability, interrupted by short periods of fundamental change. Kaufmann (1993) explains this phenomenon by the observation that complex systems move to the edge of chaos, indicating that those systems evolve to a state in which one small event can cause an avalanche of changes cascading through the system (Kauffman, 1993). Although parts of complex systems may be continuously in a state of change their nature will remain stable, until the system moves towards the edge of chaos and one extra change will cause a cascade of other changes leading to a fundamentally new equilibrium. The edge of chaos can be visualized by an hourglass. When the hourglass is turned upside down, the sand will form a cone in a gradual process. However, at some moments small avalanches will be observed which are triggered by just one piece of sand. The theory claims that, in order to cause this effect, the pile has to be in a state described as being on the edge of chaos.

The combination of nonlinearity and disproportional behavior of complex systems makes that complex systems self-organize in an unpredictable manner. When organizations are regarded as complex systems, these characteristics will thus also be found in organizations.

1.4.2 Organizations as complex systems
In Kaufmann’s example of interacting light bulbs, the interactions of the individual bulbs led to a specific pattern on the macro level. These light bulbs can be used as an analogy for the attitudes of individuals in organizations: as a result of their mutual interactions, an organization wide pattern of attitudes will emerge. This statement is supported by the observation that organizations are social systems (Katz, 1964) in which conflicts caused by disagreements/incompatible views are solved by organizational members interacting with each other. During these interactions, individuals will make their point by using social influence. However the same individuals will also be influenced by others making their point and will determine their opinion or attitude towards a behavior based on the social influence experienced from these others and their own initial attitude. Then due to the self-organizing features of complex systems, from these multiple social interactions between individuals in the organization an organizational wide pattern of attitudes...
will emerge. This perspective of organizations as self-organizing complex systems is put forward by various scholars (Anderson, 1999; Meyer et al., 2005; Monge et al., 2008; Chiles et al., 2004; Lichtenstein, 2000).

In the previous paragraph, we saw that complex systems display self-organization, nonlinear and disproportional behavior. Self-organization explains why, despite the complexity of organizations, organizations in general are relatively stable. The disproportional behavior of complex systems when they move to the edge of chaos is the driving mechanism behind the punctuated equilibrium theory for organizations. Based on these considerations it can be concluded that in organizations macro phenomena emerge autonomously, that organizations are unpredictable and that due to nonlinearity outcomes cannot be influenced by rational design. The often cited failure rate for organizational changes of 70% (Burnes, 2004; Greenwood & Hinings, 1996; Jacobs, van Witteloostuijn, & Christe-Zeyse, 2013; Young, 2009) supports the intrinsic uncertainty in organizations regarding guiding/steering organizations to strategic goals. The nonlinearity found in organizations is why the Critical Theory of Change doesn’t provide us with intervention methods; in this theory it is presumed that, due to the nonlinear character of organizations, there is no relation between cause and effect and thus any strategy is pointless.

Nevertheless, managers are expected to take initiatives and lead their subordinates to a goal with the intention to improve organizational performance (Robertson et al., 1993; Young, 2009). To facilitate managers in this task, managers have access to various organizational resources to influence their subordinates. However, from the perspective of organizations as self-organizing complex systems this influence and the effects of these initiatives will be limited. In a paper regarding the role of managers in organizations as complex systems, it was concluded that managers had an enabling role as opposed to the directing role managers are traditionally given (Marion and Uhl-Bien, 2001; Plowman et al., 2007). In this enabling role the manager doesn’t lead the organization to a goal, but rather facilitates change without knowing what the exact outcome will be. Thus, in complex organizations there is a conflict between the task of managers -to lead- and the means - their influence- with which managers have to accomplish their task.

In this thesis, organizations are regarded as self-organizing complex systems in which macro phenomena - the emergence of a shared attitude- emerge, rather than being the result of a planned rational design. By exploring the emerging process of attitude formation in organizations, we aim to obtain more insight into the dynamics and the organizational factors involved in this process. Based on the data we aim to identify organizational factors that can enhance the influence management on the emergence of a shared attitude in various situations. In this study we attempt to provide strategies that will enable managers to fulfill their task
in complex organizations: to lead the organization, and in this thesis to influence the outcome of a shared attitude.

1.5 Attitudes and attitude formation in organizations
In paragraph 1.2.3 we stated that managers are expected to improve organizational performance (Robertson, Roberts, & Porras, 1993; Young, 2009). In order to fulfill this task, leadership is required, which we defined as influencing the behavior of others in order to achieve the organizational goals (Hollander, 1986). The question to be answered in this paragraph is what drives behavior. Obviously, behavior is determined by multiple factors. The factor we will focus on in this thesis is a positive attitude towards a particular behavior. The relation between attitude and behavior is described in Ajzen’s theory of planned behavior (Ajzen, 1991). In this theory, behavior is driven by intentions, as stated by Ajzen “as a general rule, the stronger the intention to engage in a behavior, the more likely is its performance” (Ajzen, 1991: 181). The attitude towards behavior as defined by Ajzen (1991) “refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question” (Ajzen, 1991: 188), and thus directly influences intentions and indirectly behavior. When correlations coefficients between intentions and the attitude towards behavior from a number of studies were compared, they ranged from 0.92 (to play six video games) to 0.33 (to participate in an election or to lose weight) (Ajzen, 1991). Based on these data a positive attitude is thus a good predictor of behavior. However the degree of an attitude’s predictability may differ between behaviors. Nevertheless in all theories explaining behavior, attitudes play a central role (Olson & Zanna, 1993). A positive attitude towards a specific behavior is thus generally regarded as a precursor of this behavior.

The importance of attitudes in organizational change processes is reported in various studies. Bouckenooghe (2010) and Oreg et al. (2011) argue that the attitudes of employees towards proposed changes are crucial for the success of the changes. Choi (2011) concludes that the success of a change, is for an important part determined by the employees’ support for the change represented by their attitudes towards the change (Choi, 2011). Choi further argues that the key variables in the change literature, such as readiness to change, commitment to change, openness to change and cynicism to change, are in essence all representations of employee’s attitudes towards organizational change (Choi, 2011). Additionally, Solinger argues that organizational commitment can be regarded as an attitude (Solinger, van Olffen, & Roe, 2008). Therefore, a variety of organizational behaviors, such as organizational citizenship, work performance, absenteeism and turnover, which are correlated to commitment (Meyer, Stanley, Herscovitch, & Topolnytsky, 2002), are also driven by the attitudes of individuals. It is thus supported by various organizational scholars that by generating an organizational-wide positive attitude...
towards the organizational goals, management can effectively influence behavior and thus work performance. In a meta-analysis, Young (2009) identified a number of common themes in the various schools of organizational change. In comparing all schools two themes were found in all schools of organizational change: a stimulus setting the change in motion and the commitment to act (Andrews, Cameron, & Harris, 2008; Young, 2009). In this way, Young demonstrates/shows that a positive attitude towards an organizational change is recognized as an important attribute of the success of an organizational change in all schools of organizational change.

According to the theory of planned behavior also norms and the perceived behavioral control, influence intentions and thus behavior (Ajzen, 1991). These factors differ from attitudes with regard to the time needed to change them. It takes more time to change norms and behavioral control than it takes to change one’s attitude. In this thesis we will however study emergence over a period of a few weeks to a month which is too short to change norms and behavioral control. Therefore, both factors are in this thesis regarded as static parameters which contribute to the personal resistance of an individual to change one’s attitude: when the perceived behavioral control is low or the personal norms are in conflict with the required behavior, the resistance to change one’s attitude will be high.

1.6 Influencing Attitudes

The mechanism behind attitude change is described in the Elaboration-Likelihood Model (ELM) (Petty, Cacioppo, & Schumann, 1983). In the ELM two routes of persuasion are identified: the central and the peripheral route. In the central route, the recipient consciously processes information after which the attitude is determined. In the peripheral route, less time is devoted to processing the information, and a decision is made based on general information. Regardless of the route, attitudes can be changed by two means: message based persuasion and social influence. Message based persuasion is based on the power of the arguments provided by the source, whereas social influence is based on the information regarding the source of information. Attitude changes are thus driven by informational and normative motives. Wood (2000) identified three normative motives for attitude change: “(a) ensuring the coherence and favorable evaluation of the self, and (b) ensuring satisfactory relations with others given the rewards/punishments they can provide, along with an informational concern for (c) understanding the entity or issue featured in influence appeals” (Wood, 2000: 541). However, informational and normative motives will also influence each other. It was shown that depending on the normative motives of an individual, information was selectively biased in order to fulfill the normative needs (Lundgren & Prislin, 1998). However, for our purposes it is unnecessary to further elaborate on the
various motives regarding attitude change, all motives are incorporated in one factor for personal the persuasiveness without differentiating between them.

An aspect of attitudes that needs further attention is the attitude strength. The strength of an attitude has three dimensions: the durability of the attitude, the effect it has on behavior, and the resistance to change the attitude (Eaton, Visser, Krosnick, & Anand, 2009). It was demonstrate that the dimensions of attitude strength are largely independent e.g., an attitude that is strong in durability may still have little impact on behavior. Also the antecedents of attitude strength such as personal importance, the amount of knowledge on which the attitude is based, the quality of this knowledge, and the certainty of the knowledge, will differently influence each dimension of the attitude strength (Eaton et al., 2009). Therefore it is not easy or even impossible to capture the attitude strength in one parameter. For our model we only incorporated one dimension of the attitude strength: the resistance to change one’s attitude. In general, the resistance to persuasion is influenced by the characteristics of the attitude itself, such as its importance for the individual, and by the characteristics of the individual itself, such as their motivation to resist (Wheeler, Brinol, & Hermann, 2007). Personal characteristics that will influence the resistance to persuasion are a strong preference for routine, cognitive rigidity, and a short-term focus (Oreg, 2003). In addition, individuals can be highly resistant to changing their attitude when this is an important source of their identity (Krosnick, Boninger, Chuang, Berent, & Carnot, 1993). The resistance to change one’s attitude is in this thesis defined as a factor that strengthens the current attitude by which the persuasive force needs to be increased in order to persuade an individual to change his/her current attitude.

1.7 Attitude formation in groups: organizationally shared attitudes.

So far, attitude changes have been treated from the perspective of individuals, however, for organizations it is essential that organizationally preferred attitudes are shared by its members. The importance of attitude formation for organizational changes is emphasized by Choi and Boucknooghe (Bouckenooghe, 2010; Choi, 2011). Both authors recognize that attitude formation is important for the success of organizational changes, and recognize that attitude formation takes place in individuals. Choi concludes in his review that “an increasing number of researchers have argued that many change efforts fail because change leaders often underestimate the central role individuals play in the change process” (Choi, 2011: 479). Boucknooghe states that “attitudes are characterized by the fact that they are individual states that may become shared by groups of individuals (i.e., level of change)” (Bouckenooghe, 2010: 528). Both authors emphasize the importance of attitudes in organizational changes, and Bouckenooghe explicitly states that for macro level phenomena such as organizational changes a shared attitude is the key.
to a successful change. Given the importance of shared attitudes in organizations, the conclusion that such a shared attitude emerge and emerging processes can only be studied in sufficient detail by computer simulation, we needed a computer model to study this process as will be explained in section 1.8.

As a basis for our model we used the model of Nowak and Latane. By using computer simulation Nowak and Latane demonstrated how a public opinion can emerge from interactions between individuals, (Nowak, Szamrej, & Latane, 1990). This model was based on the theory of social impact (Latane, 1981). The advantage of this model in comparison to previous models was that in previous models groups used to become fully homogeneous. Whereas in real-life there is indeed a natural tendency of groups to become rather homogeneous, there are always minority groups (Moscovici & Zavalloni, 1969). The model of Nowak and Latane simulates exactly this situation: the convergence of a group to a majority attitude and a small number of agents with a minority attitude still present. In the model of Nowak and Latane thus an attitude formation process was simulated that was based on non-linear behavior, and that generated results resembling real life. Nowak and Latane were a strong proponent of the use of computer modelling. They argued that “As group size increases, as laws about individual responses become more complex, and as the macro level property requires long and complicated sequences of individual interactions, however, we reach the limits of human intelligence. The possibility of accurately checking the correspondence between mechanisms at two such levels simply with mental formulas or paper-and-pencil calculations becomes more and more remote.” (Nowak et al., 1990: 362). With regard to the nonlinear behavior Nowak and Latane stated “We believe the crucial feature that makes our simulations have different properties from previous ones is the essential nonlinearity of the impact-attitude relationship” (Nowak et al., 1990: 372). This model was the first model that truly captured the nonlinear behavior in large groups and generated real life phenomena regarding group polarization based on individual’s behavior, bridging the gap between individuals’ psychological processes and group processes.

In this thesis we used the model of Nowak and Latane as a basis to simulate the emergence of an shared attitude in organizations. However this model wasn’t made for organizations and didn’t include organizational parameters. Therefore, this model was extended and made fit to simulate organizations by including organization specific parameters and interaction patterns mimicking the interaction patterns in real-life organizations.

1.8 Computer simulation

Before going into more detail regarding the main features of our model, first computer modeling in general will be described and as well why computer modeling is an essential tool to study complexity.
1.8.1 Computer simulation as a tool for studying complexity

Self-organization in complex systems can only be studied in sufficient detail by computer simulation. The main reason is that both the type and the amount of data that needs to be gathered for such studies is far beyond what can be done manually or empirically (Davis, Eisenhardt, & Bingham, 2007; Rousseau, 2011). To give the reader an idea of the amount of data involved, I will take the relatively small virtual organization that we used in our research as an example.

In the virtual organization used in this thesis, there are 181 agents (the structure is presented in figure 1). During a simulation each agent will interact with all 180 other individuals, leading to 32,580 interactions during one round of interaction. When we use 10 to 25 rounds of interactions, this will lead to 325,800 to 814,500 interactions per virtual organization that needs to be simulated. Finally, in one simulation we include 500 to 1000 configurations of our standard organization, which leads us to 162,900,000 to 814,500,000 interactions to be calculated per simulation. Translating this to a similar real life organization, we need to correct for the fact that in real life organizations not every employee will interact with every other employee. However, when employees would interact with only 1% of the other organizational members (about 2 per interaction round), even then, 1.6 to 0.8 million interactions would occur, which is absolutely impossible to follow in real life. The possibility to follow all these interactions with computer simulation is a huge advantage and a necessity to study emerging processes in sufficient detail.

Another advantage of computer simulation relates to a conclusion of a review of 60 years of change research by Oreg (2011) stating that: “The vast majority of studies explored change processes that occurred in a single organization (or department). This prevents the consideration of variables (e.g. antecedents) at the organizational level, such as change content. A main reason for the limited amount of studies with organizational-level variable is that such studies require data from multiple organizations, which are logistically difficult to obtain” (Oreg, Vakola, & Armenakis, 2011: 47). To perform multi organization studies, Oreg pleads for parallel studies of comparable organizations going though similar types of change. However, with the help of computer simulation this gap can easily be filled, because with computer simulation multiple organizations can be included without any restrictions.

In an article of Rousseau and van der Veen (2005) in which the emergence of a shared sense of identity in societies was investigated, five benefits of using computer models were identified (Rousseau & Van der Veen, 2005). The first benefit is that, very explicit assumptions are needed to design a computer model. Davis (2007) describes this as follows: “By requiring precise specification of assumptions, simulation typically bounds the scope of the theory and so clarifies boundary conditions” (Davis et al., 2007: 495). In designing a computer program, clear choices
have to be made of how the elements are related, and thereafter connected with each other. Different choices of how empirical results are translated into algorithms may lead to different outcomes. Some of the choices can be debatable e.g., in our model an agent only changed its attitude after persuasion, never spontaneously. However, even though some choices are debatable, the model provides the possibilities to compare the effects of these choices and see which fits reality best.

The second benefit of computer simulation is that simulations can be designed at will, allowing every combination of parameters to be explored (Davis et al., 2007). Some combinations of parameters may not be frequently found in real life. However from an experimental point of view such combinations are very useful. Since the influence of one parameter is detached from the influence of other parameters, all influences of the parameters in the model can be determined directly, without any
elaborate statistical calculations to separate the influence of other parameters from the influence of the parameter to be investigated (Oreg et al., 2011).

The third benefit of computer simulation -as mentioned before- is that it can handle the large amounts of data that are necessary to investigate complex organizations. The fourth advantage of computer simulation is that computer simulations open the possibility to explore the processes and dynamics of how an outcome is established, instead of only measuring the relation between a parameter and an outcome (Rousseau & Van der Veen, 2005). In most empirical studies at a single point in time a relation is found between two or more organizational features without showing the direction of a relation, or how the dynamics in the organization led to the relation. There is, for example, a well-established correlation between a good HRM policy and performance. However, it is unknown whether good HRM leads to a good performance, or whether good performance leads to a good HRM. It is however, exactly this type of information that contributes to our understanding of what happens in organizations. Computer simulations thus open the possibility to study longitudinal processes. There is a lack of longitudinal studies in the organization literature (Oreg et al., 2011), however, by using computer simulation longitudinal processes can be simulated that are hard or even impossible to organize empirically. Davis (2007) mentions the possibility of investigating nonlinear processes when he states that “Simulation is also well-suited to theory development related to nonlinear phenomena, such as tipping points, feedback loops, thresholds and catastrophes, and asymmetries” (Davis et al., 2007: 495).

Finally, computer models can be uses in both a deductive way and an inductive way. They can be used deductively because the model is built on established theories, and is the result of the combination of these theories. Computer models can also be applied inductively since by running the model, and changing the parameters, hypothesis can be tested (Rousseau & Van der Veen, 2005).

Despite these benefits, computer simulations have disadvantages as well a. When a computer model is unable to sufficiently capture the complexities of real life and unable to mimic real life sufficiently, the generated results are of little use for real-life situations. To test whether the model is sufficiently representative for real life, validation of the model is needed. (Davis et al., 2007); the more valid the model proves to be, the more valid the conclusion will be. With regard to models simulating emerging processes in organizations, to be valid the model must self-organize into a stable pattern as observed in real life. In real life most organizations are stable since it is unlikely that a organization would survive when it constantly changes. Second, the model must be nonlinear. This is the essence of complex systems. Only when the model exhibits nonlinear behavior, we are able to study emerging processes. Finally, the outcomes should be in line with a number of mainstream features of organizations. When the model should generate
outcomes that are unlikely to happen in real life the results obtained are equally unlikely, therefore the significance of the outcomes of the model is proportionally to the ability of the model to mimic other real life organizational outcomes.

1.8.2 The specific features of our computer model

The model we used to explore complex organizations belongs to the category of the agent based models and is comparable to the light bulbs model of Kaufmann (Kauffman, 1993; Schelling, 1971). In general, such models consist of a number of agents (like the light bulbs in Kaufman’s model). Each of these agents interacts with a number of other agents (counterparts), just like organization members interact with each other. The difference between Kauffman’s model and ours is that we introduced more complex decision rules and more sophisticated interaction patterns.

What makes agent based models unique is that they are able to mimic the emergence of macro structures derived from individual, micro level behavior, and thus connect micro with macro levels (Davis et al., 2007; Rousseau, 2011). A typical characteristic of these types of models is that the behavior of the agents is defined by decision rules. Like the light bulbs in Kaufmann’s model, in which a light bulb ‘uses’ a decision rule in the form of an algorithm, in our model also a decision rule in the form of an algorithm is attached to each agent in the model. In our case this decision rule determines the attitude of each agent. In real life individuals also use decision rules, described in the social cognition theory as schemata (Markus, 1977). These decision rules are in real life used to process information in order to make sense of a situation, to adjust behavior, and to learn (Anderson, 1999; Lau & Woodman, 1995). In analogy, each agent in our model uses a schema to determine its attitude. The schema is identical for each agent and is based on the theory of social influence and includes algorithms for compliance, conformity and resistance.

Besides being subjected to a similar decision scheme, each agent in our model was also randomly given a number of ‘personal’ characteristics, such as reaction to authority, resistance to change, and its initial attitude. These personal characteristics modified the reactions to organizational characteristics. With respect to authority for instance, an interaction with a superior led to amplification of the influence of the superior; the level of this amplification was determined by the organization; in some organizations the level of authority is higher than in others. However, this influence could be reduced or strengthened by the ‘personal characteristics’ of the agent, leading to an unique response to equal organizational inputs. Thus, although the schemata were identical for each agent, each agent reacted differently to similar organizational influences. In this manner the variety between individuals in an organization was mimicked.

The model we used builds further on the model of Nowak, that was based on the theory of social impact (Nowak et al., 1990). According to the theory of social
impact, the influence one experiences, is determined by the number of people one interacts with, whether they are regarded as in- or out-group members, and their influential strength (Latane, 1981). Translating this to a mathematical model implies that an agent will interact with a number of other agents, called the counterparts and that each counterpart will influence the agent that its attitude is the right one when the agent has a different attitude, or will support the agent when it has a similar attitude. However, the influence of each counterpart will differ, as explained above, depending on its ‘personal characteristics’. Nowak demonstrated how a computer model based on the theory of social impact could mimic the emergence of a shared opinion in a group. He concluded that “Macro-level phenomena that were generated were an incomplete polarization of opinions reaching a stable equilibrium, with coherent minority sub-groups managing to exist near the margins of the whole population” (Nowak et al., 1990: 362). This model however, didn’t include organizational parameters and can thus not be used to study emergence in organizations.

Similar to the model of Nowak and Latane each agent could only generate two outcomes; a positive attitude towards a specific behavior or a negative attitude towards this behavior. We realize that this is a simplification of real life in which numerous ‘shades of grey’ can be found, but believe that we still will be able to determine the effects of various organizational parameters adequately.

To determine whether an agent had an attitude in favor or against the opinion of a counterpart, the sum of all the influences of the counterparts with whom they interacted was determined. In the model it was first determined with which agents an agent would interact. Then the agent had contact with all these other agents which all had a different persuasive of supportive influence. Each influence was then added to the total sum of either persuasive or supportive influences. However, since each individual has a personal preference, and individuals will resist changing their preference, it generally will take more effort to persuade someone than to support someone. Therefore, the sum of all influences experienced by the agent from the counterparts with the equal attitude was amplified by the agent’s resistance to change its attitude, which resulted in the total supportive force experienced by the agent. Then the total supportive force was compared with the sum of the influences of all agents having a different attitude; the persuasive force. When the persuasive force was higher than the supportive force, the agent changed its attitude. Thus more persuasion was needed to change an agent’s attitude than support to maintain its attitude. The details of the decision scheme are described in more detail in chapter 2. For now it is important to note that the decision scheme each agent used, was based on social influence and although the basic algorithm is similar for each agent, due to the “personal characteristics” given to each agent, similar influences generated different outcomes per agent.
At this point we need to mention that our model is not intended to predict the future such as a weather forecast model does, but to predict trends that can be evaluated empirically. Two major reasons prevented forecasting. The first reason is the simplicity of our model. Since only a limited number of organizational and personal features were included into the model, the model is too simple to make forecasts. Second, it is impossible to exactly determine all parameters for each individual in an organization at a given point in time. In weather forecasts large networks of weather stations are used that provide all essential information at numerous places on earth such as temperature, wind direction and strength, pressure etcetera. To make a forecast in organizations, similar to weather forecast, we need to know all parameters of all individuals in the organization such as their current attitude, the resistance to change it, their norms towards authority etcetera. Since this is impossible, forecasting is equally impossible and even then -as it is well known from weather forecasting- it is still not error proof. What our model however did, was to show trends. For a number of organizational features included into the model we could correlate the values of these factors with the outcomes and thus determine the influence of the organizational parameters on the outcome.

1.9 Summary of the introduction and outline of the thesis

In the previous sections we reasoned why attitudes are important for organizational performance. We further showed that, to make the step from the separate attitudes of separate individuals to an organizationally wide shared attitude, organizations have to be regarded as self-organizing complex systems, in which the phenomenon of emergence is responsible for organizational performance. We also demonstrated that such systems could best be studied by computer modelling.

In this thesis our aim is to identify organizational factors that can enhance the influence management has on the emergence of a shared attitude in various situations. In Chapter 2 we will start with explaining our computer model in depth. In Chapter 3 the overall results regarding the dynamics and the quality of the model are presented as well as the nonlinearity of the model. In this chapter we describe the dynamics of the emergence of a shared attitude, starting from a random pattern of attitudes. Next we will assess the influence of organizational factors and the initial majority on the level of homogeneity at the end of the simulations, in order to determine which factors will influence the homogeneity of the organizations and groups in the organizations.

Having described the dynamics of the emergence of a shared attitude in chapter 3, in Chapter 4 we address the question whether managers can influence the emergence of a shared attitude. In this chapter we investigate a situation in which an organization is confronted with a change in the environment for which no guidance is available. The simulations start with a random pattern of attitudes,
a stable pattern of attitude then emerges from this random pattern. With this simulation we will investigate the influence of managers on the outcome of this process as well as which organizational factors contributed to the influence of management.

In Chapter 5 the organization already has a shared attitude, however, the agents in the organizations in time become convinced that the behavior associated with this attitude is failing and must change. In this simulation, management does not react to the new situation, and the organization chooses its own path. In this simulation, first a majority attitude is allowed to emerge. Then the agents in the organization slowly realize that the current dominant behavior fails and over time become more susceptible to change their attitude which is simulated by lowering their resistance against the new attitude. The lowering of the resistance leads to the emergence of the new majority attitude and thus adaption. However, when this general willingness to change ones attitude is insufficient to revert the current majority attitude, escalation of commitment sets in. In this chapter escalation of commitment is thus regarded as the outcome of a self-organizing process. In this chapter we will try to answer the question why adaption and escalation occurs and which organizational factors are of influence.

In Chapter 6 we will describe a situation in which the CEO becomes aware that the current behavior is counterproductive and a new behavior and thus a new attitude is needed. In this chapter we will thus address a planned change in which the CEO takes the initiative to implement a change. In this chapter we will focus on the post-intervention period and presume that during an intervention phase a number of agents’ attitudes are changed due to an intervention. However a change can only be regarded to be successful when the changes made during the intervention are stabilized and further expanded. Therefore we will assess the dynamics of attitude formation after the intervention period. We will assess which organizational factors will contribute to a stable planned change. In addition we will also compare the effectiveness of a top down intervention with a large group intervention.

In Chapter 7 we will summarize our findings and their implications for real-life organizations and management. We will further discuss the model and provide suggestions for further research.

In Appendix 1 the computer code is provided.
2

Modeling the emergence of a pattern of attitudes in organizations; opening the black box
CHAPTER 2
2 Modeling the emergence of a pattern of attitudes in organizations; opening the black box

2.1 Introduction

As discussed in the introduction, organizations should be regarded as self-organizing complex systems (Anderson, 1999; Chiles, Meyer, & Hench, 2004; Meyer, Gaba, & Colwell, 2005; Monge, Heiss, & Margolin, 2008; Plowman et al., 2007). One of the main characteristics of self-organizing systems is that they are nonlinear, meaning that in such systems there is no clear relation between cause and effect. This creates a problem for managers, since it removes any possibility of approaching organizational change by rational design alone and thus being able to steer the organization. In this chapter, we try to open the black box of self-organization by introducing a computer model that can simulate the emergence of a shared attitude, and we use this model to explore the dynamics of self-organization and assess which organizational factors can be attributed to self-organization. With computer modeling we hope to gain new insights that might help managers to steer self-organizing processes in organizations.

To explore the dynamics of self-organization and the factors involved, we studied how a shared attitude is formed. To achieve their goals, organizations need the support of their employees. It is therefore very important that employees should have a positive attitude towards those goals. Therefore, in this respect the emergence of a shared attitude can mean either the support or rejection (success or failure) of a goal set by management (Bouckenooghe, 2010; Choi, 2011; Oreg et al., 2011). Individuals’ attitudes can be changed by both persuasion and social influence during interactions with others in the organization (Wood, 2000). Therefore, it is argued that attitude formation is a self-organizing process. During attitude formation, a stable pattern of attitudes may emerge at the organizational level through the collective interactions between individuals at the micro level. A stable attitude shared by a majority of organizational members can be regarded as a specific feature of an organization.

In our model, individuals changed their attitude due to persuasion by social influence. In the literature, various isolated factors involved in persuasion have been identified (Chaiken & Stangor, 1987; Sillince, 2002). To study the self-organization of a shared attitude, we were challenged to integrate these factors into one model and examine their effects longitudinally. Studying the emergence of a shared attitude empirically would be virtually impossible, as we would need to be able to monitor, in real time, the attitudes of all the individuals in an organization, and to continue that monitoring for a considerable period to determine how the attitudes develop over time. At the moment it is impossible to collect such data, and it may never be possible to do so. In addition, because we want to examine the influence
of organizational factors on this process, such a study would need to be undertaken in a large number of different organizations. When the type and/or amount of collectable data cannot be obtained by empirical studies, computer simulation can be overcome this problem (Davis et al., 2007; Rousseau, 2011). We thus studied self-organization, and more specifically the emergence of a shared attitude, using computer modeling. The computer model we used was based on work by Nowak (Nowak et al., 1990). In his model, Nowak programmed the theory of social impact (Latane, 1981) and demonstrated how the interactions between individuals led to a shared opinion. This model thus described how macro-level phenomena emerged from micro-level interactions in the same way as we intended to do, as outlined in the introduction.

2.2 Attitudes, nonlinearity, and homogeneity

As described in the introduction organizations are social systems in which people’s behavior is coordinated in order to achieve particular goals. (Katz, 1964). When organizations are regarded as social systems, co-ordination is achieved through roles, norms, and values. Roles relate to the place and job of an individual in the organization. Norms are regarded as specific attitudes and behaviors that are associated with the roles in the organization, whereas values direct behavior (Katz, 1964). To achieve the goals of the organization effectively, it is very important that people are committed to them and thus have a positive attitude towards them (Choi, 2011). To be successful, it is therefore essential that the majority of employees have a positive attitude towards the organization’s goals. From this perspective, it would seem to be ideal when all employees have a positive attitude to the organizational goals and thus to have an entirely homogeneous organization. However, this would contradict with Ashby’s law of requisite variation, which states that, without sufficient diversity, an organization is locked into its current form and is unable to change in response to a changing environment (Ashby, 1958; Piderit, 2000). This creates a paradox in which managers have to find a balance between aiming for homogeneity to increase efficacy and at the same time maintaining sufficient diversity to enable the organization to respond to changes in the environment. Homogeneous organizations can be regarded as organizations with a strong culture, which is defined as a culture in which norms and values are widely shared (Sorensen, 2002). Strong cultures are generally seen as beneficial (Gordon & Ditomaso, 1992), which is likely to be the case in a stable environment, but not in a volatile environment (Sorensen, 2002). The importance of finding the right balance is in line with the finding that a combination of efficacy and wild ideas is the best predictor of organizational longevity (Burgelman & Grove, 2007; March, 2006).

The emergence of a shared attitude is a self-organizing process; such processes are almost by definition regarded as unpredictable and uncontrollable. The intrinsic
uncertainty associated with emergence is caused by the nonlinear behavior of emerging processes. Nonlinear systems are characterized by the absence of a direct relation between cause and effect. They can be very sensitive – a small change in one variable can have a big impact on the outcome. However, the opposite is also true: large changes can sometimes be absorbed completely, with minimal impact on the organization. In nonlinear systems it is therefore impossible to predict the outcome by the initial parameters, especially for large groups and across time (Thietart & Forgues, 1995). Nonlinearity is typical of complex systems which consist of many interacting elements exhibiting emerging properties (Morel & Ramanujam, 1999). The emerging properties of complex systems are evident in their ability to self-organize into relatively stable systems. However, due to the nonlinear character of emergence, the outcome of this process of self-organization cannot be predicted from the initial parameters. This feature – the uncertainty/unpredictability of the outcome – explains why emerging processes in organizations are often regarded as a mysterious ‘black box’ which is beyond the grasp of managers. By gaining insight into the process of self-organization we hope to find clues that might help reduce the uncertainty associated with self-organizing processes of attitude formation.

2.3 Theoretical basis of the model

In our model we extended Nowak’s model which simulated the emergence of a shared opinion in a society and was based on the theory of social impact (Nowak et al., 1990). The theory of social impact is based on the notion individuals are influenced by their social environment (Latane, 1981). According to this theory, a change in attitude will occur when the combined influence of all the persuasive forces an individual encounters is greater than that of all the supportive forces he or she encounters. It also explicitly states that the social distance determines how influential the other is. This theory therefore lends itself quite well to being translated into mathematical algorithms. Nowak used this theory to create an algorithm that described a decision rule used by each agent in his model. By applying this decision rule to agents in his model he was able to show, through his simulation, that a shared attitude emerged as a result of the interaction between the agents. Nowak thus demonstrated how, due to social influence and the interactions between individuals, attitude changes in these individuals led to the emergence of a stable pattern of attitudes at the societal level. This model was one of the first to simulate the emergence of a shared attitude and reveal nonlinear behavior. The results obtained with this model were in line with empirical evidence that earlier models had been unable to simulate. Two real-life features brought out by Nowak’s model were incomplete polarization and the spatial clustering of agents with similar attitudes.
Our decision to use Nowak’s model as a basis followed from our interest in how interactions at the micro level, i.e. individuals, led to outcomes at the macro level, i.e., the organization. In particular, the emergence and nonlinearity found in Nowak’s model were essential properties for answering the questions that are central to our study; what are the dynamics of emergence, and which factors are prominent in emergence? Also, Nowak’s model was founded on a theoretical basis that could, with adjustments, be made fit to include organizational factors. This last condition was quite important since we were interested in whether organizational factors would influence the emergence of a shared attitude and how they might do this. With regard to attitudes, it should be said that variables other than those presented in our paper can be used to model attitude changes (Huang & Wen, 2014). Also, in terms of the formation of general opinions, other models are available in which e.g. opinions emerge based on the gambling of agents about reputations (Dykstra, Eisenbroich, Jager, de Lavalette, & Verbrugge, 2013). These are just two examples of alternative agent-based models. A number of other such models could probably also have been used as the basis for our study. However, Nowak’s model provides a relatively simple and straightforward basis that could be expanded to include organizational parameters.

Central to our model are the attitudes of the agents. An attitude refers to the degree to which a person makes a favorable or unfavorable evaluation or appraisal of the behavior in question (Ajzen, 1991: 188). According to the theory of planned behavior, attitudes directly influence intentions and indirectly behavior. An attitude is regarded as an individual’s as being how an individual feels about a particular object – whether he or she feels it to be good or bad, beneficial or harmful, pleasant or unpleasant, etc. (Ajzen, 2001). In this thesis, as in Nowak’s model, attitudes, are expressed as a dichotomous parameter indicating the agent’s general feeling regarding a specific behavior; an agent could thus have only two attitudes: either 1 or 0, in favor of or against. We are aware that this dichotomous scale is an over-simplification of reality; however, for our purpose — identifying how various organizational factors influence the emergence of a shared attitude — this scale is sufficient.

However also the strength of the attitude also has to be taken into account. The strength of an attitude consists of the durability of the attitude, the effect it has on behavior, and how resistant an individual is to changing that attitude (Eaton et al., 2009). Some of these aspects are, however, incorporated into the model, as will be explained below here.

Resistance reflects how strongly individuals are committed to a particular attitude and how unwilling they may be to change it. This aspect of attitude is represented in the model by the personal resistance of an agent to changing its attitude.

The durability of an attitude refers to whether an attitude or a shared attitude is maintained for a long period or not. In the model the durability of an attitude at the
agent level is determined by the influences to which an individual is exposed and the resistance he or she has to persuasion. In response to these influences an agent can either change its attitude or maintain the same attitude. Whatever choice is made, it will subsequently influence other agents, and from these multiple interactions between agents in an organization a stable pattern of attitudes will emerge. Interactions between agents thus determine the durability of an attitude at the organizational level. In this thesis, the durability of a shared attitude is therefore an outcome that is studied and not an input variable.

We did not model the effect of an attitude on behavior. Different attitudes will have different effects on behavior. It was shown, for example, that a positive attitude to losing weight had a much lower correlation with behavior than a positive attitude to playing an number of video games (Ajzen, 1991: 188). We therefore took the perspective that a positive attitude toward a behavior, in general will have a positive correlation with displaying this behavior without further specifying the actual relation. With regard to organizations it was demonstrated that the success of a change is determined to a significant extent by the collective support of employees for that change, as represented by their attitude towards it (Choi, 2011).

Because populations are different from organizations we had to adjust and expand Nowak’s model to be able to simulate organizations. The basic assumption underlying our model is that agents change their attitudes due to the process of social influence (Wood, 2000). Two dimensions of social influence were incorporated into the model: compliance and conformity. Compliance was defined as “a particular response – acquiescence – to a particular kind of communication – a request” (Cialdini & Goldstein, 2004: 592). Conformity was defined as “the act of changing one’s behavior to match the responses of others” (Cialdini & Goldstein, 2004: 606).

Compliance and conformity are both external forces from other individuals. However, we also have to consider an internal force: resistance. Individuals will resist persuasion to various degrees, depending on how important the attitude is to them and their own preferences (Eaton et al., 2009; Krosnick et al., 1993; Oreg, 2006).

Based on these considerations we designed a decision rule for each agent in the model by which the agent decided to change its actual attitude or not. Agents use this decision rule as a schema to process the information obtained from other agents it ‘interacts’ with in order to develop its own attitude. This approach is in agreement with social cognition theory, which states that people use schemata (Markus, 1977) to process information, make sense of a situation, adjust their behavior, and learn. The decision rule in our model consists of three building blocks, compliance, conformity, and resistance, which will be described in more detail in the following sections.
2.4 The first building block: compliance
In the case of compliance, an individual is either directly or indirectly called upon to respond to the other person with whom he or she is interacting. The other person will try to persuade that individual of the validity of his or her own attitude. In this interaction, the counterpart will try to persuade the other of the validity of his/her attitude. Therefore, for compliance to take place, an interaction between individuals is needed. Only when an interaction takes place will an agent be influenced by another agent. We will first describe the interaction pattern between agents and then the influential force of the counterpart.

2.4.1 Interaction patterns between agents
To mimic interaction patterns in an organization, we made a distinction between organizational and personal factors that affect interactions. The first organizational factor we included was organizational structure. The chance of two agents meeting will be strongly influenced by their physical proximity and the frequency of their professional interaction. Both are determined in large part by their positions in the organizational structure. When two agents belong to the same group they are likely to work in close proximity to one another and to have frequent professional interaction. Therefore, individuals who are part of the same group will typically interact more often than individuals from different groups. Another organizational factor we included was communication density, namely the frequency of communication within an organization. In many organizations, this may be determined by the organizational culture or the nature of the work. Culture can influence communication on many levels; a high frequency of communication can be associated with, for example, organizations in which decisions are made by consensus, organizations with a strong social character, or those in which informal interactions are actively stimulated. In terms of the nature of the work, less interaction is generally needed when processes are simple and can rely on codified/explicit knowledge. However, when processes are complex and tacit knowledge is needed, more interactions are likely to be required. All of these factors will determine the communication density in an organization.

Communication is also influenced by personality traits such as extraversion and agreeableness (Goldberg, 1993), and by the importance of the attitude to the individuals involved. These personal factors that influence communication were incorporated into the model through the communication index. The communication index represents the extent to which an agent’s needs to communicate its attitude to others.

Finally, coincidence plays a role in who meets whom. Although meetings are often planned, it is not always certain that an attitude will be discussed; a factor of chance is involved. Spontaneous (informal) meetings may also occur – at the coffee
corner, for example, – and these too are determined by chance. In addition, an interaction may have either a positive or negative effect on the chance of there being a further interaction. All these variables are not explicitly programmed into the model; however, the variation caused by such variables are represented by a variable that changed randomly at every new interaction. To mimic the interaction patterns in an organization we thus incorporated into the model parameters for the organizational structure, the organizational communication density, personal traits, and coincidence.

2.4.2 The strength of influence of the counterpart
When two agents interact in the model and their attitudes differ, the counterpart will knowingly or unknowingly try to persuade the agent. However, when attitudes are similar, the counterpart will support the agent. In real life, a person’s persuasive or supportive strength is determined by the expectations that the perceiver has in relation to that person, and can be based on past experiences, information about others, stereotypical beliefs, or physical attractiveness (Snyder & Stukas, 1999). Combined with the strength of the arguments, these influences determine the persuasive or supportive strength of an individual. These factors were represented in the model by the personal persuasive or supportive strength. In real life people have different supportive and persuasive strengths. For example, a politician with extreme views (i.e., who is likely to polarize opinion) may have a great supportive strength for those who are already in sympathy with their views, but a very low persuasive strength for those who hold an opposing view have large supportive strength in relation to his or her followers but no persuasive influence on adversaries. Therefore in the model the persuasive strength of an agent differs from its supportive strength (Nowak et al., 1990).

In organizations, superiors are given authority, which strengthens their influence. With regard to authority there are a number of key factors to be considered. On the micro level, each individual will react differently to authority, depending on how legitimate he or she perceives that authority to be (Raven & French, 1958). Second, organizations may have different norms relating to authority, depending on the power distance in those organizations (Hofstede, Neuijen, Ohayv, & Sanders, 1990). Finally, the organizational structure determines who has authority over whom. Therefore, to model authority we included three factors in the model to represent 1) the individual’s reaction to authority, 2) the organizational norms relating to authority, and 3) the hierarchical relations in the organization.

It is well established that in-group members are more trusted and that people are generally tend to affiliate themselves more with in-group members (Tajfel, 1974). Therefore, the influence of agents from the same group is the strongest, followed by that of agents from other groups but from the same department and
CHAPTER 2

the weakest for agents from other departments. In the model, an agent’s level of influence was thus modified by the organizational structure; the further away the agent was in the organization, the less influence that agent had (Nowak et al., 1990).

Since in real life repeated exposure to a similar argument reduces the influence of the next similar argument (Latane & Wolf, 1981), we included this feature in our model.

2.5 The second building block: conformity

This type of influence is based on the perceived expectations of others, such as the perceived shared norms and values of the group, and the culture one belongs to (Cialdini & Goldstein, 2004). It has been demonstrated that an attitude may shift to the perceived in-group norm when there is no discussion or. For that reason, group conformity may work indirectly (Hogg, Turner, & Davidson, 1990).

For conformity, we made the same distinction between personal and organizational factors as we did for compliance. As an organizational factor, we included the norms relating to conformity. These norms can be determined by the cultural dimension of individualism versus collectivism (Hofstede et al., 1990). In individualistic cultures the pressure to conform is likely to be less than in cultures with a strong collectivism. This factor thus determines the pressure that organizational members feel to conform to the group.

With regard to personal factors, research shows that the tendency for attitudes to converge to the prototypical in-group position becomes stronger when the salience of the group is stronger (Haslam, 2001). The salience of the group is personal, and can differ from person to person, and we therefore included it as a separate personal factor.

In our model we presumed that agents had a good knowledge of the majority attitude in the group and that this majority determined both the direction and the strength of the conformity factor. The relation between conformity and the size of the majority is not straightforward. Nevertheless, it seemed most appropriate to assume a positive linear relation (Bond, 2005), and this is therefore what we used in the model. For example, when 90% of the agents in the group had a similar attitude, an agent with an opposing attitude felt a greater pressure to conform than when only 51% had this attitude. We also wanted to reflect the fact that some people are more influential than others, which is known in social identity theory as referent informational influence (Turner, Wetherell, & Hogg, 1989). Thus, in the model the majority was not simply determined by the number of agents with a specific attitude, but was calculated using the weighted influence of each agent.

In contrast to compliance, the influence of conformity in our model was not dependent whether an interaction took place or not, so each agent always...
experienced this influence. However, conformity was indirectly influenced by compliance. When more agents had a particular attitude, the pressure for conformity also increased.

2.6 The third building block: resistance
Resistance in this paper is defined as the strength of one’s attachment to an attitude. Resistance is a personal factor that modifies the effects of compliance and conformity and is related to the strength of an attitude (Eaton et al., 2009). Personal traits such as a strong preference for routine, cognitive rigidity, or a short-term focus may determine resistance (Oreg, 2003). Also, people can be highly resistant to changing their attitude when the thing in question constitutes an important part of their own identity (Krosnick et al., 1993). To simulate resistance, each agent in our model was given a personal resistance factor. Changing one’s opinion, especially when this opinion is made public, may feel like being inconsistent, and being consistent is an important factor in one’s self-concept (Cialdini & Goldstein, 2004). Since the agent displays its attitude during each interaction, resistance to changing one’s attitude is likely to increase over time. To mimic this phenomenon, an agent’s personal resistance in our model increased over time.

A specific trait of organizations is that they actively seek to influence employees. Employees can be influenced by systems, processes or programs designed to stimulate specific desired behaviors. Such systems or programs are often aimed at lowering resistance to change, encouraging acceptance of a behavior, and increasing the motivation/commitment of employees to this behavior (Armenakis, Harris, & Mossholder, 1993; Fernandez & Rainey, 2006; Kotter, 2007a; Robertson et al., 1993). All aspects of organizations that influence behavior are represented in the model by organizational persuasion (Op). Op in this paper is defined as the sum of all influences present in organizations that either motivate or demotivate an individual to assume the preferred attitude. Op therefore adjusts the personal resistance; for example, being offered a high reward in return for a timely completion of a project might reduce one’s resistance to putting in extra hours. However, organizational norms and values, which guide employees in both selecting and evaluating behavior (Bourne & Jenkins, 2013), are likely to be more important than financial rewards. Norms and values are defined in this thesis as stable shared beliefs that are associated with groups and direct the behavior of individuals (Katz, 1964). More specifically, in relation to organizations, organizational norms and values are regarded as a frame of reference for employees’ behaviors (Smith et al., 2002). Some organizational norms are programmed explicitly into the model (norms that relate to authority and group conformity). However, other norms will also have an influence, depending on the nature of the attitude. Unlike attitudes, norms and values are relatively stable and more time is needed to change them. In
CHAPTER 2

our model we used 10 to 25 iterations per simulation. This represents a period of around a few weeks to a few months at most, which is too short for norms and values to change fundamentally. Norms and values are therefore included in the model as stable factors that are either built in explicitly or form part of OP. In addition, systems and processes will influence Op, as both are designed to regulate behavior. It is likely that attitudes that support behavior which is in line with the systems and processes will be stimulated by Op and attitudes that challenge this behavior will be inhibited by it. Since the exact nature of the attitudes is not specified, all these forces were combined into a single parameter (Op) and the influence of this parameter on the formation of a shared attitude was determined without any further specification of these forces.

In cases where the attitude of an agent differed from that which was preferred by the organization, resistance to changing this attitude was lowered by Op. However, in cases where the agent’s attitude was similar to the organization’s preferred attitude, the personal resistance to change attitude was enhanced by Op. In our model, the preferred attitude was always equal to the initial attitude of the CEO, on the presumption that the CEO generally has the most power to decide what specific programs and systems to implement and is thus able to influence Op.

Finally, we brought all elements together. For compliance, we calculated the total persuasive force and the total supportive force were calculated, and added these to the force of group conformity. The total supportive force, plus the force of group conformity supporting the current attitude of the agent in question, was then modified by the resistance. This then enabled us to determine, for each agent, whether the resulting persuasive force was higher than the supportive force – and where this was so, the agent had changed its attitude.

This decision rule was applied to all agents, and when all agents had undergone this procedure, one round of interactions – also referred to as an iteration – was performed. Thereafter a new interaction round/iteration was started, in which the output of the first iteration (i.e., the attitudes of the agents after iteration 1) was used as the basis for the next iteration. After 10–25 iterations had been performed and a relatively stable pattern of attitudes had emerged, the simulation was ended. Then the same process began again, with a new organization and a different set of organizational parameters and individuals. This process was repeated until data from a sufficient number of organizations had been gathered.

In our model we thus combined various factors from empirically tested theories in order to mimic as closely as possible how agents affect the attitude of a single agent in an organization. We incorporated six organizational factors in our model: norms relating to authority, communication density in the groups, departments, and the organization as a whole, level of organizational persuasion, and norms relating to group conformity. We used these six organizational factors as input
variables and assessed their influence on the emergence of shared attitudes. The other variables in the model were not used for analysis.

Note that in our model organizational and personal parameters are “summaries” of several factors that influence these parameters. Personal resistance, for instance, can be influenced by many factors that both lower and increase it; however, in our model only the result of all these factors is used as a parameter. Because these parameters were randomly assigned at the start of each run, each virtual organization was staffed with a unique set of agents that had different personal attributes and each organization was also unique in terms of its organizational features.

2.7 Mathematical description of the model
The model is an agent-based model (Kauffman, 1993; Schelling, 1971). In our model, each agent applied a schema in the form of an algorithm to decide whether to maintain its current attitude or change it. The schema for the agents used in our model was based on the various considerations outlined in the previous section. Each individual agent determined its attitude by using the schema described here.

For the translation of the theory into a mathematical model we will now describe the algorithms of the three building blocks listed above: first compliance, then conformity, and then a combination of the two. After that we will discuss resistance both on its own and in combination with the previous building blocks, to show the total schema used by the agents to decide their attitude.

2.7.1 First building block: compliance
2.7.1.1 Algorithm for interactions
Whether an agent interacted with another agent or not was determined by four factors: communication index, communication density, organizational structure, and chance. The communication index ($C_j$) represented all the personal features that determined whether an agent was likely whether agents discussed their own attitude with others. Since the personal attributes of both agent ($C_j$) and the counterpart ($C_i$) affected the chances of communication taking place between them, the communication indices of both (agent and counterpart) were multiplied. The product of these variables resulted in a number describing the chance of both individuals interacting. This number was then multiplied by a factor for coincidence ($Ch_{ij}$) that differed randomly for every interaction. Due to this random variable, we generated different chances of interaction for similar combinations of agents interacting at different points in time, resulting in a semi-random pattern of interactions similar to interaction patterns in real life, where it is more likely that people who are in close proximity to one another will interact more frequently.

After the interaction chance had calculated, the model determined whether or not an interaction took place by comparing this interaction chance with a threshold.
(Tr); only when it was above this threshold did an interaction take place. By applying different thresholds for contacts within groups, departments, and the organization as a whole, the effect of the organizational structure was incorporated into the model. Low thresholds were assigned to combinations of members of a single group, medium thresholds to combinations of agents from the same department, and high thresholds to combinations of agents from different departments. The thresholds thus determined the communication density; low thresholds generated a high likelihood of agents interacting and thus a high communication density, whereas high thresholds generated a low communication density. Mathematically, an interaction took place between agents i and j when:

$$C_i \times C_j \times C_{ij} > Tr$$

Equation 1

Although we used thresholds to calculate the interactions, hereafter we will use the more organizationally relevant term, communication density.

2.7.1.2 Algorithm for supportive/persuasive strength

For supportive or persuasive strength, we extended Nowak’s model (Nowak et al., 1990) which was based on the theory of social impact (Latane, 1981). Mathematically, in the model by Nowak et. al., persuasive ($I_p$) and supportive strength ($I_s$) are given by:

$$I_p = N_p^{1/2} \left[ \sum_{i=1}^{N_p} \left( P_i / D_{ij}^2 \right) / N_p \right]$$

$$I_s = N_s^{1/2} \left[ \sum_{i=1}^{N_s} \left( S_i / D_{ij}^2 \right) / N_s \right]$$

in which $I_p$ is the total of persuasive influences and $I_s$ the total of supportive influences. $N_p$ is the number of persuasive counterparts and $N_s$ the number of supporting counterparts. $P_i$ is the persuasive force of counterpart i, $S_i$ is the supportive force of counterpart i, and $D_{ij}$ is the distance of counterpart i from agent j. The interpretation of this formula by Nowak was that the persuasive (or supportive) impact is given by the average force exerted by each group member multiplied by the square root of the group members. A change of attitude occurs when $I_p > I_s$.

In our model, we chose to omit the division by the number of encounters, as was done in Nowak’s model. In Nowak’s approach, the average persuasive force was compared with the average supportive force; as a result, an interaction with one agent with, for example, a persuasive influence of 10 would carry more weight than an interaction with ten agents, each with a persuasive influence of 9.9. This does not represent what can typically be expected in real-life situations. Also,
Nowak indicated in the discussion that in new versions of the model this division was omitted, without providing any further indications as to why. We thus used the total sum, rather than the average.

2.7.1.3 Algorithm for group membership
In Nowak’s model, the influence based on group membership was represented by the distance ($D_{i,j}$) between two agents (Nowak et al., 1990). The influence between two agents was reduced to the power of 2 with the distance. In our model, the factor $D_i$ was determined by the organizational structure, because in real life group members are trusted more than members of another group. Based on the organizational structure, we determined whether two agents were in-group members, part of the same department, or came from outside the department. When the counterpart agent $i$ was an in-group member, $D_i$ was 1. When agent $i$ was not an in-group member, but was a member of the same department, $D_i$ was 2, and for all other agents $D_i$ was 3. This algorithm resulted in the influence of agents from a different group but the same department being reduced by a factor of 4, and by a factor of 9 for agents from outside the department.

2.7.1.4 Algorithm for authority
To simulate organizations, we had to include authority in our model, since supervisors have greater influence because of the authority given to them. With regard to authority, we first checked whether an agent’s counterpart was a superior. For all counterparts that were not a superior, the factor for authority was set to 1. The strength of authority was only calculated and added if the counterpart was a superior. The strength of authority by agent $i$ on agent $j$ ($A_i$) was calculated from the personal norms towards authority of agent $j$ ($P_{na_j}$) and the organizational norms in relation to authority ($Ona$) and expressed mathematically as:

$$A_i = Ona * P_{na_j}$$

When an agent had authority, the factor for authority was used to amplify the agent’s personal persuasive or supportive strength. Authority therefore enhanced the personal influence of an agent. Thus, when authority was included in the algorithm, the supportive ($I_s$) or persuasive strength ($I_p$) of a single agent was mathematically expressed as:

$$I_p = (Ona * P_{na_j}) * P_i / D_{i,j}^2$$

Equation 2
CHAPTER 2

Supportive influence, \( I_s = (O_{na} \times P_{naj}) \times S_i / D_{i,j}^2 \) \hspace{1cm} \text{Equation 3}

During the simulation agent \( j \) was matched with all other agents to determine whether an interaction took place or not. When an interaction did take place we determined whether the influence of agent \( i \) was supportive (\( I_s \)) or persuasive (\( I_p \)). The influence was then added to the total of supportive influences (\( I_{t,s} \)) or persuasive influences (\( I_{t,p} \)).

\[
I_{t,p} = \sum_{i=1}^{N_p} ((O_{na} \times P_{naj}) \times P_i / D_{i,j}^2)
\]

\[
I_{t,s} = \sum_{i=1}^{N_s} ((O_{na} \times P_{naj}) \times S_i / D_{i,j}^2)
\]

2.7.1.5 Algorithm for repetitive exposure of a similar argument

Following Nowak’s model a factor to correct for the reduction of influence as a result of repetitive exposure to a similar argument (\( N_{p}^{1/2} \)) had to be included (Nowak et al., 1990). However, taking the square root meant that repeated influences were enhanced instead of being reduced. To demonstrate this effect, in Table 1 we provide the results of a neutral algorithm, in which no adjustments are made to compensate for repeated exposure. This algorithm is mathematically expressed as the sum of all persuasive influences and all supportive influences (\( \sum_{\text{persuasive}} \), \( \sum_{\text{supportive}} \)). In this example, we look at a scenario in which an agent interacts with ten other agents, each having a supportive or persuasive influence of 10. From these data it can be seen that, in a neutral algorithm, for each agent that shifts from supportive to persuasive, its full influence of 10 is added to the supportive influences and subtracted from the persuasive influences.

Table 1  The sums of supportive and persuasive forces in a neutral algorithm to with gradually increasing numbers of persuasive agents.

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<tbody>
<tr>
<td>5</td>
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<td>10</td>
<td>10</td>
<td>8</td>
<td>80</td>
<td>-10</td>
</tr>
</tbody>
</table>
In Table 2 the same distribution is given with Nowak’s algorithm in which the sum of the persuasive influences was amplified by the square root of the number of agents encountered with a persuasive influence and likewise for the supportive influences ($N_p^{1/2}$). From Table 2 it is obvious that with each agent that shifts from supportive to persuasive, each subsequent agent adds more to the sum than the previous agent, whereas the persuasive force decreases less. As a result, the difference between the sum of the supportive forces and the persuasive forces increases dramatically with each extra agent, compared to the neutral algorithm. These results contradict the idea of reducing the effect of repeated influences, as put forward in Latane’s theory of social impact (Latane, 1981). The reduction of influence through repeated exposure has been well studied in relation to advertising. Although these studies have investigated the number of people that respond positively to a message, and not its effect on individuals, it has been shown that each repetition leads to fewer new individuals with a positive attitude than the previous one (McCullough & Ostrom, 1974). It has also been demonstrated that repetition of similar messages displays an inverted U-curve; after a certain number of repetitions the number of people with a positive attitude will start to decline (Reinhard, Schindler, Raabe, Stahlberg, & Messner, 2014). This observation demonstrates that, also at the level of individuals, repeated exposure can have an adverse effect. For our model we do not include the adverse effect of repeated exposure. We do, however, incorporate the notion that each new repetition will have less influence than the previous one.

Table 2  The sums of supportive and persuasive forces in Novak’s algorithm to with gradually increasing numbers of persuasive agents.

<table>
<thead>
<tr>
<th>Agents</th>
<th>Correction</th>
<th>Sum of influence</th>
<th>Effect of change in distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supp.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
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</tbody>
</table>

To achieve the desired reduction of the influence of repeated exposures we now took the square root of Np and divided by Np. From Table 3 it can be observed that with each agent that shifts from supportive to persuasive, each agent that follows adds less to the sum than the one before, as we had intended. Furthermore, the
The difference between the sum of the supportive forces and the persuasive forces decreases with each extra agent, compared to the neutral algorithm.

The change in algorithm we now incorporated has no effect on the outcomes of Nowak's model since this new algorithm will reduce the difference between the persuasive and supportive influence but will never cause the strongest force to become the weakest. However, due to the inclusion of other factors in our model (compliance and resistance), a smaller difference between the persuasive forces and the supportive forces will have an effect. Therefore it was essential for us to adjust the algorithm. Mathematically, the total persuasive and supportive forces in our model are expressed by:

\[ I_{p} = \left( N_p^{\sqrt{\frac{1}{2}}/N_p} \right) \sum_{i,j} \left( (\text{Ona} \times \text{Pna}) \times P_i/\text{D}_{ij} \right) \]  \hspace{1cm} \text{Equation 4}

\[ I_{s} = \left( N_s^{\sqrt{\frac{1}{2}}/N_s} \right) \sum_{i,j} \left( (\text{Ona} \times \text{Pna}) \times S_i/\text{D}_{ij} \right) \]  \hspace{1cm} \text{Equation 5}

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</tbody>
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Table 3  The sums of supportive and persuasive forces in our algorithm at gradually increasing persuasive agents.

2.7.2 The second building block: conformity

For the conformity factor, we assumed that agents had full information regarding the distribution of attitudes in the group and that the level of conformity was determined by this distribution of attitudes in the group. However, we also allowed for the fact that some agents in groups were more influential than others since in real life, some people are more influential than others, which is known as referent informational influence (Turner et al., 1989). The referent power of an agent was determined by two factors: the persuasive strength of the agent and the communication index. Multiplying the persuasive strength of the agent by the
communication index determined the influence of each agent in the group. Using this algorithm, we modeled how highly persuasive and communicative agents were the most influential. Once the influential strengths of each agent in a group were calculated, the total support for attitude 0 and attitude 1 was calculated. Then to harmonize all data the factor for support for attitudes 0 and 1 was calculated. Both factors were then multiplied with a factor representing the personal salience of the agent for the group and the factor for organizational norms relating to group conformity. Mathematically, first, the total support for attitudes 1 and 0 was calculated from the persuasive influence of agents i with attitude 1 or 0 ($P_{1i}$ and $P_{0i}$), multiplied by the communication index of agents i ($C_i$). For further calculation, these absolute numbers were converted into factors. The conformity factors for attitude 1 ($CF_1$) and 0 ($CF_0$) were determined by the following formulas:

$$CF_1 = (\sum_{i=1}^{N_1} (P_{1i} + C_i)) / (\sum_{i=1}^{N_1} (P_{1i} + C_i) + \sum_{i=1}^{N_0} (P_{0i} + C_i))$$

$$CF_0 = (\sum_{i=1}^{N_0} (P_{0i} + C_i)) / (\sum_{i=1}^{N_1} (P_{1i} + C_i) + \sum_{i=1}^{N_0} (P_{0i} + C_i))$$

Then $CF_1$ and $CF_0$ were multiplied by the factor for personal salience of agent $j$ for the group ($Ps_j$) and the factor for organizational norms for conformity ($ON_{con}$), resulting in the conformity strength for attitudes 1 ($CS_1$) and 0 ($CS_0$):

$$CS_1 = CF_1 * Ps_j * ON_{con}$$  \hspace{1cm} Equation 6

$$CS_0 = CF_0 * Ps_j * ON_{con}$$  \hspace{1cm} Equation 7

### 2.7.3 Combining compliance with conformity

Next, the resulting strength for conformity ($CS$) was added to the total force of compliance ($It$) to determine the total persuasive and supportive force based on conformity and compliance. That is, when agent $j$'s attitude was 1, the conformity strength for attitude 1 ($CS_1$) was supportive ($CS_{sp}$) and therefore added to the sum of supportive influences for compliance and $CS_0$ was persuasive ($CS_{p}$) was added to the sum of persuasive influences of compliance. This led to the following combinations for total persuasive force based on compliance and conformity ($Pcc$) and the supportive force based on compliance and conformity ($Scc$) (equation set 1):

Agent’s current attitude 1:  $Pcc=It_p+CS_0$  and  $Scc=It_s+CS_1$
2.7.4 The third building block: resistance

The total resistance of agent $j$ ($R_j$) was calculated from three factors: personal resistance, organizational persuasion, and a consistency factor. The personal resistance factor ($PR_j$) was assigned randomly to each agent. Organizational persuasion ($Op$) was a factor that varied between organizations to simulating the fact that different organizations have different reward systems, norms, values, and processes. $Op$ was either subtracted from personal resistance when the attitude of the agent differed from the organization’s preferred attitude or added to personal resistance when the individual and the organization’s preferred attitudes were equal. $Op$ could therefore either reduce or enhance personal resistance. The personal resistance was increased at every new iteration incremental by factor for consistency ($Ir$). This incremental factor was $0.1 \times PR_j$, so that the personal resistance doubled in 10 iterations. The resulting resistance $R_j$ of agent $j$ was therefore given by the equation set 2:

The agent has the preferred attitude, \[ R_j = PR_j + Ir + Op \]

The agent has the opposing attitude, \[ R_j = PR_j + Ir - Op. \]

The resulting resistance was used to amplify the total of supportive forces ($Scc$) giving the final supportive force ($Sccr$), which includes compliance, conformity, and resistance, given mathematically by the equation set:

The agent has the preferred attitude, \[ Sccr= (PR_j + Ir + Op)*Scc \]

The agent has the opposing attitude, \[ Sccr= (PR_j + Ir - Op)*Scc \]

2.7.5 The complete schema

In the model, agents had a choice between two mutually exclusive attitudes, 1 or 0, “in favor of” or “against”. Mathematically, the attitude of an agent changed when the total persuasive force ($Pcc$) was larger than the total supportive force ($Sccr$). In progressive detail, an agent changed attitude mathematically when:
Pcc > Sccr =

\[
\left\{ \frac{N_p^{1/2}}{N_p} \right\} \sum_{i=1}^{N_p} \left[ (Ona \times Pnaj) \times \frac{P_i}{D_{ij}^2} \right] + \left\{ CF_{1or0} \times Ps_j \times ON_c \right\}
\]

> (Pr_j + Ir +/- Op) * \left[ \left( \frac{N_s^{1/2}}{N_s} \right) \sum_{i=1}^{N_s} \left[ (Ona \times Pnaj) \times \frac{S_i}{D_{ij}^2} \right] + \left\{ CF_{1or0} \times Ps_j \times ON_c \right\} \right]

This formula represents the general schema that each agent in the model used to determine its attitude. We made the following additions or changes to Novak’s original formula:

1. In the block for compliance four additions/changes were made: 1) the personal persuasive and supportive force of an agent was modified by a factor for authority, which was lacking in Nowak’s model, 2) the algorithm for the decrease in influence of repeated arguments was changed since there was no reduction of this kind in Novak’s model, 3) instead of taking the average supportive or persuasive force we calculated the total sum, as we argued that this represented reality better and 4) we added an algorithm for interactions to represent interactions within organizations, as this also represented reality better than Novak’s algorithm in which each agent interacted with all other agents, regardless of the distance or the personal attributes of the agents.

2. We added a block for conformity, which is in integral part of social influence as defined by Cialdini (Cialdini & Goldstein, 2004: 592). This was not included in Novak’s model. With the addition of this block the model now includes all the elements of social influence.

3. The block for resistance was added to represent an agent’s internal resistance to changing its attitude. Also this block was missing in Nowak’s model. However, in his recommendations Nowak mentioned this as a potential future improvement.
Figure 2 Flow schedule of pseudo-codes and positions of equations in the model.
2.8 Method

At the start of each run, all the personal and organizational parameters as well as the initial attitudes were assigned to agents by a random generator. Each run thus represents a unique configuration of an organization with different agents and different organizational parameters. For the same reason, there is a random pattern of attitudes at the start. These simulations reflect a new situation for an organization and one, which requires it to construct a shared response. After the assignment of all variables, each agent was matched with all other agents in the organization, and it was determined whether an interaction took place or not. When an interaction took place, the influence of the agent’s counterpart was added to the total influences to which the agent was exposed. Based on the influence of the other agents, the new attitude of this agent was calculated and linked to this agent. When this process was complete for all agents, a new set of attitudes was obtained, providing the basis for the next set of interactions. Each run consisted of 25 iterations.

Using the model in sequence and programming situation-specific features allowed us to simulate various scenarios of organizational change and determine the dynamics and factors involved in each case. The scenarios that will be presented and discussed in the next chapters are:

1) In chapter 3 the same model and set-up was used as described here to validate the model, determine the dynamics, and assess which organizational factors led to organizations and groups to become homogeneous.

2) We used the model to study adaption, as we discuss in Chapter 4. To do this, we first ran the model as described here to obtain a stable pattern of attitudes. We then lowered the level of organizational persuasion at each iteration to simulate the fact that agents became aware that their current attitude was no longer appropriate and a new attitude was needed. In this simulation, we monitored the reaction of the organizations to a change in the environment and determined which organizational factors were involved in adaption or escalation of commitment.

3) In chapter 5 we our simulation how the emerging processes of self-organization influenced a planned change. For this, we first used the model to generate a stable pattern of attitudes. Then an intervention took place, which was simulated by reverting the direction of the organizational persuasion and changing the attitudes of a number of agents. We then ran the model again and followed how the changes made during the intervention were expanded, stabilized, or reverted back to the pre-intervention phase. By doing so we were able to study which organizational factors were involved in enhancing the results of the intervention.
2.9 Input parameters

With regard to the parameters, we assigned a specific range to each parameter. We had little information on which ranges to use, as there was not much literature available to guide us on this. We therefore based our ranges on two basic criteria; first, they should be sufficiently wide to include realistic values, and, second, the system had to maintain dynamism. We are aware that several of our organizations will have characteristics not easily found in real life. We nevertheless feel confident that the model can generate results representative of real-life organizations. First of all, it is our aim to detect trends, and when a relation is linear, the effect of a parameter changing at values that are unrealistic in real-life terms will be similar to the results achieved using realistic values. We found that all the parameters displayed a linear relation with the outcome (the number of agents with the preferred attitude), we are therefore confident that our results are valid. Another argument supporting the validity of our approach is that extreme values of parameters did not result in extreme outcomes. One could also argue that in actual organizations parameters will change over time. However, because we simulated a relatively short period of time (one to two months), it is quite likely that personal and organizational parameters will be stable.

With regard to organizational parameters, the range for authority was set between 2 and 25. In combination with the personal norm relating to authority, authority could amplify a superior’s personal influence by a factor of between 2 and 75, leading to a The communication index ranged from 0 to 1, equal to the range for interaction chance. The personal norms relating to authority and personal resistance ranged from 1 to 3. The maximum value for resistance was set relatively low in order to keep the model dynamic. After each iteration, the personal resistance factor increased by 0.1*the personal resistance. The ranges for all other personal parameters ranged from 1 to 10. The initial attitude was either 0 or 1 and could change after each iteration. Except for attitude, all other personal parameters remained as they were during the complete run. Since all parameters were assigned randomly, each agent was unique, as was the composition of agents during each run. range for the compliance of 0 (Pi=0) to 750 (Pi=10) for superiors, which seems to be a sufficiently broad range. The level of group conformity was set to between 2 and 25. In combination with personal salience for the group and distribution of the attitudes, the total range for conformity was thus between 0 (CS1/0=0) to 250 (CS1/0=1). For communication density, we had some guidance from a study by Lum on interaction patterns of nursing personnel. This study found that in units of approximately 11 individuals, the chance of a specific subject being discussed was about 30 to 40% (Lum, 1970). By setting the range of communication density between 20% and 60%, we were sure that realistic values were incorporated in our range. For communication density within departments and the organization, we anticipated
a twofold reduction for each level further away from the in-group. With regard to organizational persuasion from previous results, a plateau was reached at a level of 4 to 5. Therefore, to keep the system dynamic we chose a range between 0 and 3.

Finally, we should mention that maximal resistance was set at 10 and minimal resistance at 0.04. Setting a limit to maximal resistance kept the system dynamic, as an initial test of the model demonstrated that a resistance that was too high would block any attitude changes. A basic assumption of our model is that agents could not change their attitude without persuasion. To ensure this, total resistance was limited to a minimum of 0.04. Allowing the resistance to become negative would simulate that agents could not change their attitude spontaneously without persuasion. Table 4 summarizes all the parameters and gives the ranges for each parameter.

### 2.10 Organizational structure

The organizational structure in all simulations consisted of one CEO, supervising four departmental heads. Each departmental head was responsible for four team leaders who each supervised ten employees. The simulated organization thus totaled 181 people. The CEO and departmental heads were allocated to one group; each departmental head also had a group of the four group leaders under his/her supervision. Group leaders also formed a group with their members. Therefore, all departmental heads and group leaders were members of two in-groups.

### 2.11 Output parameters

To assess the dynamics of the process, we calculated the total number of changes during the first five and the last 20 iterations, the homogeneity of the organization at iteration 5, and the average homogeneity during the last 20 iterations. These were the intermediate factors that provided us with information while the process of self-organization was taking place. Our decision to draw a distinction between the first five and the last 20 iterations was based on the observation that after five iterations a relatively stable pattern of attitudes emerged and only few attitude changes took place after that. The dynamics before and after five iterations were thus quite different and this was why we needed to assess both periods separately.

Output parameters were the percentage of homogeneous groups, calculated from the number of groups in which all agents had a similar attitude, and level of homogeneity within the organization, calculated from the number of agents in the organization with a similar attitude.

With this model we were able to generate longitudinal data from which we could determine the dynamics of the emergence of a shared attitude as well as the influence of various organizational factors on this self-organizing process. The influence of the organizational parameters was determined by correlating the organizational
### Table 4: Overview of the parameters and ranges used in the model.

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<th>Range</th>
<th>Value</th>
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<th>Value</th>
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<td>Supportive strength (S)</td>
<td>1 to 10</td>
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<td>Maximal resistance</td>
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<td>Communication chance in department (Tr)</td>
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<td>Communication chance in group relating to authority (Pna)</td>
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<td>Communication chance in organization relating to conformity (OnC)</td>
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factors with the outcome parameters, such as the level of homogeneity in the groups and the organizations, at the end of the simulation. Another important feature was that we were able to assess the dynamics. For example, assessing the number of attitude changes per iteration enabled us to see how conversion took place. We were also able to assess intermediate factors, such as level of homogeneity of the organizations or the total number of attitude changes.

Despite the fact that computer simulations are always a simplified approximation of reality, they nevertheless offer us a useful tool, given that emergence can never be studied empirically in sufficient detail. The results obtained in explorative simulation experiments may generate new insights that can subsequently be tested empirically. Such tests may confirm the model’s performance but can also be used to improve the model.
The emergence of a pattern of attitudes in organizations; validation of the model and the dynamics of emergence
3 The emergence of a pattern of attitudes in organizations; validation of the model and the dynamics of emergence

3.1 Introduction

In chapter 2 described the model that we used to assess the emergence of a shared attitude in organizations. Although computer models will always be a simplification of real life, we nevertheless want to be able to draw conclusions from models that will provide us with a better understanding of real life. Because of this, testing the quality of the model is a critical step. An important criterion for determining the quality of the model is its ability to generate results that resemble reality (Davis et al., 2007). It is therefore quite positive when the model is able to conform to empirically established features of organizations. Such results demonstrate the quality of the model and make it more likely that results that cannot be determined by empirical studies but are generated from the model are also applicable for real-life organizations.

To determine the quality of the model, we defined three criteria. First, the model must self-organize into a stable pattern as observed in real life. Second, the model must represent a nonlinear system so that it must be impossible to determine the outcome from the starting conditions; similar starting conditions should therefore generate different outcomes. Finally, the outcomes should be in line with various common features of group. In other words, the programmed schemata given to every agent in the model should lead to outcomes at the macro level of groups and organizations that might be found in real life. Only when these criteria are met are the outcomes likely to be applicable to real-life situations.

To determine whether we had chosen representative ranges for the input parameters we explored the data generated to see whether some input parameters would generate extreme results. Then, based on this first set of data we assessed the dynamics of the emergence of a shared attitude as well as group and organizational polarization. These test were performed with the model described in chapter 2 in which a random pattern of attitudes was allowed to self-organize during 25 iterations in 250 virtual organizations.

3.2 Results

First we assessed whether our method of assigning all parameters randomly to the model had enabled us to cover the complete parameter space. In Figure 1 the distribution of the parameters over the parameter space is shown. From this figure it can be concluded that by randomly assigning values to the various parameters, we had indeed covered all parameter spaces in our simulation. However, as the parameters were assigned randomly, they were not evenly distributed and there
CHAPTER 3

were fluctuations. This distribution is the outcome of this specific simulation; the simulations presented in the following chapters, however, displayed a different pattern but were similar with regard to the complete coverage of the parameter space. This randomness indicates that the approach chosen to assign parameters gave us an experimental set-up that resembled an empirical study in which a similar diversity is likely to be found.

Next we determined whether extreme input parameters resulted in extreme output data. To demonstrate this, we compiled scatter plots for each parameter, plotting each parameter against the homogeneity of the organization at iteration 25. The plots for each parameter are given in Figure 2. From these plots we can see that extreme values did not result in extreme outcomes. At extreme values of the parameters we still found the same variety in outcomes as is likely to be found in real-life organizations. This finding indicates that the ranges chosen for the organizational parameters were all plausible.

Figure 1 Distribution levels of basic parameters over the ranges given as the frequency a given value for the parameter was found in the simulation.
In a following analysis, we assessed the dynamics of emergence. For this we calculated the average number of attitude changes per iteration was calculated (Table 1). From these data two conclusions can be drawn. First, The number of attitude changes per iteration indicates that most agents switch attitude during the first three iterations. During these first three iterations the organizations were highly dynamic (Table 1 and Figure 3), but from iteration 5 onwards there was a period of relative stability. (Table 1 and Figure 3). Second, from the few changes in attitudes during this second period we can conclude that the organizations had organized themselves into a relative stable pattern of attitudes. With the exception of five of the 250 organizations, attitude changes continued during iterations 6 to 25, demonstrating that the model remained dynamic (Figure 3).

Next, we wanted to know whether the outcome could be predicted from the initial parameters. To assess this, we first correlated the percentages of agents with attitude 0 at the start of the simulation with the final percentage of agents with...
attitude 0. We did the same for percentages for the following iterations. These data showed that there was a low but significant correlation between the initial distribution of parameters and the outcome (Table 2). The initial distribution of attitudes is thus a poor predictor of the final result. However, this changes rapidly after the first iteration. The results obtained from the first iteration are highly predictive of the outcome, and during subsequent iterations this predictability increases further. These data, combined with the data from Table 1, demonstrate that the first iteration is crucial. During this first iteration the system determines its course, and thereafter there is little room left for alternative outcomes. This finding is an important outcome, because most data regarding attitude formation are based on only two time points, making it impossible to determine the dynamics. The need for longitudinal studies is recognized by others as well; in a recent paper the affective, cognitive, and behavioral components of attitude towards an organizational change were measured at various intervals, demonstrating that these three components change at different paces (Solinger, Hofmans, & van Olffen, 2015).

To assess the nonlinearity of the model we performed five blocks of 25 simulations in which each simulation in a block started from identical parameters, as if one organization were allowed to go through the same emergence 25 times. It can be seen from table 3 that even when all circumstances were similar, different outcomes were generated, clearly demonstrating the nonlinearity of the model. However, the outcomes generated were not completely random, a certain degree of predictability is possible, albeit .

Next, we analyzed which factors were involved in the homogeneity of the groups. The homogeneity was calculated by taking the absolute number of the percentage of agents with attitude 0 and subtracted by 50% (ABS(%agents attitude 0-50)). This meant that highly heterogeneous groups, in which the agents were evenly split between the two attitudes (50% attitude 0 and 50% 1), obtained a score of 0 for homogeneity. Highly homogeneous groups all the agents had the same attitude (100% 0 or 1), scored 50. The factors that led to high numbers of completely homogeneous groups were the communication density in groups, authority, and organizational persuasion (Table 4, row 11). From these data we therefore conclude that the influence of the communication in groups was most significant on mostly the homogeneity within the groups. The level of group conformity, however, had no impact on the group homogeneity. This is remarkable since conformity is the act of changing one’s behavior to match the expectations of others. By definition it should lead to more group cohesion (Cialdini & Goldstein, 2004) and this feature of conformity was specifically programmed into the model. To understand this finding we need to include the intermediate parameters in our analysis. Group conformity had a negative influence on the number of changes during the first five iterations in phase 1. Based on the correlation between the number of attitude changes during
The Emergence of a Pattern of Attitudes in Organizations

Table 1  Average number of agents changing their attitude per iteration.

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</tr>
<tr>
<td>23</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>24</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>25</td>
<td>1.3</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Figure 3  Distribution of total number of attitude changes for iterations 1 to 5 and 6 to 25.

Table 2  Correlation between the percentage of agents with attitude 0 and the final percentage of agents with attitude 0.

<table>
<thead>
<tr>
<th>Iteration</th>
<th>Correlation Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>1</td>
</tr>
<tr>
<td>0.217***</td>
<td>0.976***</td>
</tr>
</tbody>
</table>

* Statistically significant (p < 0.05). ** Statistically significant (p < 0.01). *** Statistically significant (p < 0.001).
Table 3  Distribution of outcomes in 25 simulations using 10 identical starting conditions.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Levels of parameters and distribution of attitudes at start</th>
<th>Outcomes measured by the percentage of agents with attitude 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority</td>
<td>18.2 19.1 12.5 14.8 12.9 14.1 2.5 12.9 15.5 20.9</td>
<td>51.9 50.6 20.0 48.1 66.3 61.9 72.5 71.0 57.5 11.3</td>
</tr>
<tr>
<td>Comm. density in groups</td>
<td>34.9 25.3 54.2 31.5 43.3 27.1 33.3 26.8 27.7 30.1</td>
<td>46.3 30.0 16.9 43.8 68.1 55.0 73.8 9.38 57.5 10.0</td>
</tr>
<tr>
<td>Comm. density in depts.</td>
<td>9.8 12.2 9.2 12.6 10.5 13.8 35.4 6.9 14.6 10.7</td>
<td>42.5 36.9 20.6 44.4 65.0 60.6 72.5 15.0 60.0 10.6</td>
</tr>
<tr>
<td>Comm. density in orgs.</td>
<td>3.3 18.0 1.5 10.4 21.0 3.9 11.3 16.0 57.2 21.0</td>
<td>45.6 35.6 21.3 41.3 56.9 54.4 75.0 8.75 58.8 8.1</td>
</tr>
<tr>
<td>OP</td>
<td>0.1 1.4 2.3 0.3 0.4 0.0 1.9 2.8 0.1 2.9</td>
<td>42.5 28.8 20.6 44.4 62.5 56.3 73.1 14.4 62.5 5.6</td>
</tr>
<tr>
<td>Group conformity</td>
<td>10.9 19.3 20.7 19.5 8.7 16.3 16.2 15.3 23.0 20.4</td>
<td>43.8 28.1 20.0 46.9 60.6 61.3 73.8 10.6 55.6 7.5</td>
</tr>
<tr>
<td>% of dept. heads with att.</td>
<td>0 1 1 1 0 0 0 1 1 1</td>
<td>45.6 27.5 20.6 45.0 65.6 64.4 73.8 14.4 51.3 8.1</td>
</tr>
<tr>
<td>% of group leaders with att.</td>
<td>25.0 50.0 0.0 25.0 25.0 50.0 75.0 50.0 50.0 0.0</td>
<td>44.4 31.9 20.0 41.9 63.1 56.3 73.1 13.8 53.1 9.4</td>
</tr>
<tr>
<td>% of workers with att.</td>
<td>37.5 43.8 68.8 56.3 43.8 50.0 37.5 31.3 50.0 62.5</td>
<td>43.1 38.8 17.5 41.3 64.4 61.3 73.3 16.9 61.9 10.0</td>
</tr>
<tr>
<td>Repeat</td>
<td></td>
<td>AVG 46.0 34.9 20.1 46.3 62.1 58.3 73.3 13.3 54.8 9.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STD 2.9 74.1 12.4 41.4 2.2 3.7 12.2 27.4 4.0 1.7</td>
</tr>
<tr>
<td></td>
<td>AVG</td>
<td>STD</td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Authority</td>
<td>13.6</td>
</tr>
<tr>
<td>2</td>
<td>Communication density in groups</td>
<td>34.7</td>
</tr>
<tr>
<td>3</td>
<td>Communication density in departments</td>
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<tr>
<td>4</td>
<td>Communication density in organizations</td>
<td>6.6</td>
</tr>
<tr>
<td>5</td>
<td>Organizational persuasion</td>
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<tr>
<td>6</td>
<td>Group conformity</td>
<td>13.1</td>
</tr>
<tr>
<td>7</td>
<td>Homogeneity of organization at iteration 5</td>
<td>22.1</td>
</tr>
<tr>
<td>8</td>
<td>Sum of changes for iterations 1 to 5</td>
<td>72.0</td>
</tr>
<tr>
<td>9</td>
<td>Avg. homogeneity of organization for iterations 6 to 25</td>
<td>24.1</td>
</tr>
<tr>
<td>10</td>
<td>Sum of changes for iterations 6 to 25</td>
<td>32.3</td>
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<tr>
<td>11</td>
<td>Percentage of homogeneous groups at iteration 25</td>
<td>37.1</td>
</tr>
<tr>
<td>12</td>
<td>Homogeneity of organization at iteration 25</td>
<td>24.3</td>
</tr>
</tbody>
</table>

* Statistically significant (p < 0.05), ** Statistically significant (p < 0.01), *** Statistically significant (p < 0.001)
CHAPTER 3

phase 1 and the level of homogeneity at the end of phases 1 and 2 (Table 4), it can be concluded that the reduction in the number of changes during phase 1 due to group conformity led indirectly to a reduction in the homogeneity of the organization. This observation is in line with Lawler's subgroup approach which shows that attachment to subgroups will lead to fragmentation of the larger group (Lawler, 1992). Therefore, during these first iterations group conformity strengthened the initial majority attitude of the groups as programmed. This strengthening however, leads indirectly to more diversity within the organization. As a result of the greater diversity in the organization, agents will encounter more minority attitudes, which prevent groups from becoming more homogeneous. Therefore, when the initial majority attitude in the groups was increased through group conformity, this led to greater diversity in the organizations and indirectly to greater diversity within the groups. This result is thus caused by the presence of multiple groups in the organization.

In general, it could be concluded that there was a tendency for groups to become homogeneous. This tendency could go two ways; the group took over the majority attitude in the organization or it converted to the minority attitude. Given that a number of groups converted to an attitude that was in opposition to the majority attitude, organizations as a whole were, on average, less homogeneous that individual groups. The diversity of attitudes in the organizations was thus primarily caused by groups that had a minority attitude and not by individuals scattered across the organization.

With regard to the homogeneity of the organization, organizational persuasion (Op) was the most dominant factor and to a lesser extent authority. Remarkably, communication was irrelevant. Therefore, communication in groups is the major driver of the homogeneity in groups whereas at the organizational level homogeneity is stimulated most by Op. When applying this to real-life organizations we speculate that structures, systems, procedures, and culture are what makes organizations homogeneous in terms of their employees' attitudes. The dynamics showed that the level of OP determined the homogeneity already during the first iterations since the homogeneity reached during the first iteration determined the final homogeneity (correlation 0.996). We found that the number of attitude changes during the second phase (iteration 6 to 25) had a strong negative influence on the homogeneity, whereas the attitude changes during the first phase had a positive influence on the homogeneity.

3.3 Conclusions

Using our agent-based model, we integrated various parameters into one model to assess the group dynamics involved in the self-organization of the pattern of attitudes in organizations. We set three criteria to validate the model: (1) it must
self-organize into a stable pattern as observed in real life; (2) it must represent a nonlinear system; and (3) outcomes should be in line with a number of mainstream features of groups.

With regard to self-organization, all the virtual organizations organized themselves into a stable pattern of attitudes, meeting the first criterion. As in real-life groups, individuals with minority attitudes were found in all the virtual organizations.

The weak relation between the initial and final distribution of attitudes was a first indication of nonlinearity. However, a second more significant finding in terms of nonlinearity was that identical starting conditions led to different outcomes. This last finding clearly demonstrated that the model was nonlinear. However, we also found that the outcomes were not completely random but fell within certain ranges, some of which were wider than others. This result is a first indication that outcomes can be controlled to a certain extent when circumstances are chosen that limit the variation.

With regard to demonstrating the mainstream (i.e., macro) features of groups, one common feature is the tendency of groups to polarize. This feature was clearly exhibited by the model, which generated on average 28% fully homogeneous groups. In group polarization, the initial majority attitude in the group is enhanced (Moscovici & Zavalloni, 1969). Group polarization is explained in social identity theory by the greater influence of in-group members (Turner, Oakes, Haslam, & McGarty, 1994). In our model, group homogeneity was also driven by the interaction between in-group members, in accordance with the theory. Additionally, we found that authority had a significant positive influence on the level of group homogeneity, indicating that groups in organizations with high levels of authority are likely to be more homogeneous than groups in organizations with low levels of authority. However, authority did not have a positive influence on the level of homogeneity in organizations. Based on this result, raising the level of authority in real-life organizations will likely not make them more homogeneous. The most effective way of increasing homogeneity was to increase the level of Op.

Although there was a clear tendency for organizations to polarize, a minority was always found in the organizations, as in real-life organizations. These findings are in line with the literature regarding group polarization. However, the observation that the level of group conformity did not have a significant effect on group polarization was unexpected since it was programmed into the model that high levels of group conformity should lead to more polarization. We speculate that the reason for this is the speed of self-organization in combination with the determinativeness of the first round of interactions. During the first iterations group conformity will stabilize the random majority attitude present at the start. After the first round of interactions, the level of group conformity -or as a matter of fact the level of any other parameter- no longer has any effect.
With regard to group conformity, we observed that group conformity in the first rounds of iteration preserves the initial majority attitude as it reduces the number of attitude changes during the first five iterations (Table 4). Group conformity thus also stabilizes groups with minority attitudes, which leads to more diversity in the organization as a whole. Thus, by initially preserving the majority attitude in groups, group conformity adds to the diversity of the organization as a whole and indirectly to the diversity in the groups.

The simulation demonstrated that polarization is quite a prominent phenomenon, because all of the organizational parameters had either a direct or indirect stimulating effect on group polarization and the homogeneity of the organization as a whole. The only factor that inhibited the homogeneity was the sum of changes during iterations 6 to 25. This intermediate factor was, however, inhibited by all relevant organizational factors. Because all the relevant parameters had a direct or indirect positive effect on the homogeneity of the groups and the organization, there was a clear tendency of groups and organizations to polarize. This polarizing effect is demonstrated in Figure 4, which depicts the distribution of the groups according the percentage of agents with attitude 0 in the groups and organizations. The observation that the highest frequencies are found at the edges demonstrates that most groups and organizations have a tendency to polarize. If we apply this finding to real-life organizations, it suggests that organizations will have a natural tendency to stabilize into a rather homogeneous pattern of attitudes.

Figure 4 Distribution of the percentage of agents with attitude 0 in groups and in organizations.
The reason why organizations did not become fully homogeneous, and were in general less homogeneous than groups was due to the polarization of the groups. We demonstrated that factors that served to maintain the initial majority in groups enhanced the variation in organizations. From this observation it can be concluded that variation in organizations is preserved in the groups. This finding is in line with the subgroup hypothesis that states that when there are intensive interactions between members of a subgroup, these individuals will feel less attachment to the organization as a whole (Hall, 1988; Lawler, 1992). In about 40% of the organizations, the majority was less than 70%, which might be regarded as insufficient to guarantee efficient fulfillment of the organizational goals. Overall, in most organizations the majority seemed sufficiently high for the majority attitude to be regarded as “shared” by the organization and to ensure fulfillment of the goals.

We also found that the first round of interaction was the most crucial; the direction in which the organization was heading was determined in this round. Once the direction was determined, the following rounds of interaction re-enforced the path set during the first round. This might be a crucial finding for real-life organizations. It surely explains why emerging processes are so hard to control. Once they are underway, there seems to be little that can be done to change their course.

This model enabled us to gain more insight into the dynamics of groups and the emergence of attitudes in organizations, and demonstrated both the importance of the first rounds of interaction and the natural tendency of organizations to polarize. We also demonstrated that it was impossible to predict the exact outcome from the initial parameters. However, by lifting the lid a little higher on the black box of emergence, we have been able to remove some of the mystery surrounding what happens in attitude formation in groups, and reduce some of the uncertainty involved in emergence. In the literature we did not find any previous studies addressing emergence in the way that we have done, even though emerging processes are regarded as important phenomena in organizations.
Managerial influence on attitude formation in organizations: Managing emergence

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4 Managerial influence on attitude formation in Organizations; managing emergence

4.1 Abstract
The emergence of a shared attitude in organizations can be regarded as a self-organizing complex process in which a majority attitude emerges from the ensemble of interactions among individuals. Almost by definition, emerging processes seem beyond the control of management, which is in conflict with the task of management to steer an organization. By modeling the emergence of a shared attitude in organizations, we were able to demonstrate that management had a distinct influence on this process. Furthermore, the first round of interactions was decisive for the outcome. The key to influencing the emergence of a shared attitude is to reduce resistance against the preferred attitude. High levels of group conformity inhibited conversion to the preferred attitude. Although the emergence of a shared attitude can be influenced by management, there remains an intrinsic uncertainty in the outcomes of attitude development processes.

Keywords
Complexity, emergence, attitude formation, computer modeling

4.2 Introduction
Employees' attitudes are key determinants of behavior in organizations as behavior is driven by intentions and intentions are driven by attitudes (Ajzen, 1991). Attitudes are defined as a state of mind that influences an individual's behavior. A positive attitude towards a specific behavior is thus generally regarded as a precursor of this behavior and employees' attitudes towards an organizational change are shown to be crucial for its success (Bouckenooghe, 2010; Oreg et al., 2011). Further underscoring the importance of attitudes for organizations is that individuals' attitudes will influence knowledge sharing (Bock, Zmud, Kim, & Lee, 2005). Furthermore organizational commitment is also regarded as an attitude (Solinger et al., 2008), implying that various behaviors associated with organizational commitment such as organizational citizenship, work performance, absenteeism and turnover (Meyer et al., 2002) are also influenced by attitudes.

With regard to organizations, a shared positive attitude towards the organizational objectives is thus of paramount importance for the organization. But how can management influence the formation of a desired shared attitude? We know how on the micro level of individuals, attitudes can be influenced. However, what is still obscure is how these micro level changes will result in a shared attitude on the macro level of the organization. In general, individuals' attitudes are changed by exposure to information from others (Olson & Zanna, 1993) and formed by the
interactions between individuals (Friedkin, 2001). In line with this, it is acknowledged 
that attitudes are formed, sustained, and changed through social interaction (Hogg 
& Smith, 2007: 119). But how will these ongoing mutual interactions between 
individuals form into an organization-wide shared attitude and how can the 
outcome of such a process be influenced by management?

To answer these questions we will make use of complexity theory (Brown & 
Eisenhardt, 1997; Burnes, 2005). We regard organizations as self-organizing complex 
systems in which a shared attitude will emerge from the interactions among 
individuals. Emerging processes are hard to study empirically, but can be investigated 
using computer simulation (Rousseau, 2011).

In our study, we simulated the reaction of an organization to a jolt. Jolts are 
defined as “transient permutations whose occurrence are difficult to foresee and 
whose impacts on organizations are disruptive and potentially inimical” (Meyer, 
1982: 515) (page 515). Good examples of jolts are significant events, such as an 
introduction of a competing product, bad publicity, new legislation or even 
environmental catastrophes. Every jolt essentially is a crisis for an organization. 
Crises can be important change-inducing events (Seeger, Ulmer, Novak, & Sellnow, 
2005). An essential feature of a jolt is that there is no immediate guidance as to what 
the ideal response should be. Therefore it is likely that the reaction on a jolt will be 
a self-organizing process, and it has been shown that self-organization can be an 
important force in the recovery of organizations after a crisis (Murphy, 1996; Seeger, 
2002). In our study, a jolt is simulated by creating an initial situation in which there 
is a random pattern of positive and negative attitudes towards a solution proposed 
by the CEO to cope with this jolt. The random pattern represents a situation in 
which each agent has a private attitude to the new situation. Due to interactions 
between the agents, the random pattern of attitudes shifts into a relatively stable 
pattern that can be seen as the organization’s way to deal with the jolt.

The process of how groups adapt to a new situation has been previously 
described (Burke, Stagl, Salas, Pierce, & Kendall, 2006; Rosen et al., 2011). However, 
their description of this process was limited to one adaptation cycle consisting of: 
situation assessment, plan formulation, plan execution, and learning. Therefore, it 
does not fully capture the emergence of a new behavior that emerges in multiple 
rounds of re-assessment and adjustment. Neither does this description solve the 
problem put forward by structuration theory, which argues that agents are 
influenced by the social structure and at the same time influence this structure. As 
structuration is a continuous process, such mutual influence processes clearly 
make it hard to predict what their outcome will be (Jones & Karsten, 2008). Our 
simulation model, however, simulates both the longitudinal development as well as 
the interaction between the individual and the social structure during multiple 
rounds of interactions.
Our approach is grounded in complexity theory, contending that organizations should be regarded as nonlinear, self-organizing complex systems (Anderson, 1999; Chiles et al., 2004; Meyer et al., 2005; Monge et al., 2008; Plowman et al., 2007). In such systems, order emerges from interactions between interdependent agents exchanging and processing information. While organizations are continuously adapting at various levels, these numerous adaptations require quick responses that are likely to be based more on experience and personal preferences than on rational design. In this approach, organization level responses to changing conditions thus emerge from the interactions between employees over time.

Emergence is generally regarded as an autonomous process beyond the influence of management. However, the perception that emergence is an autonomous process conflicts with the task of managers to lead an organization. We therefore examined through modeling, whether management had an influence on the emerging process of attitude formation and, if so, which factors enhance this influence. With this study, we aim to contribute to a better understanding of organizational change processes or, more specifically, of adaptive change.

The main benefit of using modeling is that we are able to study the dynamics of emergence. In most empirical studies only begin and end points are determined and compared. From such studies we can learn what changed. However, by revealing the dynamics, we can learn how change occurs. In this explorative study, some outcomes may be generated that are already well-known from empirical studies. Our contribution, however, is that we will be able to provide insight into the way these outcomes were obtained. In addition, we will be able to compare various parameters and determine their respective influence on the emergence of a shared attitude.

4.3 Attitude formation and complexity

Previous modeling studies demonstrated how interactions between individual agents lead to the emergence of a shared opinion (Nowak et al., 1990). We used a similar approach to model attitude formation, which differs fundamentally from the linear perspective of organizations. In linear systems, there is a clear relation between cause and effect and thus the outcome is the direct result of defined actions. However, nonlinear systems are characterized by the absence of a direct relation between cause and effect; the outcome cannot be predicted from the initial parameters. Also, there is no relation between the size of a change and its impact; a small change can have a big impact, whereas a major change can be easily absorbed, leaving the system as it was (Thietart & Forgues, 1995). Hence, nonlinear systems intrinsically have a high level of uncertainty/unpredictability. Nonlinear behavior is typical for complex systems which – in general – consist of a large number of interacting elements leading to a system with emerging properties.
(Morel & Ramanujam, 1999). This description fits organizations, in which its members interact with one another to pursue the goals of the organization. The intrinsic uncertainty and unpredictability of complex systems therefore explains why processes of emergence in organizations are often regarded as beyond the influence of management.

Attitude formation in organizations fulfills all criteria of a self-organizing complex system. However, in the case of a disruptive change in the environment, managers are expected to take initiatives with the intention to improve organizational performance (Robertson et al., 1993; Young, 2009). It takes leadership to convince lower management and employees. Leadership can be defined as the process of influencing others to achieve organizational goals (Hollander, 1986). This brings us back to our initial research question: is it possible for management to influence the outcome of the formation of a shared attitude when this process is an emerging process that is intrinsically uncertain and unpredictable? In terms of self-organizing systems, the manager is an enabler (Marion & Uhl-Bien, 2001; Plowman et al., 2007), but does the role of enabler give a manager sufficient leverage to influence the development of a majority attitude as we study here?

The next section describes the factors used in our model that may influence attitude change in individuals and translates them into a mathematical equation that describes the decision schema each agent used to determine its attitude.

### 4.4 Mathematical and theoretical description of the model

The basic assumption underlying our model is that agents change their attitude due to social influence (Wood, 2000). Social influence has two dimensions: compliance and conformity. Compliance is defined as “a particular kind of response -acquiescence- to a particular kind of communication, a request” (Cialdini & Goldstein, 2004: 592)(p. 592). Conformity is defined as “the act of changing one’s behavior to match the responses of others” (Cialdini & Goldstein, 2004: 606) (p. 606).

Both compliance and conformity are influences from other agents influencing the focal agent. However, we also need to take into account personal resistance. Individuals will resist persuasion to various extents, depending for example on the importance of the attitude to the individual and their preferences (Eaton et al., 2009; Krosnick et al., 1993; Oreg, 2006). Therefore, to describe attitude formation we incorporated three main building blocks in our model: compliance, conformity, and resistance.

Our model further develops the Nowak model, which derives the emergence of a general opinion in societies from the interaction between individual agents exchanging information on their attitudes (Nowak et al., 1990) and which belongs to the category of agent-based models (Kauffman, 1993; Schelling, 1971). In agent-based models, agents use a schema to process the information obtained
from other agents they ‘interact’ with and develop their own attitude. This approach is in agreement with social cognition theory, stating that people use schemata (Markus, 1977) to process information, to make sense of a situation, to adjust behavior and to learn (Anderson, 1999; Lau & Woodman, 1995). Nowak successfully explored such a model to investigate how, due to interactions between agents, attitudes in a population self-organized. Nowak’s model thus provided us with the starting point to explore how interactions between individuals in organizations lead to the emergence of a shared attitude. As we were also interested in the influence of organizational factors, Nowak’s model was thus extended with algorithms for authority, compliance, conformity and resistance as well as with the interaction probabilities between agents. A number of factors influencing an individual’s attitude such as friendships and intra-group processes were not included.

We subsequently focused on different plausible configurations of factors characterizing an organization, to compare the effects of organizational factors on attitude formation, and to study these effects longitudinally. This approach to modeling can generate new ideas on attitude formation in organizations that would possibly remain difficult to tease out with empirical studies. As in Nowak’s model, an agent had a choice between two attitudes: 1 or 0, in favor or against, and based on the schema an agent ‘determined whether to keep its current attitude or change it.

First we will describe the building block for compliance, then the building block for conformity, followed by the combination of both building blocks. Subsequently, we will describe the building block for resistance and combine it with the previous building blocks. The result is one formula, which is the core of the model, describing the schema each agent in the model uses to ‘decide’ on their attitude.

4.4.1 Compliance
4.4.1.1 Algorithm for interactions
The interaction pattern between agents in our model was determined by four factors: the communication index, the communication density, the organizational structure, and coincidence. The communication index ($C_j$) represents all personal features determining whether an agent is likely to communicate about the attitude with others. This factor is important, as compliance requires a form of interaction. Therefore, when a very influential agent does not interact with others its influence is zero, whereas when a less influential agent interacts frequently its influence will be high. In real life, the communication index will be influenced by, for example, personal traits such as extraversion and agreeableness (Goldberg, 1993) but also by the importance of the attitude for the individuals involved. As the personal features of both the agent ($C_j$) and the counterpart ($C_i$) affected the chance of communication, we multiplied the communication indices of the agent and the counterpart. The
product of these variables resulted in a number describing the chance of both individuals interacting. This number was then multiplied by a factor for coincidence \((Ch_{ij})\) that randomly differed at every interaction. This random variable, for similar combinations of agents interacting at different time points, generated different chances for interactions, resulting in a semi-random pattern of interactions in order to simulate real-world networks that exhibit both ordered and random properties (Watts, 2004).

In the model, we wanted to simulate that agents interact more frequently with agents that are within their ingroup. For this purpose, we introduced a threshold \((Tr)\); by applying different thresholds for contacts within groups, departments and the organization, we incorporated the effect of the organizational structure into the model. Low thresholds were assigned to combinations of group members, medium thresholds to combinations of agents of the same department, and high thresholds to combinations of agents of different departments. So when the interaction chance was calculated, the model determined whether an interaction took place or not by comparing this interaction chance with the threshold; only when the interaction chance was above this threshold an interaction took place. The thresholds therefore determined the communication density: low thresholds generated a high likelihood for agents to interact and thus a high communication density, whereas high thresholds generated low communication densities. In real life, this factor can be determined by, for example, the organizational culture, or the nature of the jobs. Mathematically, an interaction took place between agents \(i\) and \(j\) when:

\[
C_i \times C_j \times Ch_{ij} > Tr
\]

Equation 1

Thresholds thus determined the communication density between the various parts of the organization.

4.4.1.2 Algorithm for compliance

For compliance, we built on a model (Nowak et al., 1990) which is based on the theory of social impact (Latane, 1981). Compliance consists of three factors: the personal influence of an agent, authority and the distance.

The first factor, the personal influence of an agent, is based on the perceiver’s expectancies of the target. This factor originates from experience, knowledge obtained or received from others, stereotypical beliefs, physical attractiveness, etc. (Snyder & Stukas, 1999). As in Nowak’s model, each agent has a persuasive influence \((P_i)\) and a supportive influence \((S_i)\) which are independent (Nowak et al., 1990). This independence simulated that an individual, e.g. a politician, may have a large supportive influence on followers, and thus is able to strengthen already positive attitudes, whereas the same politician may have little or no persuasive influence on
opponents, and may not be able to change negative attitudes into positive ones. The second factor, typical for organizations, was authority. Based on their hierarchical position, managers are given authority to enhance their influence. Authority is the power derived from one’s position and not from one’s expertise or personality. This type of authority is “owned” by organizations (Leavitt, 2003). However, in our model, authority has an influence on the intrinsic willingness of people to internalize an attitude, which differs from authority used to enforce obedience. In our model, the enhanced influence of superiors is thus determined by their legitimate and referent power and not by their reward power or coercive power (Raven & French, 1958) by which behavior can be enforced. For authority, we first checked whether a counterpart agent was a superior. For all counterparts that were not a superior, the factor for authority (A_i) was set to 1. Only when a counterpart was a superior, strength of authority was calculated, and ranged from 2 to 25. The strength of authority by agent i on agent j (A_{i,j}) was calculated from two factors. The first was based on the personal norms for authority of agent j (P_{na,j}). This factor simulated the agent’s perception of the legitimacy of the authority (Raven & French, 1958). The second was based on the organizational norms for authority (Ona), simulating that different organizations may have different norms, depending on the power distance in those organizations (Hofstede et al., 1990). Mathematically the authority of agent i over j (A_{i,j}) was given by:

\[ A_{i,j} = \text{Ona} \times P_{na,j} \]

For all non-superior counterparts, A_{i,j} = 1.

When an agent had authority, the factor for authority was used to amplify the personal persuasive or supportive strength of this agent. Authority therefore enhanced the personal influence of an agent.

The third factor was influence based on group membership. It is well established that ingroup members trust one another more and that there is a general desire to affiliate more with ingroup members (Tajfel, 1974). Therefore, the influence of agents from the same group was the strongest, followed by that of agents from other groups but from the same department, and weakest for agents from other departments. This decline in influence was simulated by reducing the influence between two agents by the power of 2 according to the distance (D_{i,j}) in the organization, as determined by the organizational structure. When counterpart agent i was an ingroup member, D_{i,j} was 1. When agent i was not an ingroup member, but a member of the same department, D_{i,j} was 2, and for all other agents D_{i,j} was 3.

Combining all three elements into the algorithm, the supportive (I_s) or persuasive strength (I_p) of a single agent was mathematically expressed as:
Persuasive influence, \( I_p = \frac{(O_{na} + P_{naj}) \cdot P}{D_{ij}} \)  

Supportive influence, \( I_s = \frac{(O_{na} + P_{naj}) \cdot S}{D_{ij}} \)

During the simulation, agent \( j \) was matched with all other agents to determine whether an interaction took place or not. When an interaction took place, we determined whether the influence of agent \( i \) was supportive \( (I_s) \) or persuasive \( (I_p) \) with regard to the attitude of agent \( j \). Then the influence of agent \( i \) was added to the total of supportive influences \( (I_s) \) or to the total of persuasive influences \( (I_p) \) of agent \( j \), which resulted in the total sum of persuasive and supportive forces experienced by agent \( j \) (equations 4 and 5). As in real life, repetitive exposure to a similar argument reduces the influence of the next similar argument (Latane & Wolf, 1981). To reduce the influence of repeated argument, the sum total of persuasive and supportive forces was amplified by the square root of the number of encounters \( (N_p \text{ and } N_s) \) divided through the absolute number of these encounters. Mathematically expressed, compliance defined as the sum of persuasive \( (I_{tp}) \) and supportive forces \( (I_{ts}) \) experienced by agent \( j \) was given by:

\[
I_{tp} = \left(\frac{N_p^{1/2}}{N_p}\right) \left[ \sum_{i=1}^{N_p} (O_{na} + P_{naj}) \cdot P / D_{ij}^2 \right] \\
I_{ts} = \left(\frac{N_s^{1/2}}{N_s}\right) \left[ \sum_{i=1}^{N_s} (O_{na} + P_{naj}) \cdot S / D_{ij}^2 \right]
\]

**Equation 4**

**Equation 5**

### 4.4.2 Conformity

An important antecedent of conformity is perceived consensus (Cialdini & Goldstein, 2004). In the model, level of conformity was based on the actual distribution of attitudes. The size of the majority in each group determined both the direction and strength of the conformity experienced by an agent. When, for example, 90% of the agents in the group held a similar attitude, an agent with an opposing attitude felt greater pressure to conform than when only 51% had this attitude. We also anticipated that in real life some people are more influential than others, which is known as referent informational influence (Turner et al., 1989). The influence of an agent was determined by two factors: the persuasive strength of an agent and the communication index. We determined the referent informational influence of each agent in the group by multiplying the persuasive strength of an agent with the communication index. Using this algorithm, we modeled that highly persuasive and communicative agents were most influential. Once we had calculated the influential strengths of each agent in a group, we calculated the respective support
for attitude 0 and attitude 1. The conformity factors for attitude 1 (CF₁) and 0 (CF₀) are given by:

\[
CF_1 = \frac{\sum_{i=1}^{N_1} (P_{1i} \ast C_{li})}{\sum_{i=1}^{N_1} (P_{1i} \ast C_{li}) + \sum_{i=1}^{N_0} (P_{0i} \ast C_{li})}
\]

\[
CF_0 = \frac{\sum_{i=1}^{N_0} (P_{0i} \ast C_{li})}{\sum_{i=1}^{N_1} (P_{1i} \ast C_{li}) + \sum_{i=1}^{N_0} (P_{0i} \ast C_{li})}
\]

In which \(N_1\) and \(N_0\) are the number of agents \(i\) with attitude 1 and 0, \(P_{1i}\) and \(P_{0i}\) the persuasive influence of agents \(i\) with attitude 1 or 0 respectively.

Subsequently, \(CF_1\) and \(CF_0\) were multiplied by two parameters. The first represented the personal salience of agent \(j\) for the group (\(P_{sj}\)), simulating the tendency of attitudes to converge more strongly to the prototypical ingroup position when the salience of the group is stronger (Haslam, 2001). The second parameter represented the organizational norms for conformity (\(ON_c\)), simulating the cultural dimension of individualism versus collectivism in an organization (Hofstede et al., 1990). The conformity strength for attitude 1 (\(CS_1\)) and 0 (\(CS_0\)) was mathematically expressed as:

\[
CS_1 = CF_1 \ast P_{sj} \ast ON_c \quad \text{Equation 6}
\]

\[
CS_0 = CF_0 \ast P_{sj} \ast ON_c \quad \text{Equation 7}
\]

4.4.3 Combining compliance with conformity

Next, we added the resulting conformity strength (CS) to the total force of compliance (I) to determine the total persuasive and supportive force based on conformity and compliance. Note that conformity is determined by the perception of an agent of the majority attitude and is thus independent of the interaction pattern we used for compliance, simulating the observation that conformity can work in the absence of discussion and interaction (Hogg et al., 1990).

To combine compliance with conformity, we first determined whether the conformity strengths (\(CS_1\) and \(CS_0\)) were either persuasive or supportive for agent \(j\), e.g. when agent \(j\) has attitude 0, \(CS_1\) is persuasive and \(CS_0\) is supportive. Then the persuasive and supportive strengths for conformity were added to the sum of the persuasive and supportive influences for compliance, respectively. This resulted in the following combinations for the total persuasive force based on compliance and conformity (\(P_{cc}\)) and the supportive force based on compliance and conformity (\(S_{cc}\):
Agent’s current attitude 1: \[ P_{cc} = \text{It}_p + CS_0 \quad \text{and} \quad S_{cc} = \text{It}_s + CS_1 \]

Agent’s current attitude 0: \[ P_{cc} = \text{It}_p + CS_1 \quad \text{and} \quad S_{cc} = \text{It}_s + CS_0 \]

### 4.4.4 Third building block, resistance

The total resistance of agent \( j \) (\( R_j \)) was calculated from the personal resistance, organizational persuasion, and a consistency factor. The personal resistance (\( PR_j \)) simulated the resistance to change one’s attitude and is determined by personal traits such as a strong preference for routine, cognitive rigidity, a short-term focus (Oreg, 2003) or resistance caused by the importance of the attitude for the identity (Krosnick et al., 1993).

Organizations actively seek to influence employees. Employees can be influenced by the systems and/or programs designed to stimulate specific desirable behaviors. Such aspects often aim at lowering the resistance against acceptance of – and increasing the motivation/commitment of employees for – this behavior (Fernandez and Rainey, 2006; Kotter, 2007; Young, 2009). The influence of the organization on agents’ attitudes was stimulated by the organizational persuasion (\( Op \)), defined in this paper as the total of motivators and de-motivators for a specific attitude in the broadest sense. A simple example of a motivator influencing the level of \( Op \) are financial rewards, e.g., for acquired sales. Based on this reward, individuals are likely to develop a positive attitude towards increasing sales. However, \( Op \) is not only determined by reward systems. Many organizational policies are aimed at organizing and leading the behavior of its employees, such as control mechanisms, yearly appraisals, etcetera. Less tangible aspects such as prevailing norms will also influence the resistance to changing one’s attitude (Ajzen, 1991). When, for instance, a customer friendly attitude is required one can imagine that rewards for acquiring new customers will have a positive influence on this attitude. However, when contacts with customers are guided by bureaucratic procedures or when customers are generally regarded as annoying, this is likely to negatively influence a customer friendly attitude. Another method to influence resistance described in the literature, is inoculation theory (Compton, Jackson, & Dimmock, 2016). This theory shows that individuals’ resistance to change their attitudes can be increased by sending a message that contains a warning that their attitude is threatened and already providing the arguments by which their attitude will be threatened. The \( Op \) in this paper is defined as the total sum of all factors, positively and negatively, influencing an attitude, such as customer friendliness. In our model, the organizationally preferred attitude was by definition the attitude stimulated by the \( Op \). In case an agent had an attitude opposing the organizational preferred attitude, the \( Op \) will reduce an agent’s
resistance to change its attitude. In such cases the Op is subtracted from the personal resistance. When the agent’s attitude and the organizational preferred attitude were similar, the Op strengthened the agent’s attitude and thus was added to the personal resistance. In our model, the organizationally preferred attitude was linked to the attitude of the CEO, assuming that the CEO was the most able agent to implement specific programs and systems to influence resistance.

Given that changing one’s opinion may feel inconsistent, and being consistent is an important aspect of one’s self-concept (Cialdini & Goldstein, 2004), the personal resistance in our model increases during successive iterations. Over longer periods the resistance may decrease however, since our simulation covers only a short span of time – a few weeks or months – the need to be consistent will probably dominate. In our model, this implies that the incremental factor for consistency (Ir) increased the personal resistance at every iteration with 0.1*PRj (Ir = 0.1*PRj), doubling personal resistance in ten iterations. The resulting resistance Rj of agent j was therefore given by:

The agent’s attitude was similar to the preferred attitude, \( R_j = PR_j + Ir + Op \)

The agent’s attitude opposed the preferred attitude, \( R_j = PR_j + Ir - Op \)

The resulting resistance was used to amplify the total of supportive forces (Scc) giving the final supportive force (Sccr), which includes compliance, conformity, and resistance, mathematically given by:

The agent’s attitude was similar to the preferred attitude, \( Sccr = (PR_j + Ir + Op) * Scc \)

The agent’s attitude opposed the preferred attitude, \( Sccr = (PR_j + Ir - Op) * Scc \)

### 4.4.5 The complete schema

Mathematically, the attitude of an agent changed when the total persuasive force (Pcc) was larger than the total supportive force (Sccr). Combining all equations, mathematically an agent changed attitude when:

\[
P_{cc} > S_{ccr} = \\
\left( \frac{N_p}{2} \right) \left[ \sum_{i=1}^{N_p} \left( (Ona * Pna_i) * \frac{P_i}{D_{ij}^2} \right) + (CF_{jor} * P_{Sj} * ON_{Cc}) \right] \\
> (PR_j + Ir +/- Op) * \left[ \left( \frac{N_o}{2} \right) \sum_{i=1}^{N_o} \left( (Ona * Pna_i) * \frac{S_i}{D_{ij}^2} \right) + (CF_{jor} * P_{Sj} * ON_{Cc}) \right]
\]
Figure 1  Pseudo-codes and the place of the equations in the program.
This formula represents the general schema that each agent in the model used to determine its attitude. Figure 1 depicts a flow schedule with the pseudo codes and place of the equations of the model.

4.5 Method
At the start of each run, all personal and organizational parameters as well as the initial attitudes were assigned to the agents using a random generator. Each run thus starts with a unique configuration simulating one organization with different agents and different organizational parameters. During the first round of interaction each agent was matched with all other agents in the organization, and it was determined whether an interaction took place or not. When an interaction took place, the influence of the agent’s counterpart was added to the sum of either persuasive or supportive influences. Once an agent had been matched with all other agents, the new attitude of this agent was calculated and stored. When this process was completed for all agents, the established set of new attitudes formed the basis for the next set of interactions. Each run consisted of ten rounds of interactions (iterations). The total simulation consisted of 1200 runs providing a sample of 1200 unique virtual organizations (N=1200) going through a change process of 10 interaction rounds.

4.5.1 Parameters
With regard to the input parameters, we assigned specific ranges for each parameter. For communication density, we had some guidance from the study by Lum on interaction patterns among nursing personnel. This study found that in units of approximately 11 individuals, the chance for a specific topic to be discussed was between 30% and 40% (Lum, 1970). Setting the range of communication density between 20% and 60% ensured that we incorporated realistic values. For communication density within departments and the organization, we anticipated that the communication frequency would drop by a factor of 2 for each step further away from the ingroup and these ranges were adjusted accordingly. However, we had no guidance for the ranges of other parameters. Thus, we used two basic criteria; first, the ranges should be sufficiently wide to include realistic values; second, the system had to be dynamic and allowing attitudes to change. With regard to organizational persuasion, in preliminary experiments we found that at Op levels >3 a plateau was reached. Therefore, in our simulation we chose a dynamic range between 0 and 3 for Op.

Three categories of parameters were distinguished in the model: personal parameters, organizational parameters and model parameters. The personal parameters determined the features of each agent whereas the organizational parameters determined the features of the organizations. The model parameters
represented basic choices we made. One was the choice to limit maximum 
resistance to 10 and set minimum resistance at 0.04. By setting a limit to maximum 
resistance, we kept the system dynamic, knowing that a high resistance would 
completely block any attitude changes. By making it impossible for the resistance 
to become negative, we modeled that agents could not change their attitude 
without persuasion. All random variables had a normal distribution. A summary of 
all parameters and the ranges of each parameter are shown in Table 1.

Table 1 Overview of parameters and ranges used in the model and in brackets 
the corresponding abbreviations and the formulas.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
<th>Formulas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication index (C_i, C_j)</td>
<td>0 to 1</td>
<td>( C_i \cdot C_j \cdot Ch_{ij} &gt; Tr )</td>
</tr>
<tr>
<td>Threshold (Tr)</td>
<td>2 to 60%</td>
<td></td>
</tr>
<tr>
<td>Chance of interaction between agents i and j (Ch_{ij})</td>
<td>0 to 1</td>
<td></td>
</tr>
<tr>
<td>Level of organizational norms authority (Ona)</td>
<td>2 to 25</td>
<td></td>
</tr>
<tr>
<td>Persuasive strength (P_i)</td>
<td>1 to 3</td>
<td>( I_p = (Ona \cdot Pnaj) \cdot P_i / D_{ij}^2 )</td>
</tr>
<tr>
<td>Supportive strength (S_i)</td>
<td>1 to 10</td>
<td>( I_s = (Ona \cdot Pnaj) \cdot S_i / D_{ij}^2 )</td>
</tr>
<tr>
<td>Group membership (D_{ij})</td>
<td>1, 2 or 3</td>
<td></td>
</tr>
<tr>
<td>Salience group (P_{s,j})</td>
<td>1 to 10</td>
<td>( CS_2 = CF_1 \cdot P_{s,j} \cdot ONc )</td>
</tr>
<tr>
<td>Level of organizational norms group conformity (ONc)</td>
<td>2 to 25</td>
<td>( CS_0 = CF_0 \cdot P_{s,j} \cdot ONc )</td>
</tr>
<tr>
<td>Organizational persuasion (Op)</td>
<td>0 to 5</td>
<td>( R_j = PR_j + Ir + Op )</td>
</tr>
<tr>
<td>Personal resistance factor (PR_j)</td>
<td>0 to 3</td>
<td>( R_j = PR_j + Ir - Op )</td>
</tr>
<tr>
<td>Increase in resistance per iteration (Ir)</td>
<td>0.1* PR_j</td>
<td></td>
</tr>
</tbody>
</table>

With this approach and the uncertainty involved in the ranges, we realize that 
several of our organizations will have unrealistic characteristics. However, since our 
aim is to detect trends these *unrealistic* organizations are very informative since 
they represent extremes that are either hard to find or may even not be available in 
real life. Furthermore, it is likely that in real life organizations parameters will change 
over time. Nevertheless, we kept them constant. We regarded this as a valid 
approach since we only simulated a relative short period with the 10 iterations used 
in our simulations. In such a short period it is likely that personal and organizational 
parameters will be stable.
Four output parameters were used. First, we determined the number of agents with attitude 0 per iteration. Secondly, we determined at the end of each iteration, the percentage of workers sharing the CEO’s initial attitude. Thirdly, we determined the level of convergence by subtracting the number of agents with the same additional attitude as the CEO after the first iteration from the number of those at iteration 10. Fourthly, we monitored the number of agents changing attitude per iteration to assess the dynamics.

4.5.2 Organizational structure
The organizational structure in all simulations consisted of one CEO, supervising four departmental heads. Each departmental head was responsible for four team leaders who each supervised ten employees. The simulated organization therefore had 181 people in total. The CEO and departmental heads were allocated to one group. Each departmental head also formed a group with the four team-leaders under their supervision. Team leaders also formed a group with their employees. Therefore, all departmental heads and team leaders were members of two ingroups. The CEO and the workers, however, were only allocated to one ingroup. The CEO didn’t belong to any department; therefore the reduction of influence due to the distance was maximal for all interaction of the CEO with group leaders and workers. Although the organizational structure is likely to be a factor that will affect the influence of management as well, the structure was kept constant and was not used as an organizational parameter in our simulation.

4.5.3 Analyses
To determine the level of management influence on attitude formation we correlated the initial percentage of agents with attitude 0 of each managerial level with the percentage of workers with attitude 0 at the end of the run. In case management had an influence on the emergence of attitudes, their initial attitude should be predictive for the outcome. Next, we determined which factors enhanced or reduced the influence of the CEO. For this, we correlated the percentage of workers that shared the CEO’s initial attitude after the first and the last iteration with the various organizational factors to determine the effect of these factors on the CEO’s influence. To assess the dynamics we monitored the number of attitude changes per iteration and correlated the percentage of workers with attitude 0 at the start and every next iteration with the percentage of workers with attitude 0 in the last iteration. Additionally, we correlated the level of convergence with the organizational factors to determine the effect of these factors on convergence.
4.6 Results
In the next paragraphs the results of our simulations will be presented. An important feature of computer simulations is that we need to differentiate between outcomes that are the result of choices made in the program and findings that were not explicitly programmed into the model. In the following paragraphs we will specifically address whether an outcome is a finding or a result of the way the program was created.

Analyzing the organizational factors that had an effect on the influence of the CEO on the emergence of a shared attitude, we found that organizational persuasion (Op), with a correlation coefficient of 0.753, was by far the most dominant factor (Table 2, first block). This factor was so dominant that for further analyses, in addition to the overall results, we also analyzed the results per level of Op to ensure that potential effects of the other parameters were not overshadowed by Op. The observation that the Op would influence the outcome is not surprising, as it was designed to do so. However, we did not anticipate the impact of this factor would be so strong. Besides Op, the communication within groups and departments also enhanced the influence of the CEO, but only the effect of communication in groups was consistent at all levels of organizational persuasion. The level of group conformity, however, had a consistent negative effect on the influence of the CEO (Table 2). This finding is in line with our expectations, as group conformity will strengthen the initial group majority and will thus prevent attitude changes when the CEO's attitude opposes the majority attitude in the group.

These observations suggest that, in real life organizations, management can influence the emergence of a shared attitude best by reducing the resistance against the preferred attitude and, once the preferred attitude is obtained, to enhance the resistance to change it back. This observation is in line with studies regarding the importance of reduction of resistance in management (Kotter & Schlesinger, 1979). The observation that more communication enhances the influence of the CEO is not new either. However, the finding that more communication within groups is essential to enhance the influence of the CEO is not found in the literature.

Subsequently, we assessed which management levels were able to influence the emergence of attitudes in an organization. We did this by calculating the correlation between the average percentage of agents at each managerial level with attitude 0 before the first iteration and the final percentage of workers with attitude 0 at iteration 10. This relation demonstrated whether the initial attitude of a managerial level was predictive for the outcome and thus measured the influence of this managerial level. Overall, the CEO had the most significant impact on the emergence of a shared attitude. Other managerial levels also had a significant influence (Table 3). However, the influence of the other managerial levels was most
Table 2  The means and standard deviation of the organizational factors and their effects on the influence of the CEO and convergence, expressed by the correlations between organizational factors and percentage of workers following the CEO, and the percentage of convergence, overall and at various levels of organizational persuasion (Op).

<table>
<thead>
<tr>
<th>Correlation between the organizational factors and the influence of CEO</th>
<th>OP 0 to 3 (N=1200)</th>
<th>OP 0 to 1 (N=375)</th>
<th>OP 1 to 2 (N=401)</th>
<th>OP 2 to 3 (N=424)</th>
<th>OP 0 to 1 (N=200) no increase in personal resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AVG</td>
<td>STD</td>
<td>Cor. C.</td>
<td>AVG</td>
<td>STD</td>
</tr>
<tr>
<td>Authority</td>
<td>13.4</td>
<td>6.7</td>
<td>0.071*</td>
<td>13.3</td>
<td>6.6</td>
</tr>
<tr>
<td>% Com. in groups</td>
<td>34.7</td>
<td>9.8</td>
<td>0.121***</td>
<td>35.0</td>
<td>10.1</td>
</tr>
<tr>
<td>% Com. in departments</td>
<td>15.9</td>
<td>8.8</td>
<td>0.105***</td>
<td>15.8</td>
<td>8.8</td>
</tr>
<tr>
<td>% Com. in organization</td>
<td>6.4</td>
<td>5.2</td>
<td>0.018</td>
<td>6.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Organizational persuasion</td>
<td>1.5</td>
<td>0.9</td>
<td>0.753***</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Group conformity</td>
<td>13.4</td>
<td>6.8</td>
<td>-0.134***</td>
<td>13.7</td>
<td>6.7</td>
</tr>
</tbody>
</table>

* P<0.05. ** P<0.01. *** P<0.001
prominent when the level of Op was low, and declined at higher levels of Op. By calculating the slopes we were able to compare the relative influence of each managerial level by dividing the slope by the number of persons in each level. For Op levels between 0 and 1 the influence of one departmental head, group leader or worker increased the percentage of workers with a similar attitude with respectively 5.5, 0.8 and 0.04%. The level of influence thus neatly followed the hierarchy without being programmed into the model. The observation that the CEO had a large impact on the outcome is a consequence of our choice to link the Op directly to the initial attitude of the CEO.

Analyzing the dynamics, we found that most attitude changes took place during the first few iterations. After iteration 4 only few attitude changes were observed, indicating that all virtual organizations self-organized into a relatively stable pattern of attitudes. However at increasing levels of Op more attitude changes took place during the first iterations and less during the last iterations; high levels of Op therefore stabilized the system faster (Table 4a).

When the average percentage of agents with the same attitude as the initial attitude of the CEO was calculated for each iteration we could see a similar pattern; during the first iteration most attitude changes towards the CEO’s took place,

### Table 3
The influence of each hierarchical level on the final attitude of the workers expressed by the correlation (C) between the initial percentage of agents with attitude 0 per hierarchical level and the end percentage of workers with attitude 0 and the slope (S), overall and at various levels of organizational persuasion (Op).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Correlation coefficients (C) between the initial attitude of each hierarchical level and the attitude of the workers at the end of the simulation and the slope (S)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CEO</td>
</tr>
<tr>
<td>Op 0 to 3</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Op 0 to 1</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Op 1 to 2</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Op 2 to 3</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>S</td>
</tr>
</tbody>
</table>

* P<0.05. ** P<0.01. *** P<0.001
whereas from iteration 4 onward the number of agents that conformed to the CEO’s initial attitude remained relatively stable (Table 4b). Increasing levels of organizational persuasion thus led to more agents taking over the preferred attitude during the first iteration and higher levels of agents with the preferred attitude at the end.

The importance of the first iteration was made even clearer by correlating the percentage of workers with attitude 0 per iteration with the final percentage of agents with attitude 0; the outcome of the first iteration was almost absolutely predictive of the final outcome. We showed that also the initial distribution of attitudes was to some extent predictive for the final outcome (Table 4c). However, this correlation decreased at higher levels of Op when the influence of Op became more dominant. The weak correlation between the initial attitudes and the outcome demonstrates the nonlinearity of the model. The high predictability of the first iteration for the final outcome and the observation that most changes took place during the first few iterations were not programmed into the model and thus represent true findings, showing that convergence is fast and the majority of the agents changed their attitude during the first iteration. Higher levels of organizational persuasion enhanced the importance of this first iteration.

Figure 2 visualizes the relation between the outcome of the first and the last iteration and demonstrates the linear relation between both parameters. It also shows that, on average, conversion after the first iteration is limited to ±10-15%. In only a few organizations conversion after the first iteration greatly exceeds the level reached at iteration 1. The limited level of conversion is supported by the data in Table 5, in which the influence of the organizational factors on conversion is calculated. From these data it can be concluded that only two factors influence conversion; Op (positively) and group conformity (negatively). Both the effects of Op and group conformity on conversion are similar to their effects on the influence of the CEO as expected since the enhancement of the CEO’s influence will lead to more conversion. Analyzing the correlations at various levels of Op resulted in a diffuse pattern of relations in which, with the exception of the negative influence of group conformity, various factors have a small but inconsistent influence on conversion. Therefore, as hardly any organizational factors stimulated conversion whereas group conformity structurally inhibited conversion, conversion after the first iteration is very limited.

Figure 3 visualizes the relation between Op and the outcome. It shows that any outcome can emerge at low levels of organizational persuasion; majorities supporting and opposing the CEO’s attitude, as well as heterogeneous organizations can be found in this region. Therefore, the uncertainty regarding the outcome was highest at low levels of Op. However, with increasing levels of Op, fewer organizations with an opposing or a mixed attitude are found. In addition, the variation between the outcomes small in comparison with those at low levels of Op.
**Table 4** The dynamics of attitude formation based on the number of attitude changes per iteration (a). The percentage of agents with a similar attitude as the CEO’s initial attitude at start (iteration 0) and all following iterations (a) and the correlation between the percentages of workers with attitude 0 with the last iteration (c) for the complete range of organizational persuasion (Op) and categories of Op.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean number of attitude changes per iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Op 0 to 3</td>
<td>1200</td>
<td>44.2</td>
</tr>
<tr>
<td>Op 0 to 1</td>
<td>375</td>
<td>31.8</td>
</tr>
<tr>
<td>Op 1 to 2</td>
<td>401</td>
<td>43.2</td>
</tr>
<tr>
<td>Op 2 to 3</td>
<td>424</td>
<td>56.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Mean percentage of agents converted to a similar attitude as the initial attitude of the CEO per iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Op 0 to 3</td>
<td>50.2</td>
<td>67.6</td>
</tr>
<tr>
<td>Op 0 to 1</td>
<td>50.0</td>
<td>56.4</td>
</tr>
<tr>
<td>Op 1 to 2</td>
<td>50.2</td>
<td>67.5</td>
</tr>
<tr>
<td>Op 2 to 3</td>
<td>50.2</td>
<td>77.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Correlation coefficients of the percentage of workers with attitude 0 per iteration with the final iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Op 0 to 3</td>
<td>.182**</td>
<td>.978***</td>
</tr>
<tr>
<td>Op 0 to 1</td>
<td>.358***</td>
<td>.917***</td>
</tr>
<tr>
<td>Op 1 to 2</td>
<td>.204***</td>
<td>.975***</td>
</tr>
<tr>
<td>Op 2 to 3</td>
<td>.119**</td>
<td>.990***</td>
</tr>
</tbody>
</table>

* P<0.05. ** P<0.01. *** P<0.001
Table 5  The means and standard deviation of the organizational factors and their effects on convergence, expressed by the correlations between organizational factors and the percentage of convergence overall and at various levels of organizational persuasion (Op).

<table>
<thead>
<tr>
<th>Correlation between the organizational factors and the percentage of convergence</th>
<th>OP 0 to 3 (N=1200)</th>
<th>OP 0 to 1 (N=375)</th>
<th>OP 1 to 2 (N=401)</th>
<th>OP 2 to 3 (N=424)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AVG  STD  Cor. C.</td>
<td>AVG  STD  Cor. C.</td>
<td>AVG  STD  Cor. C.</td>
<td>AVG  STD  Cor. C.</td>
</tr>
<tr>
<td>Authority</td>
<td>13.4   6.7  -0.020</td>
<td>13.3   6.6  0.066</td>
<td>13.3   6.7  -0.029</td>
<td>13.5   6.8  -0.125**</td>
</tr>
<tr>
<td>% Comm. in groups</td>
<td>34.7   9.8  0.023</td>
<td>35.0  10.1  0.118*</td>
<td>34.7   9.8  0.033</td>
<td>34.4   9.8  -0.089</td>
</tr>
<tr>
<td>% Comm. in departments</td>
<td>15.9   8.8  0.012</td>
<td>15.8  8.8  0.043</td>
<td>15.6  8.5  -0.013</td>
<td>16.3   9.3  -0.021</td>
</tr>
<tr>
<td>% Comm. in organization</td>
<td>6.4    5.2  0.040</td>
<td>6.5  5.4  0.044</td>
<td>6.4  5.3  -0.031</td>
<td>6.0    5.0  -0.125**</td>
</tr>
<tr>
<td>Organizational persuasion</td>
<td>1.5    0.9  0.274***</td>
<td>0.5  0.3  0.082</td>
<td>1.5   0.3  0.165***</td>
<td>2.5    0.3  0.033</td>
</tr>
<tr>
<td>Group conformity</td>
<td>13.4   6.8  -0.138***</td>
<td>13.7  6.7  -0.109*</td>
<td>13.6  6.7  -0.178***</td>
<td>13.1   7.0  -0.120*</td>
</tr>
</tbody>
</table>

* P<0.05. ** P<0.01. *** P<0.001
Besides organizational persuasion, the initial majority (Table 4c) and the alignment of the departmental heads (Table 3) also had an influence on the outcome. We were interested in the way these parameters interacted with Op. In Table 6a, we show the combined effect of the initial distributions of the attitudes and the levels of Op on the percentage of organizations with 70% or more of the agents having the preferred attitude. We regard a level of support for the CEO’s attitude of more than 70% as a desirable outcome, as a successful organization. In Table 6b, we show the combined effect of the alignment of the departmental heads and the level of Op. From this table we observed that there is indeed a mutually reinforcing effect; when more agents had a similar attitude as the CEO at the start, or when more departmental heads were aligned, less Op was needed to obtain high percentages of successful organizations (Table 6a and Table 6b).

However, when the level of Op was higher than 2, both the initial majority and the alignment of the departmental heads did not have much influence anymore. The results also show that, at low levels of Op, the effect of initial majority was more prominent than the effect of the alignment of the departmental heads which is in agreement with the correlations reported in Tables 3 and 4c.

**Figure 2** Relation between the results of the first iteration and the final outcome measured as the percentage of agents with the same attitude as the CEO after the 1\textsuperscript{st} and 10\textsuperscript{th} iteration.
4.7 Discussion

With computer simulations, we were able to mimic the emergence of a pattern of attitudes from a random distribution of attitudes. Although we are aware that many aspects of real-life organizations cannot be incorporated in our simple model, this very simplicity allowed us to observe patterns that would have remained undetected otherwise. We will not pretend that this model is an actual description of real life nor that it is complete. However, it does reveal the dynamics of the emergence of a shared attitude and provides clues on how emergence takes place.

Our model simulated a jolt, where an organization was confronted with a new situation for which there was no obvious guidance on how to respond; the response was self-organized. The jolts simulated in the virtual organizations are thus not planned changes, initiated and directed by management, but reflect a self-organized response.

A key finding of our simulations is that management indeed has an influence on the emerging process of attitude formation. This finding conflicts with the general notion that emergence cannot be managed. However, despite the influence of management on attitude formation, this influence was not determinative. That is, there was a substantial variation in the final levels of support for the organizationally preferred attitude.

Figure 3 Relation between level of organizational persuasion and the outcome measured as the percentage of agents following the CEO after 10 iterations.

Influence of the level of organizational persuasion on the attitude of the agents

![Graph showing the relationship between level of organizational persuasion and percentage of agents following the CEO after 10 iterations.](image-url)
Table 6  The effect of the initial majority on the outcome (a) and the alignment of the departmental heads (b) in relation to the level of organizational persuasion (Op).

<table>
<thead>
<tr>
<th>a. Initial percentage of workers with the same attitude as the CEO</th>
<th>N</th>
<th>Percentage of organizations in which ≥70% workers obtained the attitude of the CEO in relation to the levels of Op</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Op 0 to 0.5</td>
</tr>
<tr>
<td>39-45%</td>
<td>85</td>
<td>0%</td>
</tr>
<tr>
<td>45-50%</td>
<td>487</td>
<td>9%</td>
</tr>
<tr>
<td>50-55%</td>
<td>519</td>
<td>15%</td>
</tr>
<tr>
<td>55-63%</td>
<td>109</td>
<td>20%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b. Number of departmental heads aligned with the CEO at start</th>
<th>N</th>
<th>Percentage of organizations in which ≥70% workers obtained the attitude of the CEO in relation to the levels of Op</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Op 0 to 0.5</td>
</tr>
<tr>
<td>0</td>
<td>65</td>
<td>8%</td>
</tr>
<tr>
<td>1</td>
<td>323</td>
<td>9%</td>
</tr>
<tr>
<td>2</td>
<td>456</td>
<td>13%</td>
</tr>
<tr>
<td>3</td>
<td>293</td>
<td>17%</td>
</tr>
<tr>
<td>4</td>
<td>63</td>
<td>27%</td>
</tr>
</tbody>
</table>
The finding that in a number of simulated organizations majority support for the preferred attitude was not obtained, is intriguing. It suggests that in more or less identical circumstances, more or less identical efforts to obtain a majority may lead to very diverse outcomes. Such diverse outcomes of change efforts are also found in real organizations, and our findings suggest that this may not be the consequence of differences in management efforts, but rather as a consequence of emerging processes. As the outcomes could not be fully predicted from the starting conditions in the simulation, apparent differences in points of departure in real organizations may not fully explain differences in outcomes either. People are used to analyzing underlying causes for failed efforts, but our findings suggest that some of these analyses might be fruitless, as there may not always be such specific underlying causes. Emerging processes may be more powerful than people are willing to believe and may in itself ‘explain’ why similar management efforts do not always yield similar results and, therefore, management should not always be blamed for failures.

It should be noted that although the CEO was the most influential agent, the CEO was only one of many mutually competing influences. In this respect we found that the alignment of the departmental heads with the CEO enhanced the influence of the CEO. Overall, when the departmental heads were aligned, less organizational persuasion was required to obtain successful outcomes. This finding supports Kotter’s advice that for a successful organizational change strong coalitions are needed (Kotter, 2007a). Interestingly, however, in our data even complete alignment was not always enough to obtain full support, emphasizing the relevance of emergent processes.

The key organizational factor to influence emergence was the level of organizational persuasion (Op). Of the other organizational parameters, the communication in the groups was shown to have a consistent positive effect on the influence of the CEO. The level of group conformity, however, had a consistently affected the CEO’s influence negatively, because group conformity strengthens the initial majority attitude of the group. All other organizational factors didn’t seem to matter and one might argue that these factors may be excluded from the equations. At this point, however, we think it is too early for this conclusion, as in other situations and other simulations such factors may be influential as well.

We defined Op as the sum of all motivators and de-motivators to the preferred attitude. This broad definition not only includes reward systems but also the systems and processes that organize workflows, formal and informal agreements on ‘how things are done’. In other words, it pretty much encompasses the identity of the organization. The organizational identity is defined as that what is central, distinctive and enduring about organizations. The role of the organizational identity is that it influences the meaning of events and the actions taken in response (Dutton &
Dukerich, 1991). This is exactly what Op did in our model. Based on our data we can therefore conclude that a route by which the organizational identity influences choices made in an organization, is by reducing the resistance against behavior in line with the organizational identity and by increasing the resistance against behavior opposing the organizational identity.

With regard to the strength of Op in our model, we presumed that Op was always positive and similar for each agent. Based on all organizational features that add to the perceived Op, both presumptions are unlikely to apply to real-life organizations. First, Op experienced by each employee will be different due to personal preferences (Cialdini & Goldstein, 2004; Krosnick et al., 1993; Oreg, 2003). Secondly, differences between subgroups in organizations in, for example, type of work, organizational climate, leadership, and group norms, will create differences in the level of Op perceived by individuals in various groups and departments. In combination with personal preferences, this will lead to substantial variation in the experienced Op, not only in the levels of Op but also in the direction; individuals, or groups of individuals, may also experience a negative Op, enhancing the opposed attitude. Although our model clearly points at the importance of Op, in real life the perceived Op is likely to be far more diverse and will most likely be small. Therefore, we expect that the low ranges of Op we analyzed represent real-life best. Nevertheless, Op is clearly the key organizational factor to acquire influence.

As a consequence, to influence attitude formation most effectively, the role of managers is thus to motivate, enable and facilitate subordinates in the preferred direction to lower their resistance. This is in agreement with the findings that, in complex systems, managers can exercise most influence by acting as enablers (Plowman et al., 2007), that successful leaders display behavior associated with facilitating, engaging, motivating and energizing employees (Higgs & Rowland, 2011; Kotter, 2001); and that it is vital to reduce resistance in planned organizational changes (Dent E. B., 1999; Kotter, 2007a). Our findings are in line with these observations; during jolts, managers should try to reduce resistance in order to adjust the organization.

For real-life organizations, this would indicate that the person in the best position to influence Op has the most influence. Our findings suggest that in organizations where one individual, or a small group of individuals, are able to create a very high level of Op, a high level of influence on emergent processes may be acquired. However, as Op is determined by many factors it is not likely that one (group of) individual(s) is able to fully determine the Op. Furthermore, as reasoned above, Op is likely to be low and rather diverse in real life organizations. Based on these considerations, it is probably hard to influence emerging processes in real life, even if you know that Op is the key factor. This strengthens our previous conclusion that positive or negative outcomes of organizational changes are not necessarily
related to the competence of the change agent, because especially since at low levels of Op the uncertainty regarding the outcome is high.

With regard to the dynamics we found that the majority formed during the first iteration was determinative for the outcome. This is an interesting result that has not been reported yet. After the first round of interactions, an average of 68% of workers had already acquired a similar attitude as the CEO and during the following round, this number increased only slightly to 73% during following iterations where after it stabilized. Only few organizations were found in which conversion was enhanced during the following iterations and in which a tipping point could be observed. The concept of a tipping point relates to the Critical Mass theory (Macy, 1990) and the Threshold model (Granovetter, 1978). Both theories are used to describe the spread of an innovation and presume that a minimal number of agents are needed for an invention to spread. In both theories it is described that once a tipping point is reached the amount of supporters will grow autonomously. This is not the case in the majority of our virtual organizations.

Since the initial majority obtained during the first iteration was the most determinative factor for the outcome, influences of management, the initial attitude of the CEO and the alignment of the departmental heads thus predominantly had an effect during this first round determining the size of the majority after the first iteration, and thus the final outcome. The importance of the first round of interactions indicates that if management wants to exercise any influence they will have to do this quite early. As a consequence, management should be present at these first rounds of interaction and have to display unity. Due to the complexity and size of organizations this is hard to achieve, as organization members may use a number of communication channels, both formal and informal ones (Krackhardt & Hanson, 1993). However, speculating about the factors could facilitate an early involvement, we suggest that flat organizations with short lines of communication between the work floor and management might facilitate influence. This notion is supported by the literature, as a flat organizational structure matches with a need for effectiveness and fits best in a “locally stormy environment” (Burton, 2011). Similarly, Anderson and Brown presented preliminary evidence that a flatter organization is to be preferred when groups work on complex and ambiguous tasks (Anderson & Brown, 2010) which is also in line with our suggestion. An alternative solution for the need of management to be present during the first rounds of interaction is the presence of other influential individuals with a similar attitude as the CEO. This is achieved when management is sufficiently aligned with the CEO.

It is an empirical question for future research whether the large influence of the first round of interactions will be found in real organizations. Research on attitude change rarely reports attitude measures at more than two points in time, usually in
an attempt to measure the effect of some message or intervention aimed to result in attitude change. In our simulation, as individuals do in real life, agents are continuously interacting and are thus continuously subject to persuasive communication, a process that will be extremely hard to monitor in real life. Nevertheless, longitudinal research in organizations including early time points should at least be able to establish whether attitude changes resemble the pattern found in our simulations. We see it as an asset of our simulation that it focuses on the longitudinal dynamics.

With regard to the role of management our simulations suggest that, despite all the efforts made by management, there is still a certain level of uncertainty regarding the outcome, as the influence process cannot be fully controlled and some influence attempts simply fail without any real specific apparent cause. Interestingly, at the same time the power of emergence is not absolute and although attitude formation is an emerging, complex process management does have possibilities to steer this process.

Combining emergence and influence processes, as we did in our simulation, helps to better understand that majorities may arise by self-organization, that this process can be influenced, but that full control is unattainable. In that sense, our simulations contribute to both attitude change and emergence literature, as it emphasizes that the interaction between the two processes determines outcomes at the macro level of organizations.
5

Adaption or escalation of commitment in organizations; a group dynamics perspective

Peter van Woensel
Dick de Gilder
Peter Groenewegen

This chapter is Submitted
CHAPTER 5
5 Adaption or escalation of commitment in organizations; a group dynamics perspective

5.1 Abstract
We used computer modeling to study how mutual and on-going interactions between individuals led either to adaption or to escalation of commitment in organizations. We found that a high level of attitude homogeneity was the primary cause of escalation of commitment. We demonstrated that due to cycles of mutual confirmation, adaption was prevented even when all individuals were willing to adapt. High levels of authority, organizational persuasion and the level of homogeneity in the organization, inhibited adaption. Only communication was found to stimulate adaption.

Keywords
Agent based social simulation, attitudes, complexity, organization theory, escalation of commitment, groupthink.

5.2 Introduction
Employees’ attitudes towards the goals of the organization are an important antecedent of the organization’s success (Bouckenooghe, 2010; Choi, 2011; Oreg et al., 2011). However, over time organizations change and devise new strategies, requiring employees to develop new attitudes. Frequently, organizational members have difficulties with adapting to change. In cases where organizational members are unable to abandon a failing course of action, escalation of commitment occurs: that is, groups adhere to a particular behavior even when it is obvious that it does not work (Staw & Ross, 1989).

A recent meta-analysis concluded that there is a lack of longitudinal studies and empirical research on the social and structural determinants involved in escalation of commitment (Sleesman, Conlon, McNamara, & Miles, 2012a). To begin to fill this gap, we use computer modeling to longitudinally explore processes leading to escalation of commitment in organizations. Specifically, we sought to understand: a) how the ensemble of individual interactions between organizational members may lead to adaption or escalation of commitment in organization as a whole, b) which structural determinants in the model influence adaption and escalation of commitment in multiple-group organizations, and c) how escalation of commitment can be counteracted.
CHAPTER 5

5.3 Theoretical background

5.3.1 Escalation of commitment in organizations

Escalation of commitment is a common phenomenon in organizations (Guler, 2007; Hietala, Kaplan, & Robinson, 2003; Shepherd, Wiklund, & Haynie, 2009). Obviously, sticking to a failing strategy, project or investment has detrimental consequences for organizations. Escalation is frequently studied from the perspective of individuals. In this approach the focus is on individuals’ characteristics leading to escalation (Sleesman et al., 2012a) such as sunk costs or time investments. In our study, however, we will focus on escalation of commitment at the group and organizational level.

Groups such as teams and departments are responsible for many organizational decisions made in organizations and escalating commitment is a well-recognized feature in group decision making literature (Bazerman, Giuliano, & Appelman, 1984). Individuals in groups experience a pressure to conform, leading to polarization (Hogg & Terry, 2000) and escalation. Another well-known pitfall for groups that is closely related to escalation of commitment is ‘groupthink’. In groupthink a group decision is made that individuals in the group privately regard as bad (Janis, 1971).

Escalation of commitment in organizations can take many forms (Sleesman, Conlon et al. 2012). For instance, the inability to adapt has led to project failure or time and cost overrun (Keil, Mann, & Rai, 2000). Organizations often cling to a once successful strategy such as expansion or job design even when it leads to negative results, i.e. the “too-much-of-a-good-thing” effect (Pierce & Aguinis, 2013). In some situations, employees may have rational arguments to collectively conceal problems from management, leading to negative outcomes for the organization (Ford & Sterman, 2003).

5.3.2 Social influence and escalation of commitment in groups

To explain escalation as a group phenomenon we need to determine how the interactions between individuals in the group might lead to a shared attitude in the group. In order to do so, we took the perspective of organizations as self-organizing complex systems in which micro level interactions between individuals may lead to macro level phenomena like escalation of commitment at the macro level of organizations (Anderson, 1999). Therefore, escalation of commitment in this paper is seen as a collective positive attitude individuals have towards a failing behavior. We fully realize that behavior is determined by multiple factors. Nevertheless we argue that a positive attitude to a particular behavior is a major determinant of this behavior (Ajzen, 1991).

Attitudes are formed by the interactions between individuals (Friedkin, 2001) and attitude change by individuals is caused by social influence (Chaiken & Stangor, 1987; Wood, 2000). From our perspective, attitude formation in groups – and thus
escalation of commitment – therefore is the result of the on-going interactions between organizational members, resulting in a stable pattern of attitudes. It is hardly possible to study the dynamics of such processes empirically for a sufficient large group of organizations. We therefore, addressed this problem by using an agent-based computer model (Davis et al., 2007).

5.3.3 The elements of social influence
As stated above, in our model escalation of commitment is driven by social influence. Two dimensions of social influence can be distinguished: compliance and conformity (Cialdini & Goldstein, 2004). Compliance is “a particular kind of response—acquiescence—to a particular kind of communication—a request” (Cialdini & Goldstein, 2004: 592) (p 592). Consequently an interaction is necessary to exercise influence through compliance. Conformity is “the act of changing one’s behavior to match the responses of others” (Cialdini & Goldstein, 2004: 606) (p 606). For conformity, therefore, no interaction has to take place; the knowledge or the perception of other individual’s positions is sufficient to induce attitude change. Due to the group pressure to conform, group members can adhere more strongly to their behavior or attitude (Guler, 2007), which increases the chances of escalation of commitment at the individual level. Another effect of conformity is cohesiveness: due to the mutual pressure to conform, groups become more homogeneous (Mcgarty, Turner, Hogg, David, & Wetherell, 1992). Conformity, therefore, probably promotes both escalation of commitment and group cohesiveness.

Attitudes evolve and change continuously (George & Jones, 1997) and are predominantly formed within groups (Friedkin, 2001). Individual group members will influence each other, during interactions, supporting those with a similar attitude and wittingly or unwittingly persuade others with a different attitude to comply (Wood, 2000). Hence, the macro pattern of attitudes in an organization is established, changed and preserved by micro-level interactions.

However, individuals may resist persuasion to various degrees, depending on the importance of the attitude for the individual and the individual’s preferences (Eaton et al., 2009; Krosnick et al., 1993; Oreg, 2006). In our model, the personal resistance to change represents all individual attributes that hinder individuals to change their positive attitude towards the failing behavior, such as the need for self-justification, self-presentation (Sleesman et al., 2012a) and self-enhancement (Pfeffer & Fong, 2005).

5.4 Model description
Our model represents an agent-based model. For its description we followed the ODD protocol (Grimm et al., 2006), which is a standardized method for the description of agent-based models.
CHAPTER 5

5.4.1 Purpose
The purpose of our model is to assess the dynamics of adaption and escalation of commitment in organizations from the perspective of organizations as self-organizing complex systems and to determine which factors influence adaption and escalation. Our model assumes there is a preferred attitude, as it is better suited to deal with a change in the organizational environment. Escalation occurs when organizations are not able to adapt to the preferred attitude and stick with the, clearly wrong, old attitude. The preferred outcome in our model is adaption; adaption in our model is defined as when a majority of the agents changed their attitude in reaction to a change in the environment.

5.4.2 Entities, state variables and scales
There are two entities with states in the model; the agents and the organization. In this section the state variables and their scales will be presented, a more detailed description of these variables and the mathematical relation between the various state variables is given in the section submodels. The agents in the organization are described by the following state variables: attitude, supportive strength, persuasive strength, communication index, norms towards authority, group salience, the personal resistance factor and an increase in resistance after each round of interactions.

The agent’s attitude will change depending on the influences it is subjected to. The attitudes of the agents, therefore, are the primary outcome of the model. An agent’s attitude is regarded as a general summary of a state that is either good or bad, beneficial or harmful, pleasant or unpleasant, etcetera (Ajzen, 2001). This state is represented by the dichotomous scale used in the model in which an agent could have two attitudes; 1 or 0.

This dichotomous scale doesn’t represent the differences in attitude strength found in real life. The attitude strength is represented by the contributing factors: the durability of the attitude, its relation with behavior and the resistance to change one’s attitude (Eaton et al., 2009). The durability refers to the stability of the attitude; the stability of an attitude in our model is an outcome, and not an input variable. The relation between attitude and behavior is not modeled as it is presumed in our model that a shared positive attitude towards an organizational goal is positively correlated with behavior supporting this goal. The resistance to change one’s attitude is incorporated in our model by the personal resistance. This factor thus represents that an individual is strongly attached to the attitude (high resistance) or has no strong preference towards this attitude (low resistance).

The organizational environment in which the agents operates is characterized by the following state variables: norms towards authority, communication densities in groups, departments and organization, organizational persuasion and the norms towards group conformity. The organization is further characterized by its structure.
In our model, we simulated an organization containing one CEO supervising four departmental heads. Each departmental head was responsible for four group leaders who each supervised ten workers. Hence, the simulated organization consisted of 181 agents in total. With the exception of the organizational persuasion, all organizational parameters remained constant.

The literature provides little information regarding the precise values of the scales to be used. Therefore we based our scales on two principles: the scales should be sufficiently wide to include realistic values, and the model has to generate real-life outcomes. We realize that some of our virtual organizations probably have unrealistic combinations of parameters. However, we argue that the obtained results are nevertheless valid for real-life organizations. If a relation is linear, an observed trend at unlikely values will be similar for realistic real-life values. Therefore, for linear relations it is irrelevant whether a value is realistic or not. Analyses of the scales indeed confirmed that all observed correlations were linear. Curvilinear relations, for which this argument would not hold, were not found. Also we observed that extreme values of any parameter did not necessarily result in extreme outcomes. This indicates that the chosen ranges fulfilled our second criteria, that the model should generate real-life outcomes.

For the values regarding the frequency of communication within groups we had some guidance from a study on interaction patterns of nursing personnel (Lum 1970). In this study it was found that in units of approximately 11 individuals, the chance for a specific topic to be discussed was about 30 to 40% (Lum, 1970). Based on this study, we decided to tweak the range of chances to interact with group members further on referred to as the communication density, to a of 20% to 60%. For the communication density within the departments and the organization, we assumed that the communication density was reduced with 20% for communications with group in the same department and 40% for groups outside the department.

The parameters for the supportive and persuasive strength ranged from 1 to 10. The supportive or persuasive influence of an agent was modified by the level of authority provided by the organizations and the personal norms towards authority. Authority can increase the supportive or persuasive influence by a factor of 2 to a maximum of 75, a sufficiently wide range. The level of group conformity was kept equal to that of authority. The level of conformity was modified by the personal salience for the group (1 to 10) and the distribution of the attitudes in the group (0 to 1). The final level of conformity could therefore take values ranging from 0 to 100.

With regard to the total resistance a maximum value (10) was arbitrarily included in order to keep the model dynamic and a minimal value (0.04) was chosen in order to prevent a negative resistance, which would result in an attitude change without persuasion. After each iteration the personal resistance factor was increased by 0.1 times the personal resistance, allowing the personal resistance to double after
every 10 iterations. With regard to the Organizational persuasion (Op) a scale between 0 and 3 was chosen. Sensitivity analysis demonstrated that between 0 and 3 Op was linear. At a level higher than 3 a plateau was reached at which all organizations at iteration 5 obtained a level of homogeneity between 95 and 100%. Therefore, levels higher than 3 were not included. An overview of the entities and the scales is given in table 1.

5.4.3 Process overview and scheduling
During each iteration, agent j is linked to every other agent i. It is then determined whether an interaction takes place. If so, the influence of agent i is added to the total scores for conformity. After all agents have been linked to agent j, agent j determines its attitude based on the scores for conformity, compliance and resistance. Then the next agent is linked to all other agents. When all agents have completed this process a new iteration starts. At the start of each run, from a random pattern of attitudes, a majority attitude emerges during the first five iterations.

Table 1 Overview of entities in the model their scales and the abbreviations used in the equations.

<table>
<thead>
<tr>
<th>State variables for the organizations</th>
<th>State variables for the agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>Scale</td>
</tr>
<tr>
<td>Level of organizational norms</td>
<td>2 to 25</td>
</tr>
<tr>
<td>authority (Ona)</td>
<td></td>
</tr>
<tr>
<td>Communication density in</td>
<td>20 to 60%</td>
</tr>
<tr>
<td>groups (Tr)</td>
<td></td>
</tr>
<tr>
<td>Communication density in departments</td>
<td>5 to 40%</td>
</tr>
<tr>
<td>(Tr)</td>
<td></td>
</tr>
<tr>
<td>Communication density in</td>
<td>2 to 20%</td>
</tr>
<tr>
<td>organizations (Tr)</td>
<td></td>
</tr>
<tr>
<td>Organizational persuasion (Op)</td>
<td>0 to 3</td>
</tr>
<tr>
<td>Level of organizational norms</td>
<td>2 to 25</td>
</tr>
<tr>
<td>group conformity (ONc)</td>
<td></td>
</tr>
<tr>
<td>Personal resistance factor (PRj)</td>
<td>1 to 3</td>
</tr>
<tr>
<td>Increase in resistance per</td>
<td></td>
</tr>
<tr>
<td>iteration (Ir)</td>
<td></td>
</tr>
</tbody>
</table>


When this baseline pattern of attitudes was established, due to environmental pressure (e.g., the arrival of a new competitor in the market), agents became aware that their behavior did not lead to the anticipated results. We modeled this awareness by lowering the factor for organizational persuasion after iteration 5 by 0.5 at each subsequent iteration. When the total resistance became less than 1 as a consequence of this procedure, the persuasive force needed to change the attitude of an agent was less than the supportive force. This implies that lowering the resistance with 0.5 made sure each agent became willing to change their attitude at some point during the simulation. When, despite this personal willingness to change, the majority of the agents still kept their old attitude, this is considered as escalation of commitment.

5.4.4 Design concepts
Several models have been published that relate to our research question, each highlighting other aspects of similar phenomena. With regard to escalation, a simulation assessing the role of an individual’s commitment was modeled (Gilroy & Hantula, 2016). With regard to adaption, variations of agent-based models model are used (Vidgen & Padget, 2009). Also with regard to attitudes other variables than presented in our paper can be used to model attitude changes (Huang & Wen, 2014). In our paper, however, we build on a model first described by Nowak et. al. that describes how due to attitude changes at the level of individuals, a norm emerges in a population (Nowak et al., 1990). This model is an established model and one of the first models that simulated the emergence of a shared attitude, which displayed nonlinear behavior. This model fitted our purposes since we were interested in how interactions on the micro level of individuals would lead to outcomes on the macro level of an organization. Especially the emerging properties and the nonlinearity displayed by the model of Nowak et. al. were of great importance for our study’s purpose. Most importantly however, this model could be adapted to include organizational factors. This last condition was essential since we were interested in whether and how organizational factors would influence adaption, as approach from the perspective of self-organization.

The model of Nowak et. al. already modeled compliance. However, to study attitude formation in organizations, we expanded Nowak’s model with algorithms for authority, conformity, and resistance. As compliance depends on interactions, we also had to include an algorithm for the interaction patterns between agents, as it is unlikely that in real-life organizations every employee communicates with every other employee.

With the exception of their attitude, agents did not have any adoptive or learning traits. Thus, during a simulation all personal and organizational variables remained constant as our simulation roughly represents one or two months, which
is too short for these variables to change significantly in real life. The agents were supposed to sense all organizational parameters as well as the level of conformity in the group. The sensing of conformity is supported by the observation that conformity can work in the absence of discussion and interaction (Hogg et al., 1990). Therefore for conformity no interaction is required.

In contrast, for compliance always some kind of interaction is needed, such as a meeting, an e-mail or even gossip. The interaction pattern for compliance is programmed to be semi stochastic, as although interactions are often determined by chance, there is a higher likelihood that an agent interacts with agents that are physically near. Therefore, besides chance, also the organizational structure will have an influence on the likelihood two agents will interact.

The organizational structure also determines the collectives present in the model. It is well established that in-group members are trusted more than out-group members (Tajfel, 1974). The various organizational groups were regarded as collectives whose members strongly influence each other but whose influence on members of other groups is relatively weak (Haslam, 2001). Based on the organizational structure, the following collectives were present in the model: higher management, consisting of the CEO and the four departmental heads; middle management, consisting of one department head and four team leaders belonging to a specific department, and the work units consisting of one team leader and the workers falling under the supervision of the team leader.

The observations in the model reflected the dynamics of the process and the level of adaption. For the dynamics, we used two dependent variables: 1) the homogeneity of the organization at iteration 5, being the starting point after which the environment changed and the resistance to change one’s attitude was gradually lowered, and 2) the number of attitude changes during iterations 6 to 25. Other dependent variables were the level of adaption after 25 iterations and the onset of adaption. To calculate the level of adaption, we subtracted the percentage of agents following the preferred attitude at iteration 25 by the percentage of agents with the same attitude at iteration 5 and dividing this number by the maximal possible percentage of adaption times 100. When an organization with a high adaptive potential of e.g. 0% of agents with the preferred attitude at iteration 5 adapted to 40% of the agents with the preferred attitude at iteration 25 the level of adaption is (40/100) *100 = 40%. When an organization with a low adaptive potential of e.g. 30% of the agents with the preferred attitude adapted to 60% of the agents with the preferred attitude, the level of adaption would be (30/70)*100 = 43%. By calculating this percentage, organizations with a high adaptive potential could be compared better with organizations having a low adaptive potential since the differences in adaption potential were levelled out. A positive result thus indicated that a number of agents shifted towards the new attitude. Escalating organizations
were defined as organizations in which the majority of the agents still had the old attitude. Preliminary analysis revealed that at various levels of Organizational persuasion (Op) different relations were found. For this reason, we also analyzed subsets of organizations with low (0 to 1), medium (1 to 2) and high levels (2 to 3) levels of Op.

5.4.5 Initialization
At the start of each run, all state variables were randomly assigned to the agents and the organizations. Therefore, each run represents a unique configuration of an organization with a unique assembly of agents and organizational features. In total, we simulated 1500 virtual organizations.

5.4.6 Submodels
5.4.6.1 Interactions
For compliance to occur, an interaction is needed. Whether an agent interacts with another agent or not is determined by four factors: communication index, organizational structure, the chance to meet and the communication frequency. The communication index (C) represents all personal features determining whether an agent is likely to communicate about the attitude with others. In real life, the communication index will be influenced by, for example, personal traits such as extraversion and agreeableness (Goldberg, 1993), but also by the importance of the attitude for the individuals involved. In addition, a factor for the chance to meet ($\text{Chi}_{ij}$) is added that differs randomly in every interaction, to simulate that real-world networks exhibit both ordered and random properties (Watts, 2004). Due to this random variable, different chances to interact for similar combinations of agents are generated at different points in time. The interaction chance is calculated by multiplying the communication indexes of agents i and j with the chance to meet.

After calculating the interaction chance, the model determines whether this chance was large enough for an interaction to take place by comparing the interaction chance with a threshold ($\text{Tr}_i$); only when the interaction chance is above this threshold an interaction takes place. We incorporated the effect of the organizational structure into the model by applying different scales of thresholds for contacts within groups, departments and the organization. People that are physically near are likely to interact more frequently, and we assumed that the organizational structure was a good predictor for the physical distance between employees. We realize that other aspects, such as belonging to a project team, may also affect the communication density, such relations are disregarded in our model. Interactions between group members were assigned low thresholds. Combinations of agents in the same department were assigned medium thresholds, and combinations of agents from different departments were assigned high thresholds.
Mathematically, an interaction took place between agents i and j when:

\[ C_i \times C_j \times \chi_{ij} > T_r \]  

Equation 1

Thresholds thus determine the communication density as reported in the results. A low threshold will result in intensive communication i.e., a high communication density, whereas a high threshold indicates a low communication density.

5.4.6.2 Supportive/persuasive strength

The strength of the influence of a counterpart was determined by its personal persuasive or supportive strength (Nowak et al., 1990). In real life, these factors will be determined by the expectancies of the perceiver about this person and can be based on e.g. past experiences, information about others, stereotypical beliefs, and physical attractiveness (Snyder & Stukas, 1999) but also by the power of the arguments (Petty et al., 1983). As in Nowak’s model, the persuasive strength of an agent is independent of its supportive strength (Nowak et al., 1990).

As in Nowak’s model, the influence of an agent is inversely proportional to the square root of the physical distance between two individuals (Latane, 1981). In our model, this distance \( D_{ij} \) was determined by the organizational structure. When the counterpart was a group member \( D_{ij} \) was 1, 2 when it was not a group member but was a member of the same department, and 3 for all other agents.

5.4.6.3 Authority

To simulate organizations, we needed to incorporate authority. The strength of authority by superior i over agent j \( A_{ij} \) is calculated by multiplying two factors. The first factor represents the personal evaluation of authority by agent j \( P_{na_j} \), such as the agent’s perception of the legitimacy of the authority (Raven & French, 1958). By including \( P_{na_j} \) a superior will have a different influence on each individual agent. The second factor is based on organizational norms for authority \( O_{na} \), representing the differences in power distance among organizations (Hofstede et al., 1990). The authority of agent i exercised on agent j \( A_{ij} \) thus incorporates both personal and organizational variables and is given by:

\[ A_{ij} = O_{na} \times P_{na_j} \]

For all non-superior counterparts \( A_{ij} = 1 \).

To calculate the level of compliance, the model determines whether an interaction takes place between two agents. Depending on the attitude of agent j, the influence of agent i is then added to the total of supportive influences \( (I_{ts}) \) or to the total of persuasive influences \( (I_{tp}) \). Since in real life repetitive exposure to a
similar argument reduces the influence of the next similar argument (Latane & Wolf, 1981), the total sum was amplified by the square root of the number of persuasive or supportive encounters \( (N_p \text{ and } N_s) \) divided by the same number of encounters (Nowak et al., 1990). Mathematically, the sum of persuasive \( (It_p) \) and supportive forces \( (It_s) \) is given by:

\[
t_D = \left( N_p^{1/2}/N_p \right) \left[ \sum_{i=1}^{N_p} \left( |1 \text{ Ona} \times P_{ia}| \times P_{1i/D_{1i}^2} \right) \right] \\
It_s = \left( N_s^{1/2}/N_s \right) \left[ \sum_{i=1}^{N_s} \left( |1 \text{ Ona} \times P_{ia}| \times S_{1i/D_{1i}^2} \right) \right]
\]

**Equation 2**

**Equation 3**

5.4.7 Conformity

The relation between conformity and the size of the majority is not straightforward. However, a positive linear relation seemed adequate (Bond, 2005) and was therefore used in the model. In real life, some people are more influential than others, which is known as referent informational influence (Turner et al., 1989). The referent power of an agent in the model was determined by the persuasive strength and communication index. Multiplying the agent’s persuasive strength \( (P_{1i/0i}) \) with the communication index \( (Cl_i) \) determined the influence of each agent in the group. Once the influential strength of each agent in a group is known, the model calculates the support factors for attitudes 0 and 1. The conformity factors for attitude 1 \( (CF_1) \) and 0 \( (CF_0) \) are given by:

\[
CF_1 = \left( \sum_{i=1}^{N_1} (P_{1i} \times Cl_i) \right) / \left( \sum_{i=1}^{N_1} (P_{1i} \times Cl_i) + \sum_{i=1}^{N_0} (P_{0i} \times Cl_i) \right)
\]

\[
CF_0 = \left( \sum_{i=1}^{N_0} (P_{0i} \times Cl_i) \right) / \left( \sum_{i=1}^{N_1} (P_{1i} \times Cl_i) + \sum_{i=1}^{N_0} (P_{0i} \times Cl_i) \right)
\]

In which \( N_1 \) and \( N_0 \) are the numbers of agents i with attitude 1 and 0, and \( P_{1i} \) and \( P_{0i} \) is the persuasive influence of agents i with attitude 1 or 0, respectively. Factors \( CF_1 \) and \( CF_0 \) modify the level of the organizational norms regarding group conformity \( (ONc) \), and may in real life be determined by the cultural dimension of individualism versus collectivism (Hofstede et al., 1990). These organizational norms for conformity are influenced by a personal factor; the salience of agent j for the group \( (Ps_j) \). The tendency of attitudes to converge to the prototypical in-group position becomes stronger when the salience for the in-group is stronger (Haslam, 2001). The conformity strength for attitude 1 \( (CS_1) \) and 0 \( (CS_0) \) was mathematically expressed as:
\[ CS_1 = CF_1 \times Ps_j \times ONc \]  \hspace{1cm} \text{Equation 4}

\[ CS_0 = CF_0 \times Ps_j \times ONc \]  \hspace{1cm} \text{Equation 5}

5.4.8 Combining compliance with conformity

To combine compliance with conformity, it is determined whether the conformity strengths (CS\(_1\) and CS\(_0\)) are either persuasive or supportive for the agent. Next, the persuasive and supportive strengths of conformity is added to the sum of the persuasive and supportive influences of compliance, respectively. This leads to the following combinations for the total persuasive force based on compliance and conformity (Pcc) and the total supportive force based on compliance and conformity (Scc):

Agent’s current attitude 1: \[ Pcc = I_{ts} + CS_0 \]  and \[ Scc = I_{tp} + CS_1 \]

Agent’s current attitude 0: \[ Pcc = I_{ts} + CS_1 \]  and \[ Scc = I_{tp} + CS_0 \]

5.4.9 Resistance

The total resistance of agent \( j \) (R\(_j\)) is determined by three factors: personal resistance, organizational persuasion, and a consistency factor. The personal resistance factor (Pr\(_j\)) represents the resistance to change one’s attitude as described earlier and links the model to the escalation literature regarding personal attributes involved in escalation (Sleesman et al., 2012a).

However, employees’ resistance can be influenced by activities by the organization designed to stimulate specific desirable behaviors (Fernandez and Rainey, 2006; Kotter, 2007; Young, 2009). Furthermore, reduction of resistance is an important part of managerial influence tactics (Furst & Cable, 2008). We simulated the influence of the organization on an agent’s personal resistance with the parameter organizational persuasion (Op). The Op is subtracted from the personal resistance, when the attitude of the agent differs from the organizationally preferred attitude and is added to the personal resistance, when the agent’s and the organizationally preferred attitude are identical. In our model, the organizationally preferred attitude is coupled with the attitude of the CEO, on the assumption that the CEO is the person with the most decision power to implement specific programs/systems to influence resistance.

As consistency is an important factor for one’s self-concept (Cialdini & Goldstein, 2004), and changing one’s opinion may feel like an inconsistency, we...
increased the personal resistance over time. We simulated this in the model with an incremental factor for consistency ($Ir$) which increased by $0.1 \times Pr_j$ at every new iteration. The resulting resistance $R_j$ of agent $j$ when the attitude is identical to the preferred attitude (equation 6) or opposing the preferred attitude (equation 7) is given by:

$$R_j = Pr_j + Ir + Op \quad \text{Equation 6}$$

$$R_j = Pr_j + Ir - Op \quad \text{Equation 7}$$

The resulting resistance is used to amplify the total of supportive forces ($Scc$) resulting in the final supportive force ($Sccr$), which includes compliance, conformity and resistance.

5.4.10 The complete schema

Mathematically, the attitude of an agent changes when the total persuasive force ($Pcc$) is larger than the total supportive force ($Sccr$), that is when

$$Pcc > Sccr = \left( \frac{N_p^{1/2}}{N_p} \right) \sum_{i=1}^{N_p} \left( (Ona \times Pna_j) \times \frac{P_i}{D_{ij}^2} \right) + (CF_{1or0} \times P_{Sj} \times ON_c) \right) > (Pr_j + Ir +/- Op_0) \times \left( \left( \frac{N_S^{1/2}}{N_S} \right) \sum_{i=1}^{N_S} \left( (Ona \times Pna_j) \times \frac{S_i}{D_{ij}^2} \right) + (CF_{1or0} \times P_{Sj} \times ON_c) \right)$$

This formula represents the schema that each agent in the model uses to determine its attitude. In Figure 1, the flow schedule with the pseudo codes and place of the equations of the model is given.

5.5 Results

In Table 2, organizations are categorized according to the percentage of agents with the old attitude at iteration 5, just before the environmental change set in, and agents with the new attitude at iteration 25, at the end of the simulation. At iteration 25, in 16% of the organizations less than 50% of the agents had acquired the new attitude whereas before the change all organizations had more than 50% of agents supporting the old attitude. Hence, 84% of the organizations adapted and acquired a majority for the new preferred attitude.
Figure 1 Pseudo-codes and the place of the equations in the program.
Subsequently, we assessed which factors influenced adaption. In Table 3, the relations between the various organizational factors and the outcomes are given. The data in Table 3 demonstrate that adaption was predominantly influenced by the number of attitude changes taking place after the awareness of the failing behavior set in. In addition, high levels of communication in groups and departments consistently stimulated adaption. However, the correlations show that the influence of communication was of little relevance. The number of attitude changes, however, were highly relevant (r = 0.771). However, the number of attitude changes were not specifically enhanced by any of the organizational factors and were thus predominantly caused by the gradual reduction of resistance against the new attitude as programmed into the model. Therefore, the main source of adaption was the willingness of individuals to change their attitude.

Although only communication in groups and departments marginally stimulate adaption, Op persuasion highly inhibited adaption. When we categorized the organizations according to the level of Op it was seen that adaption was lower at high levels of Op than at low levels. Another observation is that at low levels of Op, the positive influence of communication in groups and departments became stronger. In addition, at low levels of Op, group conformity became a inhibiting factor. This was expected as group conformation was programed to support the current attitude and thus to inhibit adaption. However, when the level of Op increased these effects were overshadowed by the dominant influence of the Op.
Table 3  Correlation coefficients between the basic parameters, intermediate parameters and the level of adoption and the onset of adoption.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>N</th>
<th>AVG</th>
<th>STD</th>
<th>Authority</th>
<th>Communication density in</th>
<th>Op</th>
<th>Gr. conf.</th>
<th>Hom. It. 5</th>
<th>Sum att. changes it. 6-25</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Groups</td>
<td>Dep.</td>
<td>Org.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Authority</td>
<td>1500</td>
<td>13.4</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comm. density in groups</td>
<td>1500</td>
<td>34.7</td>
<td>NA</td>
<td>-0.029</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comm. density in dep.</td>
<td>1500</td>
<td>15.9</td>
<td>NA</td>
<td>0.028</td>
<td>-0.017</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comm. density in org.</td>
<td>1500</td>
<td>6.4</td>
<td>NA</td>
<td>-0.046</td>
<td>0.025</td>
<td>0.020</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizational persuasion</td>
<td>1500</td>
<td>1.5</td>
<td>NA</td>
<td>0.063*</td>
<td>-0.006</td>
<td>-0.015</td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group commitment</td>
<td>1500</td>
<td>12.9</td>
<td>NA</td>
<td>0.031</td>
<td>-0.015</td>
<td>-0.036</td>
<td>0.024</td>
<td>-0.045</td>
<td></td>
</tr>
<tr>
<td>Homogeneity iteration 5</td>
<td>1500</td>
<td>77.1</td>
<td>13.8</td>
<td>0.099***</td>
<td>0.078**</td>
<td>0.050</td>
<td>0.005</td>
<td>0.789***</td>
<td>-0.123***</td>
</tr>
<tr>
<td>Att. changes iteration 6-25</td>
<td>1500</td>
<td>123.9</td>
<td>41.9</td>
<td>0.020</td>
<td>0.017</td>
<td>0.026</td>
<td>-0.015</td>
<td>-0.337***</td>
<td>-0.052*</td>
</tr>
<tr>
<td>Adoption Op 0-3</td>
<td>1500</td>
<td>58.6</td>
<td>19.4</td>
<td>-0.071**</td>
<td>0.155***</td>
<td>0.087</td>
<td>0.024</td>
<td>-0.607***</td>
<td>0.004</td>
</tr>
<tr>
<td>Adoption Op 0-1</td>
<td>492</td>
<td>58.7</td>
<td>10.2</td>
<td>0.115*</td>
<td>0.323***</td>
<td>0.100*</td>
<td>-0.056</td>
<td>-0.139**</td>
<td>-0.251***</td>
</tr>
<tr>
<td>Adoption Op 1-2</td>
<td>486</td>
<td>72.5</td>
<td>9.9</td>
<td>-0.107*</td>
<td>0.155***</td>
<td>0.182***</td>
<td>-0.013</td>
<td>-0.189***</td>
<td>-0.078</td>
</tr>
<tr>
<td>Adoption Op 2-3</td>
<td>522</td>
<td>84.2</td>
<td>6.6</td>
<td>-0.076</td>
<td>0.200***</td>
<td>0.066</td>
<td>0.099*</td>
<td>-0.400***</td>
<td>0.060</td>
</tr>
<tr>
<td>Start adoption Op 0-3</td>
<td>1500</td>
<td>9.9</td>
<td>3.8</td>
<td>-0.159***</td>
<td>0.055*</td>
<td>0.078**</td>
<td>0.093***</td>
<td>-0.702***</td>
<td>0.092**</td>
</tr>
<tr>
<td>Start adoption Op 0-1</td>
<td>492</td>
<td>7.1</td>
<td>1.7</td>
<td>-0.160***</td>
<td>0.096*</td>
<td>0.135**</td>
<td>0.107*</td>
<td>-0.249***</td>
<td>0.004</td>
</tr>
<tr>
<td>Start adoption Op 1-2</td>
<td>486</td>
<td>9.3</td>
<td>2.5</td>
<td>-0.247***</td>
<td>-0.014</td>
<td>0.111*</td>
<td>0.163***</td>
<td>-0.301***</td>
<td>0.072</td>
</tr>
<tr>
<td>Start adoption Op 2-3</td>
<td>522</td>
<td>13.2</td>
<td>3.9</td>
<td>-0.119**</td>
<td>0.134**</td>
<td>0.071</td>
<td>0.144***</td>
<td>-0.410***</td>
<td>0.112**</td>
</tr>
</tbody>
</table>

* P < 0.05  ** P < 0.01  *** P < 0.001
NA = Not applicable, input data were roughly equally distributed over the ranges given in table 1.
The other factor that had a strong inhibiting influence on adaption was the level of homogeneity at iteration 5. This homogeneity, however, is a direct effect of the Op. Due to high levels of Op during the first 5 iterations, organizations became highly homogeneous, both factors are thus related (coefficient= 0.789). The homogeneity was only inhibited by the level of group conformity, which was as expected since group conformity was designed to preserve current majority attitude being the majority attitude at iteration 0.

With regard to the onset of adaption, high levels of authority, Op and the homogeneity at iteration 5 inhibit the onset of adaption, whereas in general more communication in the organizations stimulates the onset of adaption. The adaption and the onset of adaption in relation to the level of Op are visualized in a time series presented in Figure 2. It shows that adaption is indeed fastest at low levels of Op. Furthermore, it can be seen that at higher levels of Op, in a number of organizations adaption was limited to -10 and 10, which is a display of escalation of commitment. Although the vast majority of the escalating organizations were found at high levels of Op, also at medium levels of Op some escalating organizations were observed. This clearly demonstrates that the relation between Op and escalation is not absolute and a certain level of uncertainty regarding the outcome remains.

When we compared the means of the organizational parameters from organizations displaying escalation of commitment with organizations that adapted (Table 4), the mean levels of authority, organizational persuasion, and the homogeneity at iteration 5 were all significantly higher in escalating organizations as compared to the adapting organizations. The level of group conformity and the number of attitude changes, however, were significantly lower in escalating organizations. The most striking difference was found in the number of attitude changes; an average of 4 was found in escalating organizations versus an average of 124 in adapting organizations. From the lack of attitude changes it can be concluded that organizations displaying escalation of commitment were “frozen” in their present state.

With regard to authority and group conformity, the range of values found for authority and group conformity in escalating organizations were quite wide, including almost the full range of these variables. From this observation it can be concluded that these variables may influence escalation but are unlikely to be the primary cause of escalation. In contrast, the ranges found for Op and the homogeneity of the organizations at iteration 5 were quite narrow, 1.2 to 3 and 81 to 98 respectively. Therefore, for escalation to occur in our model, the Op in our model should be at least 1.2 and the homogeneity at least 81%. Based on this observation, we argue that the initial level of homogeneity at iteration 5 is likely to be a direct cause of escalation.

To further support this conclusion, we need to examine the causal loops in our model (Sterman, 2000). In Figure 3, the relevant loops are visualized. Central in
these diagrams is the ratio between the levels of both attitudes. In Figure 3A the loops active during the first 5 iterations are visualized. Due to Op, relatively more agents with an attitude opposing the CEO will change their attitude than agents with an attitude supporting the CEO. Due to this inequality, the number of agents with an attitude supporting the CEO will grow more than agents with an attitude opposing the CEO. As a consequence, the ratio between supporting and opposing will grow in favor of the attitudes supporting the CEO.

This reinforcing loop (R1) is balanced by the reduction of agents with an attitude opposing the CEO (B1). In this situation the chance of meeting an agent with an
opposing attitude becomes smaller and thus the number of agents changing their attitudes from opposing to supporting decreases. Instead, more agents with a supporting attitude will meet with agents having a similar attitude by which their current attitude is confirmed. This is visualized by the conformational loop (C1).

When the circumstances change and the resistance towards the old attitude gradually drops, agents become willing to change their old attitude. Because of this, the reinforcing loop R2 kicks-in leading to adaption (Figure 3B). Loop R2 is stimulated by the reversion in resistance. This will facilitate the first agents to change their attitude. Subsequently, due to these first attitude changes, the number of agents supporting the old attitude will decrease which will further boost loop R2 and finally loop C2.

In escalating organizations however, due to the low number of agents with a new attitude, the reinforcing loop R2 is not activated. Instead, the support for the old attitude remains high and cycles of conformation (C1) prevent agents to change their attitude (Figure 3C). The few agents with the new attitude that are interacted with have insufficient leverage to persuade agents with the old attitude. From the observation that loop C1 is the primary cause of escalation, it can be concluded that Op doesn’t play a direct role during the escalation phase as loop R2 is not used. The role of Op in escalation is indirect.

High levels of Op will cause high homogeneity at the start, preventing loop R2 to kick-in and stimulating loop C1. In addition, at some point all agents become willing to change their attitude and Op is thus no limitation anymore. This further demonstrates that the level of resistance is not a direct cause of escalation. Therefore we can conclude that the primary cause of escalation is when organizations are too homogeneous harboring too few agents with an alternative attitude.

Table 4  Comparison of averages of parameters in organizations that adapted and in which escalation of commitment was found.

<table>
<thead>
<tr>
<th>Averages and standard deviations</th>
<th>Authority</th>
<th>Communication density in Groups</th>
<th>Dep.</th>
<th>Org.</th>
<th>Op Gr. conf.</th>
<th>Hom. It. 5</th>
<th>Sum att. changes it. 6-25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaption AVG</td>
<td>13.4</td>
<td>12.5</td>
<td>25.0</td>
<td>40.5</td>
<td>1.5</td>
<td>12.9</td>
<td>72.1</td>
</tr>
<tr>
<td>STD</td>
<td>6.6</td>
<td>4.3</td>
<td>8.7</td>
<td>11.6</td>
<td>0.9</td>
<td>6.9</td>
<td>13.8</td>
</tr>
<tr>
<td>Escalation AVG</td>
<td>16.6***</td>
<td>13.6</td>
<td>25.5</td>
<td>42.0</td>
<td>2.6***</td>
<td>10.4***</td>
<td>90.8***</td>
</tr>
<tr>
<td>STD</td>
<td>6.4</td>
<td>4.0</td>
<td>8.6</td>
<td>12.3</td>
<td>0.4</td>
<td>7.2</td>
<td>4.0</td>
</tr>
<tr>
<td>Min</td>
<td>2.1</td>
<td>5.1</td>
<td>10.6</td>
<td>20.3</td>
<td>1.2</td>
<td>1.0</td>
<td>81.3</td>
</tr>
<tr>
<td>Max</td>
<td>24.9</td>
<td>19.9</td>
<td>40.0</td>
<td>59.7</td>
<td>3.0</td>
<td>24.9</td>
<td>98.1</td>
</tr>
</tbody>
</table>

* P < 0.05  ** P < 0.01  ***P < 0.001
Figure 3  Causal loops during non-escalating conditions (A) leading to a majority attitude supporting the CEO (iterations 1 to 5). After this, agents were stimulated to change their attitude leading to either adaption (B) or escalation of commitment (C) (iterations 6 to 25). The thickness of the lines indicates the dominance of the paths, whereas dotted lines indicate paths that are not used.
5.6 Discussion and conclusion

In our simulation, we showed that escalation of commitment might be a natural outcome of group dynamics, irrespective of the willingness of individuals to change their attitude. According to our model, escalation of commitment in organizations is caused by the limited chance of actors to interact with others holding a minority attitude. In escalating conditions, individuals are caught in loops of mutual confirmation of the old attitude (figure 3. loop C_1). As in the fairy-tale about the Emperor’s new clothes, mutual confirmation of the majority attitude strengthens and preserves the prevailing attitude, even when each agent knows that it will lead to failure.1

When this finding is extrapolated to real-life organizations, it suggests that organizations with a strong organizational culture are more likely to display escalation of commitment. A strong culture is generally defined as a culture in which norms and values are widely shared (Sorensen, 2002), which is represented in our model by highly homogeneous organizations. Strong cultures are generally seen as beneficial (Gordon & Ditomaso, 1992), which is likely to be the case in a stable environment, but not in volatile environments (Sorensen, 2002). Our results support these findings.

1 The Emperor’s New Clothes (Hans Christian Andersen) is about two weavers who promise an Emperor a new suit of clothes that is invisible to stupid or incompetent people. When the Emperor parades his new suit, everyone admires it until a child cries. “But he isn’t wearing anything at all!”
CHAPTER 5

demonstrating that high levels of homogeneity, and thus strong cultures, prevent organizations to adapt (Table 3 and figure 2). This provides a paradox for organizations.

With regard to the role of Op, we were able to demonstrate that its primary role in escalation was to create a homogeneous organization. We also demonstrated that high levels of Op caused organizations to adapt relatively slowly (figure 2). The strong influence of Op also underscores the importance of personal resistance to change in general, which is in line with findings regarding the importance of personal attributes in escalation of commitment (Pfeffer & Fong, 2005; Sleesman et al., 2012a), as these attributes all have an influence on the resistance to change. A key finding in our study is that, even when all individuals were willing to change, escalation still could occur due to social pressure, provided that the organization was highly homogeneous. The homogeneity of an organization is therefore a major antecedent of escalation.

Besides Op and the homogeneity of the organization, authority was uniquely associated with the speed of adoption. Authority had a significant and consistent negative influence on the speed of adoption. Extrapolated to real-life organizations, this finding suggests that, in volatile environments, organizations with low levels of authority will do better in avoiding escalation of commitment than organizations with high levels of authority.

The factor that consistently stimulated adaption was communication. Of the various communication lines, the communication within groups and departments consistently stimulated adaption. However, for the onset of adaption the interaction between agents from different departments was essential. Therefore, communication at all levels is essential, albeit for different reasons.

A remarkable finding was that group conformity didn’t affect escalation of commitment. Group conformity had an inhibiting effect on homogeneity, and at low levels of Op it even inhibited escalation. This observation seems to contradict a previous study in which high levels of group conformity were associated with high levels of escalation (DietzUhlner, 1996). In a single-group simulation, as described by DietzUhlner (1996), high levels of group conformity will indeed strengthen the present group majority. In a multi-group organization, however, strengthening the initial majority in groups will result in more diversity between groups and thus in a less homogeneous organization. Due to this increased variety, adaption is stimulated. Therefore, the effect of group conformity in a multi-group organization possibly counters its effect in a single group.

Using computer simulation, we were able to assess how mutual and on-going interactions between individuals may lead to the ability of organizations to adapt to a changing environment. In relation to the organizational change literature our model simulated a complex adaptive systems change (Lichtenstein, 2000). Our simulation represents the perspective of organizations as self-organizing
systems that are able to adapt to environmental changes by self-organization rather than by a planned change (Anderson, 1999; Chiles et al., 2004; Meyer et al., 2005; Monge et al., 2008; Plowman et al., 2007). Based on the perspective of organizations as self-organizing systems, we assessed how organizational factors influenced the adaptive capacity of organizations by computer modeling. We were able to demonstrate that organizations have the capacity to adapt and this capacity is highly depending on the diversity present in the organizations. With regard to the speed of adaption we were able to identify the factors that can enhance and inhibit emergent adaption.

Thus by using computer simulation we were able to gain more insight into the dynamics and factors influencing emergent adaption of organizations. Further development of our model may render a more elaborate understanding of social influence processes in organizations. For instance, including more subtle differences in the strength of attitudes in the model than the dichotomy we used might reveal whether groups with individuals who have – for example – relatively indifferent attitudes may protect organizations from escalation.
When emergence interacts with planned changes

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Peter Groenewegen

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6 When emergence interacts with planned changes

6.1 Abstract
In organizational change efforts, attitudes of employees can be changed by planned interventions. However, during the post-intervention period, the self-organizing properties of organizations will further modify the outcomes of these interventions. From this process of self-organization, a stable pattern of attitudes emerges that will determine the eventual success of the change effort. To assess how this emerging process may modify the outcome of an intervention, we used computer simulation. Our simulations demonstrated that, due to self-organization, similar outcomes of interventions indeed led to a variety of long-term outcomes, demonstrating that self-organizing properties of organizations play an important role in the uncertainty regarding the outcomes of planned changes. Based on these findings, a change model is proposed that aligns emergence with planned organizational changes. The implications for change strategies are discussed.

Keywords; attitudes, complexity, planned changes, emergence

6.2 Introduction
Organizational change has been one of the major topics in management literature since Lewin (1947) published his seminal work (Lewin, 1947). In recent decades, our knowledge of change processes has significantly expanded, as have our insights in the complexities involved in organizational change processes. However, scholars frequently indicate that many organizational change efforts tend to fail (Burnes, 2004; Greenwood & Hinings, 1996; Jacobs et al., 2013; Young, 2009). Although it is not possible to establish the percentage of such failures, (Hughes, 2011), most scholars do agree that a high degree of uncertainty is involved in the outcomes of organizational changes.

Basically, there are two types of organizational changes: planned changes and emergent changes (Mintzberg & Waters, 1985). Emergence is generally regarded as an autonomous and uncontrollable process and thus out of the scope of management. Therefore, the change literature mainly focuses on planned changes, in which management takes deliberate actions to achieve their goals. Nevertheless, some authors convincingly argued that emerging processes can be a quite important—or even the most dominant—process in the development of organizations. In this perspective, organizations are seen as self-organizing complex systems in which order emerges spontaneously (Anderson, 1999; Meyer et al., 2005; Monge et al., 2008; Chiles et al., 2004; Lichtenstein, 2000). Regardless of the exact contribution of emerging processes to organizational development, it is quite likely that emerging processes will interfere with planned changes, and the actually realized change is
the outcome of both processes (Mintzberg & Waters, 1985). Therefore, to truly understand organizational change processes, we need to incorporate both planned and emergent changes into one model. In this paper we will explore how emerging processes can modify the results of planned changes and how emergence can be aligned with planned changes. For this we will focus on the formation of a shared attitude in an organization. With this study we aim to contribute to a better understanding of change processes by incorporating planned and emergent changes into one model. We are convinced that only by merging planned changes with emerging changes we are able to reduce the uncertainties associated with organizational changes.

The perspective of organizational change by emergence is represented by the Systems Designs school which emphasises the nonlinear dynamics in organizations (Thietart & Forgues, 1995). The key feature of this school is that there is no clear relationship between cause and effect in organizational changes (Lichtenstein, 2000; Snowden & Boone, 2007). This explains the dilemma of trying to influence emergence in organizations: when there is no relation between cause and effect it is impossible to design plans to influence the outcome. The change perspective connected to the Systems Designs School is the Critical Theory of Change. Due to the lack of a relation between cause and effect in nonlinear systems, Grieves (2010) remarked: ‘The Critical Theory should be considered as change theory without an intervention strategy’ (Grieves, 2010: 33).

In general, emerging processes are regarded as autonomous and thus largely out of the control of management. This lack of control over emerging processes can lead to serious negative effects on (long-term) organizational performance and strategic choices (Burgelman & Grove, 2007; Henning, 2008; March, 2006). To understand the intrinsic uncertainty of emerging processes, one has to regard organizations as self-organizing complex systems (Anderson, 1999; Burnes, 2005; Meyer et al., 2005). By definition, complex systems consist of a large number of interacting elements exhibiting emerging properties (Morel & Ramanujam, 1999). This definition perfectly matches an organization with all its interacting employees. A characteristic feature of complex systems is that they display nonlinear behavior, meaning that there is no direct relation between cause and effect. Furthermore, in nonlinear systems there is no relation between size of a change and the size of the effect: a small change, e.g., an attitude change in one agent, can have a large impact on the final outcome, whereas a large change, such as the attitude changes in 10% of the agents, can be completely absorbed by the system without leaving any lasting effect (Lichtenstein, 2000; Snowden & Boone, 2007). Therefore, in nonlinear systems it is impossible to predict the outcomes based on the initial parameters of such systems, especially for large groups and over time (Thietart & Forgues, 1995). Thus, due to emerging processes during the post-intervention
period, the outcome of an intervention may have no relation with the situation at the end of the post-intervention phase.

Due to its nonlinearity, emergence is largely treated as a black box and, as a consequence, we have little knowledge about the extent to which emerging processes will interfere with the long-term outcome of planned interventions. Will it result in the intended behavioral changes or frustrate the intended outcomes? This provides us with the challenge to get a grip on emergence.

The emerging process we will focus on is the emergence of a shared attitude towards an organizational change, as we argue that the success of an organizational change is for an important part determined by the employees’ support for the change, represented by their attitudes towards the change (Choi, 2011). The key variables in the change literature, such as readiness to change, commitment to change, openness to change and cynicism to change are in essence all representations of employees’ attitudes towards organizational change (Choi, 2011). Therefore, the shared attitude that is formed due to interventions and self-organizing processes will have a major influence on the eventual success of the organizational change.

As we consider attitudes as the major driving force of a successful organizational change, we need to demonstrate how the attitude formation at the micro level of individuals and groups, ultimately results in a stable pattern of attitudes in which the majority of the individuals have a positive attitude towards the change. At the level of individuals, attitudes are shaped by the interactions with others (Friedkin, 2001), and attitude changes are caused by persuasion (Chaiken & Stangor, 1987; Wood, 2000). Therefore, during interactions between employees, individuals may either persuade or support attitudes of other employee, by verbal and any other forms of communication, such as emails, reports etcetera. Persuasion in our paper is not restricted to deliberate attempts to influence others, as any form of information may have a persuasive or supportive effect, intended or not. Series of interactions between various employees will, over time, result in a stable pattern of attitudes within the organization. When, e.g., 75% of the employees have adopted the new attitude by the end of the post-intervention period, and this pattern is relatively stable, the prevailing majority attitude may be considered as a shared organizational attitude. We thus define a successful organizational change as a shift from one pattern with a defined majority attitude favoring the current status quo, to another pattern with a new majority attitude favoring the change of the status quo. The more employees have an attitude favoring the change, the higher the success of the organizational change is considered to be (Choi, 2011).
6.3 Method
To study emergence we will use the complexity theory (Morel & Ramanujam, 1999), that studies how multiple interactions at the micro level will self-organize into a stable pattern at the macro level. This self-organizing feature of complex systems has been studied extensively by using computer simulation (Kauffman, 1993; Schelling, 1971). We also used computer simulation to assess to which extent emergence changed the outcomes of a planned change and whether this interference explained the uncertainty regarding organizational changes. Using our data, we were also able to assess the dynamics of this process, to establish which organizational factors in the model influence the outcome, and to determine what can be done to align both processes.

In our study, we distinguish three phases of the organizational change process. In the first phase, the pre-intervention phase, a stable pattern of attitudes is formed from a random pattern of attitudes. This pattern represents the situation before the intervention. At some stage, the need for change, i.e., the need to change the majority attitude becomes evident, and on the initiative of management the intervention phase starts. This second phase is aimed at changing the attitudes of individuals into an attitude favoring the change. During the intervention, which takes place during a limited period of time, a number of employees change their attitude in favor of the desired change. After the intervention phase, the post-intervention phase starts. During the post-intervention phase, employees return to their normal routines in the organization and are subjected to the influences of the organization and other employees. We assume that no interventions take place during the post-intervention period, and thus only emerging processes are present during this period. We assess how the results of the intervention further develop into a stable pattern of attitudes and which organizational factors influence the final outcome, which we defined as the number of employees, which acquired a new attitude.

In our simulations, we modeled two types of interventions, a top down approach and a large group intervention (LGI), since both approaches are common practices in organizations but with large differences in the intensity of the efforts made. A top-down intervention describes a situation in which a management team comes to a decision on how to deal with a problem. This decision then needs to be cascaded down the organization during the post-intervention phase. In the top-down intervention, only the CEO and a variable number of departmental heads will acquire the new attitude. In our study it was assessed whether the newly desired attitude indeed cascaded down through the hierarchy and resulted in a majority of the agents supporting the change. In the LGI all employees in the organizations are subjected to an intervention aimed at motivating them for the desired change. Due to the intervention, the attitudes of a variable number of employees are changed in the new attitude supporting the change. After the intervention the post-interven-
tion phase starts, during which the results obtained in the intervention are further modified. In our simulations, we assessed whether the new attitude was taken over by agents in the organization and whether this led to a majority attitude supporting the change. By using computer simulation, we thus had the unique opportunity to compare the effects of a top-down intervention and a LGI.

6.4 Description of the computer model

There are two main arguments for using computer simulations. First, the number of organizations that can be tested, and the variations that can be made are limitless, avoiding the practical limitations of empirical studies. Only due to this feature we were able to test the effect of organizational factors. In empirical studies it is impossible to include a sufficient number of organizations that only differ in the organizational factors to be tested. Second, it is impossible to monitor the current attitudes of every employee in an organization over a period of time. Both can be done by computer simulation, which enables us to connect the micro-level changes in the agents with the macro-level outcome of the organization. In addition, by gathering longitudinal data we were not only able to show what changes but also how changes evolve. This last aspect is essential to understand the dynamics of emergence.

The basic assumption underlying our model is that agents change their attitude due to social influence (Wood, 2000). Two dimensions of social influence are incorporated into the model: compliance and conformity. Compliance is defined as “a particular kind of response — acquiescence — to a particular kind of communication — a request” (Cialdini & Goldstein, 2004: 592). Conformity is defined as “the act of changing one’s behavior to match the responses of others” (Cialdini & Goldstein, 2004: 606).

Compliance and conformity are both influences caused by other individuals. However, we also need to include a personal factor; resistance. Individuals will resist persuasion in various degrees; this resistance depends on e.g., on the importance of the attitude for the individual or individual preferences (Eaton et al., 2009; Krosnick et al., 1993; Oreg, 2006). Therefore, our model contains three main building blocks: compliance, conformity, and resistance.

Our model is an agent-based model (Kauffman, 1993; Schelling, 1971). This type of model typically simulates interactions between agents. In these interactions, each agent uses a schema to process the information obtained from other agents it interacts with. Therefore, the model relates to social cognition theory (Markus, 1977), stating that people use schemata to process information in order to make sense of a situation, to adjust their behavior and to learn (Anderson, 1999; Lau & Woodman, 1995). In our model, each agent applies a schema based on compliance, conformity and resistance to decide whether to keep its current attitude or change it.
Our model is based on a previous model in which the emergence of a general opinion in societies is modeled (Nowak et al., 1990) and which was founded on the theory of social impact (Latane, 1981). In this model however, only compliance was incorporated. Also this model was designed for societies whereas we wanted to simulate organizations. To make this model fit for our purposes it was expanded with algorithms for interactions, group conformity and the organizational factors authority, communication density, organizational persuasion and group conformation. In the following paragraphs we will give a brief description of the model and the variables used in it. For a detailed description of the model we refer to a previous publication in which the model is described (van Woensel, de Gilder, van den Besselaar, & Groenewegen, 2016) and chapters 2 and 3.

At the start of the simulation all personal and organizational parameters are assigned randomly in order to create a unique organization with a unique set of agents. At this point, each agent is also randomly given an attitude: 0 or 1. Subsequently, for the first agent it is first determined with which other agents this agent would interact. The algorithm determining whether an interaction takes place or not, is based on the personal characteristics of the agents and a factor for coincidence. Based on these variables an interaction chance is calculated which is compared with a threshold; only when the interaction chance is above this threshold, an interaction takes place. Low thresholds are assigned to combinations of group members, medium thresholds to combinations of agents of the same department but different groups, and high thresholds to combinations of agents of different departments, thus simulating that interaction chances are higher for agents that work together in the same unit or department. Therefore, the thresholds determine the communication density; low thresholds generate a high likelihood for agents to interact, resulting in a high communication density, whereas high thresholds generate low communication densities. Thresholds vary between different organizations and are used to determine the influence of the communication density on the outcome.

Next, all persuasive and supportive influences of the agents interacts with are added to the total sum of persuasive or supportive forces. However, before a persuasive or a supportive influence is added, two modifications are performed. First, we increase the persuasive or supportive influence by a factor for authority when the counterpart is a superior. Second, the influence of agents outside the own group is decreased. The organizational factor for authority is determined by the organizational factor representing the norms towards authority, simulating that power distance differs across organizations (Hofstede et al., 1990) and a personal factor representing the agent’s perception of the legitimacy of authority (Raven & French, 1958). By varying the level of the organizational norms towards authority between organizations, the influence of authority on the outcome can be
determined. By reducing the influence of outgroup members, we simulate that in-group members are more trusted and that there is a general desire to affiliate more with in-group members (Tajfel, 1974). Finally, the total sums of persuasive and supportive forces are reduced depending on the number of contacts, to simulate that, in real life, repetitive exposure to a similar argument reduces the influence of the next similar argument (Latane & Wolf, 1981).

Thereafter, the strength of conformity is calculated. For conformity no direct interactions are needed, since conformity can work in the absence of discussion and interaction (Hogg et al., 1990). Although the relation between conformity and the size of the majority is not straightforward, a positive linear relation seems most adequate (Bond, 2005), and is therefore used. In addition to the organizational factor for conformity, conformity is further modified by a personal factor of the agent; the salience for the group of this agent (Haslam, 2001). The norms for group conformity vary per organization, making it possible to determine the influence of group conformity on the outcome. The persuasive and supportive strengths of conformity are added to the sum of the persuasive and supportive influences of compliance, respectively.

Next, the total supportive force to maintain the current attitude, which includes compliance and conformity, is multiplied by a factor for resistance to simulate that agents will often resist persuasion. The factor for resistance for each agent is calculated from three factors: personal resistance, organizational persuasion and a consistency factor. The factor for personal resistance simulates the resistance to change one’s attitude and is, e.g., determined by personal traits such as a strong preference for routine, cognitive rigidity, or a short-term focus (Oreg, 2006), the importance of the attitude for the agent’s identity (Krosnick et al., 1993) and/or personal norms and perceived behavioral control (Ajzen, 1991). The personal resistance is different for each agent. The organizational persuasion (Op) represents all factors in the organization that have an influence on the resistance of an agent. Employees can be influenced by systems and/or programs designed to stimulate specific behaviors. Such systems and/or programs are often designed to lowering the resistance against and increasing the motivation/commitment of employees for the behavior desired by management (Fernandez and Rainey, 2006; Kotter, 2007; Robertson et al., 1993; Young, 2009; Armenakis et al., 1993). In addition, shared norms and values will also guide employees (Smith et al., 2002) and will influence the Op. The Op in our model is thus the resultant of all factors present in the organization that have an influence on the personal resistance. We presume that the factor for Op supports the organizationally preferred attitude. Therefore, depending on the attitude of the agents, the Op is subtracted from personal resistance when the attitude of the agent differs from the organizationally preferred attitude or is added to the personal resistance when the agent’s and the organiza-
tionally preferred attitude are already identical. The Op can, therefore, either reduce or enhance the personal resistance. Since changing one’s opinion may feel as being inconsistent, whereas being consistent is an important aspect of one’s self-concept (Cialdini & Goldstein, 2004), a consistency factor is added by which the personal resistance increases over time.

Finally, the total persuasive force is compared with the total supportive force multiplied by the resistance. When the total persuasive force is larger than the supportive force multiplied by the resistance, the agent changes its attitude. This algorithm was the decision schema that each agent uses to establish its attitude. When the first agent has finished this cycle, the next agent goes through the same cycle. When all agents have finished this cycle, the first round of interactions was done.

In all simulations the same organizational structure is used, consisting of one CEO, four departmental heads each leading four group leaders which each are in charge of a group of ten workers. At the start of each run, values for all attitudes, organizational and personal parameters are assigned using a random generator. Therefore, each run represents a unique virtual organization. In our simulation we 850 virtual configurations of one organization with different agents and different values for the organizational factors are included the analysis.

Although all parameters are randomly assigned, they are kept within certain ranges. Since there is no guidance regarding the values of the parameters, ranges are chosen to be wide enough to contain realistic values. Additionally, tests were conducted to ensure that within the chosen ranges no extreme outcomes are generated, and that the model remains dynamic. After all attitudes and parameters are assigned, 10 rounds of interactions are performed, further on referred to as iterations. During the first 10 iterations, starting from a random pattern of attitudes, the organizations are allowed to self-organize into a relatively stable pattern of attitudes that is characteristic for that specific virtual organization. At this point, the level of variety is calculated for each virtual organization. The level of variety is defined by the percentage of agents with a minority attitude. The pattern of attitudes that emerged after these first 10 iterations is then used as the basis for the intervention period.

The interventions themselves are not simulated; instead, various results of interventions are incorporated into the data by simply changing the attitudes of a number of agents to the new attitude. These agents thus represent agents that have acquired the new attitude during the intervention. In total, 5 top-down interventions and one large group intervention (LGI) are simulated. Each intervention starts from exactly the same configuration, making them fully comparable.
To simulate the effect of a top-down intervention, 5 outcomes of an intervention are incorporated in our simulations; only the CEO changes its attitude, the CEO
and one, two, three or four departmental heads change their attitude. For the LGI, the attitudes of the CEO and a random number of randomly chosen agents are changed into the new attitude. This simulation represents the results of an LGI in which the whole organization participated and, depending on the efficiency of the intervention, more agents will obtain a positive attitude towards the change. However, since it is unknown which employees will be persuaded by the intervention and which not, in this simulation it is randomly determined how many and which agents will change their attitude to the new attitude at the end of the intervention.

After the attitudes of the agents are changed, the intervention phase ended and the organizations are again allowed to self-organize during 10 iterations in the post-intervention phase. For both the top-down intervention and the LGI, we assume that after the intervention, the factor organizational persuasion now supported the new attitude. The long-term stability of the intervention is then determined by calculating the percentage of agents that have acquired the new attitude after 10 iterations in the post-intervention period. The output parameter in our study is given by the percentage of agents with the new attitude at the end of the post-intervention phase. This output parameter is correlated with the organizational factors and the variety at the start of the intervention.

6.5 Results

During the pre-intervention phase, the organizations self-organized from a random pattern of attitudes into a stable pattern of attitudes in which on average 81 per cent of the agents had acquired the same attitude as the CEO. This pattern provided the basis for the 6 interventions each followed by a post-intervention phase.

To assess the overall effect of the post-intervention phase on the outcomes of the various interventions, we defined four categories of outcomes each representing different levels of success of failure. For each category we calculated the percentage of organizations per intervention falling into that category (Table 1). We regarded an intervention as successful when its results were able to generate organizations in which at the end of the post-intervention phase, more than 75% of the agents had acquired the new attitude. With this definition, a few features can be observed.

First, a better alignment of the departmental heads resulted in a higher number of successful outcomes. Therefore, our data support Kotter’s advice to form a strong coalition (Kotter, 2007a). Second, overall a LGI was more effective than a top-down intervention. And third, regardless of the type of intervention, we always found a number of organizations in which the new attitude was not supported by a majority.
In Table 1 we compared the average outcome of an LGI with the top-down interventions. However, in our simulations the number of agents that changed their attitude due to the LGI differed for each configuration of the organization. In Figure 1 we plotted the outcomes of each organization against the effectiveness of the intervention in that organization. As can be expected, the more effective the intervention, the higher the chance of a long-term successful change. However, also at less effective interventions a number of organizations can be found in which a majority of the agents acquired the new attitude. Note that most organizations in Figure 1 are found above the diagonal. This finding indicates that, in the vast majority of the organizations, the results obtained during the intervention were either stabilized or enhanced. Reversion of the results obtained during the intervention did also take place, albeit in a few cases, as is represented by the organizations below the diagonal.

Subsequently, we assessed which factors enhanced or inhibited the results of the intervention during the post-intervention phase. In Table 2 the correlations are presented between the various organizational factors and the number of agents having acquired the new attitude. These results show that authority was only effective in a top-down intervention, but its influence is quite weak.

With regard to communication, a diffuse pattern of relations was found. The most consistent result was that communication within the organization, in all interventions had a positive effect (Table 2 and Figure 2). This is what can be expected, since only by communication the new attitude can spread further. Communication within groups had a diverse, but small effect, whereas the communication within the departments only became significant when 3 or 4 departmental heads were aligned.

Table 1  The distribution of organizations over the various categories of success measured by the number of agents with the new attitude at the end of the post-intervention period in various top down interventions and a large group intervention (LGI).

<table>
<thead>
<tr>
<th>Percentage of agents with the new attitude</th>
<th>Percentage of organizations per category for each intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 25%</td>
<td>40% 25% 11% 6% 3% 10%</td>
</tr>
<tr>
<td>25 to 50%</td>
<td>32% 28% 27% 23% 23% 16%</td>
</tr>
<tr>
<td>50 to 75%</td>
<td>22% 29% 38% 42% 41% 31%</td>
</tr>
<tr>
<td>75 to 100%</td>
<td>6% 19% 25% 30% 34% 42%</td>
</tr>
</tbody>
</table>
Overall, only communication within the organizations had a consistent significant positive influence on a long-term success of an intervention. However based on the correlation coefficients its relevance is low.

The impact of organizational persuasion (Op) on the outcome is high, although not straightforward. To explain the effect of Op we plotted the outcomes of the various interventions against the level of Op (Figure 3). From Figure 3 it can be seen that on average high levels of Op are associated with high levels of agents taking over the new attitude. However, in simulations in which only the CEO and the CEO and one departmental head supported the new attitude, a significant part of the organizations with high levels of Op didn’t convert to the new attitude, which caused the negative correlation in Table 2. This same phenomenon was also observed in the other intervention, but to a lesser extent, which resulted in a positive correlation. The reason for this phenomenon is that in organizations with high levels of Op, the homogeneity at the start of the intervention period is quite high (correlation coefficient 0.829). Due to the high homogeneity at the start of the intervention, organizations with a high Op need more leverage to initiate a change, and when this leverage is insufficient these organizations will not change. This leverage is
Table 2  The correlation between the organizational factors and the number of agents with a new attitude at the end of the post-intervention period for the various top-down interventions and a large group intervention (LGI).

<table>
<thead>
<tr>
<th>Percentage of agents with new attitude</th>
<th>Average</th>
<th>std</th>
<th>Authority</th>
<th>Com. groups</th>
<th>Com. departments</th>
<th>Com. organization</th>
<th>Op</th>
<th>Group conformity</th>
<th>Level of variety pre-intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEO only</td>
<td>33.8</td>
<td>24.6</td>
<td>0.042</td>
<td>-0.070*</td>
<td>-0.051</td>
<td>0.185***</td>
<td>-0.391***</td>
<td>0.127***</td>
<td>0.475***</td>
</tr>
<tr>
<td>CEO+1 Dep. H</td>
<td>46.9</td>
<td>27.3</td>
<td>0.072*</td>
<td>0.077*</td>
<td>0.040</td>
<td>0.140***</td>
<td>-0.020</td>
<td>0.074*</td>
<td>0.105**</td>
</tr>
<tr>
<td>CEO+2 Dep. H</td>
<td>56.4</td>
<td>24.0</td>
<td>0.058</td>
<td>0.150***</td>
<td>0.027</td>
<td>0.140***</td>
<td>0.237***</td>
<td>0.034</td>
<td>-0.174***</td>
</tr>
<tr>
<td>CEO+3 Dep. H</td>
<td>61.3</td>
<td>21.9</td>
<td>0.096**</td>
<td>0.086*</td>
<td>0.101**</td>
<td>0.173***</td>
<td>0.430***</td>
<td>-0.009</td>
<td>-0.325***</td>
</tr>
<tr>
<td>CEO+4 Dep. H</td>
<td>63.5</td>
<td>20.1</td>
<td>0.079*</td>
<td>0.026</td>
<td>0.109**</td>
<td>0.231***</td>
<td>0.558***</td>
<td>-0.031</td>
<td>-0.402***</td>
</tr>
<tr>
<td>LGI</td>
<td>65.5</td>
<td>27.0</td>
<td>0.056</td>
<td>0.060</td>
<td>-0.010</td>
<td>0.114***</td>
<td>0.321***</td>
<td>0.062</td>
<td>-0.174***</td>
</tr>
</tbody>
</table>

* = P < 0.05, ** = P < 0.01, *** = P < 0.001
Figure 2  The influence and trend lines of communication within the organization on the number of agents with a new attitude at the end of the post-intervention phase (PI) for various top-down interventions and a large group intervention (LGI).

provided by the number of departmental heads aligned in top-down interventions or the number of agents converted during the LGI. However, when organizations with a high level of Op passes a tipping point, the same high level of Op will now support the new attitude and cause the organizations to become highly homogeneous regarding the new attitude.
The role of the variety at start of the intervention period can also be explained best by plotting the level of variety against the percentage of agents with the new attitude (Figure 4). Overall in figure 4, two trend lines can be observed; one line in which the level of variety is positively correlated with the number of agents having a new attitude and one which is negatively correlated. In Figure 4 we differentiated organizations based on the level of Op. From this differentiation it is seen that, at low levels of Op (black dots), there is a positive relation between the level of variety and the number of agents with the new attitude. However, at high levels of Op (medium grey dots), two clusters of organizations are observed at low levels of variety; one including organization with low percentages of agents converted and one with high levels of agents converted. In the cluster with low percentage of
agents converted a positive correlation is found between the level of variety and the outcome whereas in the cluster with high percentages a negative correlation is found. From these data it can be concluded that in general the level of variety before the intervention is positively correlated with the number of agents with a new attitude at the end. However, there is a strong negative correlation between the level of variety and the Op (-0.829) by which organizations with high levels of Op have little variety at start of the intervention. At these high levels of Op the strong positive effect of Op on the outcome simply overshadows the effect of the variety. This feature manifested itself more when the interventions became more effective.

Next, we assessed the dynamics of the post-intervention phase for the various interventions. By assessing the number of attitude changes per iteration it was shown that, regardless of the intervention, the pattern of attitudes in the organizations stabilized after 4 iterations. Most changes, however, took place during the first iteration, after which the number of changes exponentially declined to stabilize at a few attitude changes per iteration. The number of changes during these first iterations was positively correlated with the effectiveness of the interventions (Table 3).

To further illustrate the dynamics of attitude changes, in Figure 5 two time-series are presented: the top-down intervention starting with the CEO and two departmental heads and the LGI. At the start of the top-down intervention, depending on the level of the Op, most organizations still have the old attitude. Then, during the first iteration, the majority of the changes take place and the organizations are starting to shift towards the new attitude. What was observed is that most organizations shifted towards the new attitude. However, at high levels of Op some organizations did not convert. During the following iterations, this pattern was further enhanced; the changing organizations moved further towards the new attitude whereas the organizations that didn’t change remained as they were. At high levels of Op, a number of organizations were thus unable to make the change. However, when organizations with high levels of Op did change, they did so very effectively. Another phenomenon observed in the top-down simulation was that organizations with low levels of Op changed at iteration 1 but converted little further. In organizations with higher levels of Op, more conversion took place after the first iteration. A similar pattern was seen for the LGI. However, different from the top-down intervention, at the start of the LGI intervention more agents had already acquired the new attitude.

For the LGI, we could demonstrate that also for this intervention, the alignment of the departmental heads was important factor for success, just as it was for the top-down simulations. To demonstrate this, we correlated the initial attitudes of the various hierarchical levels at the start of the post-intervention phase, with the outcome. A high correlation is indicative for the influence of each managerial level.
From this analysis (Table 4), it is clear that all hierarchical levels had an influence on the outcome. By calculating the slope and dividing it by the number of agents per hierarchical level, we were able to calculate the influence of one agent at each hierarchical level on the outcome. This number expresses the average percentage of agents that acquired the new attitude due to the attitude change of one agent at a given hierarchical level. These results demonstrate that the influence per agent neatly followed the hierarchical line, and that it indeed was quite important to persuade the departmental heads during a LGI, since after the CEO they clearly were most influential; the conversion of one departmental head caused an average increase of 10% in the number of agents with a new attitude.

Figure 4 The influence of the level of variety before intervention on the final number of agents with a new attitude in various top down interventions and a large group intervention (LGI) differentiated for the levels of Organizational persuasion (Op).
Table 3  The dynamics expressed by the average (avg) number of agents changing their attitude at each iteration and the standard deviations (std) for the various simulations.

<table>
<thead>
<tr>
<th>Simulation</th>
<th>Average number of agents changing their attitude per iteration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Pre change</td>
<td>avg</td>
</tr>
<tr>
<td></td>
<td>std</td>
</tr>
<tr>
<td>CEO only</td>
<td>avg</td>
</tr>
<tr>
<td></td>
<td>std</td>
</tr>
<tr>
<td>CEO+1 Dep. H</td>
<td>avg</td>
</tr>
<tr>
<td></td>
<td>std</td>
</tr>
<tr>
<td>CEO+2 Dep. H</td>
<td>avg</td>
</tr>
<tr>
<td></td>
<td>std</td>
</tr>
<tr>
<td>CEO+3 Dep. H</td>
<td>avg</td>
</tr>
<tr>
<td></td>
<td>std</td>
</tr>
<tr>
<td>CEO+4 Dep. H</td>
<td>avg</td>
</tr>
<tr>
<td></td>
<td>std</td>
</tr>
<tr>
<td>LSI</td>
<td>avg</td>
</tr>
<tr>
<td></td>
<td>std</td>
</tr>
</tbody>
</table>

Table 4  The influence of the various managerial levels in a large group intervention, expressed as the correlation between the initial attitude of a hierarchical level and the number of agents with that attitude at the end, the slope of the relation and the influence of each individual agent per hierarchical level expressed as the percentage of agents that changes to the new attitude due to an agent on this level.

<table>
<thead>
<tr>
<th>Hierarchical level</th>
<th>Corr.</th>
<th>Slope</th>
<th>% change/agent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEO</td>
<td>0.498***</td>
<td>0.800</td>
<td>80%</td>
</tr>
<tr>
<td>Departmental heads</td>
<td>0.373***</td>
<td>0.405</td>
<td>10%</td>
</tr>
<tr>
<td>Group leaders</td>
<td>0.418***</td>
<td>0.327</td>
<td>1.7%</td>
</tr>
<tr>
<td>Workers</td>
<td>0.407***</td>
<td>0.281</td>
<td>0.2%</td>
</tr>
</tbody>
</table>
Figure 5 A time series displaying the influence of organizational persuasion (x-axis) on the number of agents with a new attitude (Y-axis) in the simulation in which the CEO and two departmental heads acquired the new attitude and the LGI.
6.6 Discussion
We realize that by using computer simulation we oversimplify reality. Nevertheless, only by using computer simulation we are able to gain insight into emergence (Dooley, Corman, McPhee, & Kuhn, 2003) and, for our study, how emergence may interact with the outcome of a planned change. With our study, we contributed to a better understanding of change processes and we provided the Critical Theory of Change with an intervention strategy.

Based on our results we were able to demonstrate that results obtained during an intervention are modified during the post-intervention period. It was also clear that the uncertainty regarding organizational changes can be explained by the influence of emergence. We demonstrated that similar outcomes of an intervention could result in a variety of final outcomes due to the emerging process in the post-intervention phase (Table 1 and Figure 1). Emergence thus clearly contributes to the uncertainty involved in the outcomes of organizational change processes: even when management does the right things, a variety of outcomes are possible. However, our study also demonstrates that this uncertainty is to a certain extent manageable; by doing the right things the chance of success is increased.

An important benefit of our simulation is that we were able to generate longitudinal data, as they yield insight in the dynamics of emergence. We found that, already after 2 to 4 rounds of interaction, the pattern of attitudes in organizations stabilized and an equilibrium set in. However more surprising was that most attitude changes took place during the first iteration, further conversion during sequential iterations was rather low. The outcome of the first iteration was therefore rather determinative for the final outcome. These observations have not been reported before and it will be a challenge to verify these results empirically, since longitudinal studies are quite scarce. When extrapolated to real-life organizations, these findings have important consequences for change agents. In finding the right balance between stability and change, stability seems to come naturally whereas change has to be provoked. Once a change is initiated – either planned or forced upon the organization by external influences – stability sets in quite rapidly, making organizations rather insensitive for efforts to correct the direction set in at the start of the intervention. This suggests that, for planned changes, a first-time-right approach is essential. However, for changes initiated by external influences, the direction and the outcome is most likely already set before management is aware that things are shifting. Our study demonstrated that the direction and the outcome of emerging processes are best guided by the Op. When the direction and the level of Op supports the desired outcomes, active guidance is less essential. We also observed that organizations with a high variety in their pattern of attitudes and low levels of Op changed faster than homogeneous organizations with high levels of Op. This finding provides another dilemma for management: although
high variety makes organizations more changeable, it also makes them less effective and vice versa. In a dynamic, changing environment efficacy, therefore, must be sacrificed for dynamics.

To align the organizational factors with planned changes, three phases need to be distinguished, each having different factors enhancing the long-term success: the pre-intervention phase, the intervention phase and the post-intervention phase. For the pre-intervention phase, high levels of variety were correlated with high numbers of agents acquiring the new attitude. This observation confirms findings that a sufficient amount of variety must be present in organizations to be able to respond to changes (Ashby, 1958; Piderit, 2000). It was shown that variety was strongly inhibited by high levels of Op.

With regard to the intervention phase, it was clear that an LGI was more effective than a top-down intervention. However, also in a top-down intervention, a large number of organizations were able to make the transition to the new attitude. The alignment of the departmental heads was shown to be crucial for the success of the change for both a top down and an LGI. This result confirms Kotter’s advice that strong coalitions enhance the success of an organizational change (Kotter, 2007a, b). The result further demonstrates that, although less efficiently, the hierarchy was able to cascade down changes. For an LGI it was shown that the long-term success was directly related to the number of agents that changed their attitude during the intervention, as well as the alignment of the departmental heads.

Applying these findings to real-life organizations, a top-down intervention emphasizing the alignment of the staff, is effective and economic and is thus preferable used in day-to-day changes to solve relatively simple issues (Snowden & Boone, 2007). However, when change is essential, and needs to be implemented fast or involves a complex problem (Snowden & Boone, 2007), an LGI is the best choice. However, also in an LGI the emphasis should be placed on changing the attitudes of the staff, in addition to reaching as many employees as possible.

During the post-intervention phase, two major factors had a consistently positive impact on the success of a change: communication in the organizations and the Op. Communication in the organization consistently stimulated change in all simulations. The most dominant factor, was the level of Op. Overall, high levels of Op resulted in large numbers of agents acquiring the new attitude. However, there was also a catch, since although high levels of Op had a positive effect during the post-intervention phase, these high levels of Op inhibited the variety during the pre-intervention phase and thus also indirectly inhibited the change. For highly homogeneous organizations, more effort was needed to convert them, but when this happened, the same high level of Op stimulated these organizations to reach high levels of agents having the new attitude. In Figure 6, a schematic overview is presented regarding the effect of the various factors on the outcome of an
organizational change. By applying these factors in change processes, the emerging processes can be brought into alignment with the planned change.

The importance of Op supports the importance of resistance reduction that is extensively described in literature regarding organizational change (George & Jones, 2001; Nesterkin, 2013; Oreg et al., 2011). For real-life organizations, it thus essential to not only change the attitudes of individuals during the intervention phase, but to also to adjust their processes, systems, norms and values so that they support the desired change. The role of Op also underscores the importance of motivating, enabling and facilitating employees to lower their resistance against the preferred attitude. This conclusion is in line with the observations that managers can exercise most influence by acting as enablers (Plowman et al., 2007), that successful leaders facilitate, engage, motivate and energize (Higgs & Rowland, 2011; Kotter, 2001), and that reducing resistance in planned organizational changes is essential (Furst & Cable, 2008; Kotter, 2007a).

**Figure 6** Change model with the major factors influencing success at the different phases of organizational change processes.

However, Op also had an indirect negative effect, which was caused by the fact that organizations with high levels of Op were quite homogeneous at the start of the intervention, making it hard to begin a change process. Such organizations resemble organizations with a strong culture. A strong culture is defined as a culture in which norms and values are widely shared (Sorensen, 2002), making it likely that most employees will have a positive attitude towards the current status quo. Strong cultures are generally regarded as beneficial (Gordon & Ditomaso, 1992), since they align the behaviors of its employees without the negative effect of a bureaucracy (Kotter & Heskett, 1992; Oreilly & Chatman, 1996). Our finding that organizations with a strong culture were harder to change, is in agreement with previous studies concluding that strong cultures are less prone to adapt, and are more resistant to
change (Sorensen, 2002). Nevertheless, when they adapt, the same strong culture will drive organizations to becoming quite homogeneous again.

It should be noted that before the organizational change process sets in, Op stimulated the prevailing attitude, whereas after the intervention it stimulated the new, desired, attitude. This was a choice we made in the model demonstrating the role of Op. We realize that due to the many factors that will influence Op, this complete inversion of the Op is hard to achieve in real-life organizations. In real-life organizations, it is more likely that the Op may not change direction so abruptly and more time is needed to align the major factors with the goals of the change. Although this was not shown we know that when the Op remains as it is, and thus becomes negative in terms of encouraging the new attitude, organizations are very likely to return to their pre-intervention state. Adjusting the Op to the new attitude and increasing the level of Op are essential for a successful change. However, in real life this might not be that easy. Many factors, such as norms, values, systems and processes, will influence the level and the direction of Op. Therefore, due to the diversity of factors influencing Op there are no single measures that can be taken to align the Op with the change goals. In this light, change models emphasizing adjustments at all levels of the organization will be best equipped to adjust the Op. An example of such as change model is McKinsey’s 7S framework, which emphasizes the need to align strategy with structure, systems, shared values, skills, style and staff.

In our introduction we argued that in order to fully understand organizational changes and reduce the uncertainty involved in organizational changes, we needed to obtain some control over emergence. This is extremely challenging, as emergence is almost by definition autonomous and uncontrollable. Using computer simulation, we were able to slightly open the black box of emergence and demonstrate that emergence, to a certain level, can be influenced. With our change model presented in Figure 6, the Critical Theory of Change is now provided with an intervention strategy.
7

General discussion and future prospects
7 General discussion and future prospects

7.1 Summary of results

7.1.1 Introduction

At the end of the introduction I concluded that organizations can be regarded as self-organizing complex systems in which the outcome of organizational change emerges, rather than being planned. Self-organization is an emerging process characterized by its nonlinear behavior, meaning that there is no clear relation between cause and effect. From this perspective, it is thus impossible to plan an action in such a way that it fully achieves a specified goal. Consequently, the outcomes of planned organizational changes are never quite as anticipated. This indeed seems to be the case since, in practice, most planned changes fail or do not achieve the expected results (Burnes, 2004; Greenwood & Hinings, 1996; Jacobs et al., 2013; Young, 2009). The way in which emerging processes disrupt or even dominate planned change initiatives presents a challenge to managers and limits what they can achieve. Emergence certainly helps to explain why there is such a high level of uncertainty regarding the outcome of planned changes. An interesting consequence of nonlinearity is that it is not justifiable to blame someone for the failure of a planned change, even though this frequently occurs: when the team fails, the coach is fired.

The concept of emergence is thus at odds with our perception of rationally led organizations, organized on the basis of rational – linear – processes and operating in a predictable environment. As argued in the introduction, due to the increasing complexity of organizations and the environment in which they operate, emerging processes are likely to be more dominant than we think. There is therefore a need to understand emergence better; only when emergence can be controlled to some degree can the uncertainty regarding organizational change be reduced. By opening the black box of emergence a little and looking specifically in this dissertation at the emergence of a shared attitude, we have gained more insight into the organizational factors that may influence emergence and therefore how the intrinsic uncertainty surrounding emerging processes can be reduced. These insights might help managers to consider strategies which take into account the various factors that can affect the process of attitude formation, and they may thus be able to reduce the uncertainties involved in leading an organization. We argued that computer simulation is an excellent tool for achieving such insights as it allows one to explore the full spectrum of potential outcomes and the factors involved.

In Chapter 4 we simulated a situation in which a new issue suddenly arose, requiring a reaction from all members in the organization. The literature refers to the arising of new issues as jolts, defined as “transient permutations whose occurrences are difficult to foresee and whose impacts on organizations are disruptive and
potentially inimical” (Meyer, 1982: 515). However, since jolts are usually unique, there is no guidance available on how to cope with them. At the start of the simulation, every agent thus had its own personal preference for how to cope with this situation. Then, in time, over successive rounds of interaction with other agents, a shared way of coping with this new situation emerged. This situation was represented in the model such that at the start of the simulations each agent had either a positive or negative attitude towards the solution preferred by the CEO, and initially these attitudes were randomly distributed. From this random pattern of attitudes, a majority attitude emerged due to self-organization. The situation described in Chapter 4 relates to the theory of adaptive fit and change (Baard, Rench, & Kozlowski, 2014) in which employees at the operational level have to cope with changes in the environment and reach a consensus on how to do so. Our point of reference in all the simulations was the initial attitude of the CEO. The extent of the alignment of agents with the initial attitude of the CEO at the end of the simulations was our measure of organizational success. In our simulations we thus tested how far the CEO was able to steer the organization. Note that we did not question whether the CEO’s approach represented the best solution for the problem.

In Chapters 5 and 6 we started our simulation with the organizations already acquired a stable majority attitude already present. However, we now simulated a scenario in which organizational change was needed to deal with changing circumstances: a new way of doing things was required. In Chapter 5 we simulated that the agents and the CEO became aware of the need to change course. In this respect, the simulations reported in Chapter 5 were, as in Chapter 4, simulating an adaptive change. The difference was that in Chapter 4 the organization was reacting to a new situation and there was no clear majority attitude, whereas in Chapter 5 the organization was reacting with a majority attitude already established. In Chapter 6 we simulated that the CEO initiated the change. This simulation represented a top-down approach to organizational change (Kotter, 2007a) and a large group intervention. We first simulated the intervention by changing the attitudes of a limited number of agents to the desired attitude and then tested which majority attitude would emerge from these interventions.

This thesis addressed two specific aspects of organizational change from the perspective of organizations as complex systems: the emergence of a shared attitude from a random distribution of attitudes, and the changing of an existing pattern of attitudes. This approach is different from most of the literature on organizational change, which usually considers the change process to be the outcome of rationally designed plans for change in which senior management steers the organization in a specific direction. This view, in which the CEO or managers in general are seen as a reflexive systematic planners, is regarded by Mintzberg as “folklore” (Mintzberg, 2011). According to Mintzberg, “Study after study has shown that (a) managers work
at an unrelenting pace; (b) their activities are characterized by brevity, variety and discontinuity; (c) they are strongly oriented to action” (Mintzberg, 2011: 19). He argues that managers hardly have time to plan and constantly feel the pressure to respond to the many obligations they have. He concludes that “[t]he pressures of the managerial environment do not encourage the development of reflective planners, the classical literature notwithstanding. This job breeds adaptive information manipulators who prefer the live, concrete situation” (Mintzberg, 2011: 25). Being a manager myself, I can fully support the picture described by Mintzberg. The pace of multiple interactions on diverse subjects during one day hardly leaves time to plan or reflect. What this suggests is that organizations are managed not by careful planning but by continuous interactions between managers and their subordinates, peers and supervisors, creating an ideal environment for emergence. It is this process of multiple agents interacting with each other over time that is simulated by the model. In contrast to the classical view of organizational change, our model simulates the hectic way in which managers cope with all kinds of demands taking place in real time and meanwhile try to steer the organization into the desired direction. Although some attention is given in the literature to the daily activities and practices of managers, most studies of change are based on a rational approach to change processes. In such processes, the assumption that managers can find time to plan, analyze, implement and reflect. It is also implicitly assumed that manager have all the necessarily information available to them and are free from biases – all of which are quite unrealistic assumptions. In contrast, we studied emerging organizational changes driven by the multiple interactions taking place between the various people within the organization over time. In this respect our approach is unique in its attempt to better understand emerging processes and to combine them with planned changes.

7.1.2 Validation of the model
Chapter 2 introduced the model and described its design. In Chapter 3 the quality of the model was assessed, and the dynamics. Three quality criteria were defined: self-organization, display of real-life features, and nonlinearity.

First, the outcomes of the model had to be the result of self-organization. This condition was met in all the simulations. Most attitude changes took place during the first iteration, and after that the number of changes declined rapidly. After five iterations, a relatively stable pattern of attitudes emerged in every simulation. The formation of a shared attitude was thus a rapid process, with most changes taking place during the first and second iterations.

The second criterion was that the model should be able to generate macro results that relate to empirical findings. In Chapter 3, the results from the model converged with empirical results as we demonstrated a clear tendency for groups
and organizations to polarize. However, in all the simulations described in this thesis, only rarely did organizations become 100% homogeneous; pockets of resistance were found in each of our virtual organizations, as happens in real-life organizations. We also found that the extent of the agents’ influence followed the line of hierarchy, as in real life. This was remarkable, as this was not programmed into the model; every superior in the model was given an equal amount of authority. Chapter 5 described how the model displayed and explained the escalation of commitment in real-life organizations.

The observed macro-level features resulted from the interactions between individual agents, each of which used a decision rule to determine its attitude. The model was thus able to connect micro-level individual choices to macro-level outcomes for groups and organizations (Anderson, 1999; Lau & Woodman, 1995) and in doing so it generated organizational phenomena that have been demonstrated empirically in the literature. This is an interesting feature of the model. When we programmed behaviors at the individual level and the interaction rules between these individuals, stable patterns of attitudes emerged at the organizational level as a result of self-organization, and these patterns were similar to those found in real-life organizations.

Third, the model proved to be nonlinear. That is, the initial distribution of attitudes was seldom predicted the outcome. Furthermore, as demonstrated in Chapter 3, similar starting conditions led to varying outcomes. In this simulation, it was as if an organization was allowed to self-organize for a given period and was then sent back in time to start all over again, like Bill Murphy in the movie Groundhog Day, with the difference being that our virtual organization had no memory of any previous self-organization processes. This simulation generated various outcomes, which not only demonstrates the nonlinearity of the model but also counters one of most widespread criticisms of computer modeling, that ‘what goes in comes out’. Evidently, similar starting conditions generated a variety of results, and thus the outcome cannot be predicted from the starting conditions. Therefore, although the model is fully mathematically described, it is nevertheless able to generate different outcomes from similar starting positions, just as in real life.

Although validation of the model was limited and not tested empirically or experimentally, we demonstrated that the model generated empirically established organizational features without these features being explicitly programmed into the model. This indicates that the basic mechanism of the model is valid and it is quite plausible that the results obtained by this model are relevant for real-life organizations. Therefore, the model can be used to study emergence and its outcomes, and provides us with new insights regarding the interplay between various choices or options in the emergence of a new shared attitude in real-life organizations.
GENERAL DISCUSSION AND FUTURE PROSPECTS

Having said that, we fully recognize that, although our model is more complex than other models such as Nowak’s model (Nowak et al., 1990), it is still a simplification of real life. This might be seen as a disadvantage since it excludes the influence of a large number of factors. Simplicity can, however, be an advantage in a model, as it means that factors can be studied in isolation. Additionally, the value of modeling is that simulation studies can test a great variety of parameters and conditions longitudinally, something that very difficult to achieve in empirical studies. The large spectrum of parameters that can be tested in computer simulations may aid the design of empirical studies, as we will discuss further at the end of this chapter. It should also be acknowledged that some features found in simulation experiments simply cannot be tested empirically. In such cases, simulation can fill a void in organizational studies, complementing empirical studies.

7.1.3 Dynamics of attitude formation

A unique property of our model is its ability to simulate the longitudinal process of attitude formation in groups and see how interactions between individuals lead to a stable shared attitude. This approach addresses the need for more longitudinal studies in organization science (Oreg et al., 2011). Very little is known about the dynamics of how attitudes emerge and stabilize. In the vast majority of empirical studies a cross-sectional design is used. Ployhart and Vandenberg (2010) argued convincingly that a longitudinal study generates more reliable results than a cross-sectional study (Ployhart & Vandenberg, 2010). In a cross-sectional study it is far from certain whether the correlations found between a parameter and the output parameter represent a real causative relation; many other explanations may apply, thus leading to false conclusions (Maxwell & Cole, 2007). As an example, one might find a good correlation between a good HRM system and organizational performance, leading to the conclusion that HRM is important for organizational performance. However, many factors will influence performance, and unless these are included in the study it remains unclear whether HRM is indeed the main parameter influencing performance. Also, it is equally right to conclude that organizations with good performance have the means to set up a good HRM system – and therefore a good HRM system might be the result of previous good performance, rather than being responsible for current good performance. Cross-sectional studies can thus gather no information regarding the nature of the relation between two parameters: whether the relation is linear, exponential, or a curve with an optimum or minimum. Furthermore, it was demonstrated that observed changes in two-wave studies can be caused by differences in change errors (Rogosa, Brandt, & Zimowski, 1982). In such cases there is in reality no difference between the scores at a certain point in time and a point in time after this. However, in cases where there are few data points and normal distributions
with a high standard deviation, the scores at the first point in time may by coincidence be situated in the low part of the normal curve and those at second in the high part, making it appear that there is an increase between both measurements. These drawbacks of two-wave studies are not found in longitudinal studies. Unlike two-wave studies, longitudinal studies capture changes over time and show how a change develops, thus generating more reliable results. A longitudinal study has a minimum of three measuring points and preferably more (Ployhart & Vandenberg, 2010). Ployhart and Vandenberg suggested that the lack of longitudinal studies was caused by uncertainty as to how they should be conducted (Ployhart & Vandenberg, 2010).

An alternative to empirically designed longitudinal studies are computer simulations. Although computer simulations can never fully capture the complexity of real life, with our simulations we were able to follow changes at the level of the individual, unit, and entire organization over time. The simulations demonstrated that the number of attitude changes declined exponentially in the first five iterations and then leveled to a few changes per iteration. We found that the outcome of the first iteration was already quite determinative of the final outcome. Only a few organizations changed the trend set in the first iteration. Thus in the very first iteration the direction in which organization was heading was already being determined. Note that, although the outcome of the first iteration was very predictive of the outcome, the starting situation itself was little predictive of the outcome, demonstrating the nonlinear character of the system.

Concerning the dynamics of conversion, we found that when a majority was formed after the first iteration, in the almost all the simulations this majority was further strengthened during subsequent iterations. Extrapolating these results to real-life organizations indicates that when the number of individuals in the organization with a similar attitude passes a tipping point, the organization will most likely convert further to this attitude. We thus found that the majority formed during the first round of interactions determines the final outcome in the emergence of a shared attitude. After this first round, further interactions will have little or no influence on the direction in which the shared attitude is going to.

The implication for real-life organizations is that, later on, there will be little chance of diverting the organization from the course that has been established during these initial interactions. As we concluded in Chapter 4, to influence emergence, management should thus be present in these first rounds of interaction. Due to the complexity and size of our organizations this is hard to achieve, considering how communication takes place both inside and outside the formal channels of the organization (Krackhardt & Hanson, 1993). The determinative role of the first round of interactions implicates that the outcome is already determined before one realizes it. This does away with any notion of planned changes or
rational approaches to organizational change, as there is simply not enough time to gather data and design a rational response. It is, however, in line with Mintzberg’s description of managers as being action-oriented and rather unreflective, since the determinative influence of the first round of interactions suggests that managers have the best chance of influencing emergence if they react swiftly and communicate as much as possible.

Speculating on which factors could facilitate early involvement by management, we suggest that flat organizations with short lines of communication between the work floor and management might facilitate this. The literature supports this notion: a flat organizational structure matches the need for effectiveness and fits best in a “locally stormy environment” (Burton, 2011). Similarly, Anderson and Brown presented preliminary evidence that a flatter organization was preferable when groups were working on complex and ambiguous tasks (Anderson & Brown, 2010), which is in agreement with our suggestion. However, it was also found that units in a flat organization need to have a high level of autonomy, as otherwise the coordination between the units will rapidly outgrow the capacity of the management (Burton, 2011). This finding clearly limits the possibility of management being present during these first rounds of interaction. One can speculate that using short lines of communication in a flat organization will enhance the influence of management, reducing the coordination effort needed and enabling more units to be managed. However, there will be a point at which the number of units to be led outstrips the capacity of management and the time available per unit is too short to make a difference. New simulations which compare different organizational structures could provide clues as to how to find the optimal balance. An alternative solution to the need for management to be present in the first rounds of interaction is for other influential individuals with a similar attitude to take their place. This can be achieved when managers at lower levels are in sufficient alignment with those higher up. Later on we will discuss the effect of an actively managed coalition of leadership.

Group polarization in our simulation was driven primarily by communication within the groups and by authority, whereas the homogeneity of the organization was driven primarily by organizational persuasion. With regard to group polarization, it was not surprising that communication within the group played such a prominent role. However, in the model, group conformity played no role at all in the polarization of the groups. It should be emphasized that it was programmed into the model that high levels of group conformity should lead to more group polarization. In contrast, we found that group conformity led indirectly to less group polarization. The explanation for this contradictory finding was that, at the start of the simulation, the initial majority in the groups was stabilized as a result of group conformity. This was the expected effect of group conformity as programmed. However, because the majority attitude had been, more groups kept their initial majority, and as a consequence the
diversity within the organization as a whole increased. Due to the greater degree of diversity within the organization, interaction with agents outside the group was more likely to stimulate an attitude that differed from the majority attitude of the group: the greater diversity in the organization thus led to greater diversity in the groups and less polarization. Thus, somewhat unexpectedly, the indirect effect of group conformity was greater diversity in the organization and less polarization within the groups. If a single group had been simulated, group conformity would indeed have had a positive effect on group polarization, in accordance with the literature (Mcgarty et al., 1992). However, in our multi-group organization, group conformity stimulated diversity in the organization, and consequently also in the groups. This example shows how complex longitudinal studies can reveal pathways of cause and effect that are not shown in two-wave or cross-sectional empirical studies.

The simulations indicated that the diversity found in organizations is preserved in groups but not in individuals. This conclusion is based on the observation that the groups were quite homogeneous, and thus diversity in the organizations was caused by there being groups in which most of the members had an attitude which conflicted with the majority attitude in the organization as a whole. Although the literature has mentioned the need for diversity in organizations (Ashby, 1958; Piderit, 2000), we are not aware of any studies that focus on this type of group-based diversity. This finding is important for organizations: it shows that stimulating communication in general is likely to enhance the prevailing attitudes, since most communication will be between group members. Only when communication outside the groups is stimulated specifically will it lead to more diversity.

Concerning planned change processes, one can speculate that when a change is communicated to employees by means in which large groups are one-directionally informed, this may have an adverse effect since it is most likely that the change will be further discussed within the groups. Based on the results of the simulations, communication within the group will enhance/strengthen the prevailing attitude, especially when the change is perceived as threatening to the group. This is exactly the opposite of what management is trying to achieve. A general practice of calling together all employees to announce a major organizational change might be quite counterproductive. On such occasions the CEO will communicate the change, and the announcement is then likely to be discussed further within the individual groups, which will probably re-inforce the attitude of the group –and for some groups this will not necessarily be the desired attitude. This can be regarded as the first, determinative, interaction round. Instead a “silent or guerrilla change” can be applied in which change agents start to implement changes from within the organization and by doing so prevent the discussion within the groups. Here it is worth mentioning what Meyerson (2001) describes as ‘tempered radicals’, who use
an array of subtle approaches to change (Meyerson, 2001). Such approaches will certainly minimize the perceived threat for the group, and this thus avoids increasing the amount of communication within the groups that will strengthen the current (undesired) attitude.

7.1.4 Influence
In Chapter 4 we addressed the first research questions: can leaders influence the emergence of a majority attitude, and which tools can they use best to enhance their influence? Traditionally, emerging processes are regarded as autonomous, uncontrollable and unpredictable. However, our simulations clearly demonstrated that the CEO was able to influence the emergence of a shared attitude; a high correlation was found between the initial attitude of the CEO and the shared attitude that emerged at the end of the simulation. Two organizational factors were shown to significantly enhance the influence of the CEO: organizational persuasion and the alignment of the departmental heads with the CEO, also referred to in the literature as a power coalition.

Organizational persuasion in our model is defined as the sum of all the organizational factors that served to lower employees’ resistance to changing their attitude. By this definition, many facets of the organization can be attributed to organizational persuasion. There is no single variable that can be identified as the key element in organizational persuasion. In its simplest form, organizational persuasion can be thought of as rewards and punishments but also behavioral control, organizational norms, and values, as mentioned in the introduction. Behavioral control is determined both by individual factors and by organizational procedures and systems. It is easy to see that when an organization is asking its employees to be more proactive, a procedure that requires them to fill out five forms to obtain a pencil will not encourage this proactive attitude. This phenomenon is described by Kanter (2010) as organizational powerlessness, which determines the degree to which employees can pursue and realize their goals. Powerlessness is shown to be caused by rule-minded management styles (Kanter, 2010) and a complex web of restrictions in the organization (Clegg, 1981).

In our simulations, the level of organizational persuasion was strongly correlated with the number of agents that had acquired the preferred attitude. When there was relatively little organizational persuasion, the organizations concerned typically had had a lower percentage of agents with the preferred attitude than organizations with a much higher level of organizational persuasion. Another difference between organizations with low and high levels of organizational persuasion was that for those with low levels the outcomes were quite diverse and could range from organizations with 10% of agents with the preferred attitude to organizations with 100% of agents with the preferred attitude. Organizations with high levels of
organizational persuasion, however, were less divergent and ranged from organizations having 80% to 100% agents with the preferred attitude. With regard to the level of organizational persuasion, it is important to acknowledge that motivators and demotivators will have different or even totally opposing effects on different individuals, because of the differences in personalities. For example, some people might regard getting to a training as being something negative; i.e., you cannot be performing well, otherwise you would have not needed this training. Another person, however, might regard it as good thing; your employer sees your potential and wants to invest in you. Therefore, it is likely that the level of organizational persuasion will be experienced quite differently from person to person, which makes it hard for organizations to increase organizational persuasion on an organization-wide basis. Also, because many organizational factors contribute to organizational persuasion and it is unlikely that all of these can be channeled in the same direction, the total effect is thus expected to be small. This suggests to me that, in real life, organizations are more likely to use a lower level of organizational persuasion. If we further speculate that organizational persuasion in real-life organizations is low, our simulations demonstrate that the alignment of departmental heads is an important factor that enhances the influence of the CEO. This finding supports Kotter’s recommendation that a strong coalition is needed for successful change (Kotter, 2007a).

Management can thus influence the emergence of shared attitudes. This influence is best enhanced by organizational persuasion and the formation of a strong coalition at the top, as Kotter suggests (Kotter, 2007a). Organizational persuasion lowers employees’ resistance to changing their attitude to the preferred attitude, and once this preferred attitude has been adopted, resistance to reverting to the previous attitude is strengthened by organizational persuasion. These results therefore show the importance of reducing resistance, a subject discussed extensively in the literature (Armenakis et al., 1993; Oreg, 2003). The contribution of our model is that by comparing various organizational factors it demonstrates that reducing resistance is by far the most effective tool for steering emerging processes.

Oreg examined how various factors affect three different types of resistance: affective, behavioral, and cognitive. (Oreg et al., 2011). He demonstrated that affective resistance had a negative effect on job satisfaction, behavioral resistance stimulated the intention to quit, and cognitive resistance reduced commitment. The social influence of resisting colleagues was strongly correlated with affective and behavioral resistance. In our model, this form of social influence was represented by agents with an attitude that was in opposition to that of the CEO. Also, in our model it was shown that when a large number of other agents had this type of opposing attitude, it was harder for an individual agent to adopt the organization’s preferred attitude. This is in agreement with Oreg’s findings. A noteworthy finding in his study was the role of information; more information increased resistance.
Oreg explained this by reasoning that changes always included negative aspects, and providing more information highlighted these negative aspects, leading to the negative correlation found in his study. Secondly, he suggested that too much information could have the same effect as too little information (Oreg et al., 2011). However, the simulations presented in this thesis may provide an alternative explanation. The positive correlation between the quantity and quality of information and the degree of resistance found by Oreg is in line with our observation that new information will inevitably trigger discussions within the group. As our simulations show, this will most likely strengthen the prevailing attitude and inhibit attitude change. We therefore argued that a ‘silent’ change might be preferable in order to avoid intra-group communication.

7.1.5 Organizational adaption versus escalation of commitment

In Chapter 4 we looked at how a shared attitude emerges from a random distribution of attitudes. In the simulation presented in Chapter 5, however, a shared attitude was already established. The simulation starts when, due to some changes in the business environment, agents had become aware individually that the current attitude was no longer appropriate. Because of this awareness, the agents became willing to change their attitude, which we simulated by lowering their resistance to change. Because of this willingness to change, in most of the simulated organizations a new shared attitude emerged, and organizations were able to adapted to the new situation. However, in a significant minority of the organizations no adaption was observed, and escalation of commitment was found.

Adaption was caused by the reduction of resistance towards the new attitude and was stimulated by communication. The pace of adaption was faster when there was more variety within the organization, and slowed down at high levels of. Escalation of commitment in our model was caused by a lack of variety in the organizations. The limited variety in such organizations restricted the chances for agents to interact with others that held a minority attitude. In organizations displaying escalating of commitment, ‘agents were caught in a loop in which the existing attitude was constantly being reinforced. It could be demonstrated that this lack of variety was directly related to high levels of organizational persuasion. Organizational persuasion thus indirectly promoted the escalation of commitment whereas during adaption it had an inhibiting effect on the speed of adaption in all the organizations.

Extrapolating these results to real-life organizations, it suggests that sufficient initial diversity is needed for adaptive change to occur. When an organization is too homogeneous it may become unable to adapt. This suggests that escalation of commitment is more likely to be found in organizations with a strong organizational. A strong culture is generally defined as one in which norms and values are widely
shared (Sorensen, 2002). Of course an organization with a strong culture to innovate will be less likely to display escalation. However, if there is widely shared agreement and thus a strong culture of adhering to the current business model, escalation of commitment is more likely to occur. Our finding that escalation of commitment is linked to organizations with strong cultures conflicts with managerial literature emphasizing the importance of strong cultures (Sorensen, 2002). Such cultures may indeed be beneficial in stable conditions but may become a problem when circumstances change and a new business model is needed. In a paper on the cultural legacy of founders (Ogbonna & Harris, 2001), this phenomenon was aptly reflected in the title of the paper: “The founder's legacy: Hangover or inheritance”. In the article, Sorensen demonstrated that strong cultures tend to show more reliable performance in relatively stable environments, however the better performance of strong cultures disappeared in volatile environments. Sorensen suggested: “When the environment shifts, strong-culture organizations have no fall-back position, and the lack of internal diversity in perspectives makes it more difficult for the firm to adapt.” (Sorensen, 2002: 89). Our simulations showed that this is indeed correct and that diversity stimulates both adaption and the speed of adaption. However, in order to exploit this diversity communication needs to be encouraged.

The role of organizational persuasion in adaption indicates that today’s success in creating a strong shared attitude may be tomorrow’s failure to adjust to the new demands of the business environment. For real-life organizations this means that too much emphasis on trying to persuade all employees of the correctness of the chosen strategy will make the organization susceptible to escalation of commitment and thus unable to adapt to changing circumstances. In studies on the longevity of organizations it was shown that a combination of efficacy and wild ideas was the best predictor of longevity (Burgelman & Grove, 2007; March, 2006). Our results support this conclusion and demonstrate that the source of these wild ideas could be the diversity present in the organization and that efficacy might be achieved by having stable, homogeneous clusters of employees with the preferred attitude. Finding the right balance between homogeneity and diversity presents a challenge for management.

Another consequence of the finding that homogeneity is driven by organizational persuasion is that when employees all over the organization experience a similar level of organizational persuasion, the organization is likely to become more homogeneous. Extrapolating this to real-life organizations would suggest that using a concept of expansion based on cloning an existing business concept, as McDonald’s and IKEA have done, makes organizations more susceptible to escalation of commitment. The rationale for this is that by cloning their business model they will have similar systems and processes and a more homogeneous culture than organizations that expand by means of takeovers. Takeovers make it
more likely that a variety of systems, procedures, protocols and cultures will be present in the organization, which will lead to a greater degree of diversity. In conclusion, strong corporate cultures and a greater emphasis on efficiency and identical business processes will all stimulate homogeneity and reduce diversity, and can thus be seen as serving to escalate commitment.

7.1.6 Planned change
In Chapter 5 we simulated a spontaneous reaction by organizations to a changing business environment. In Chapter 6, however, we simulated a situation in which management initiated a change in the organization, and here the focus was on the post-intervention period. We reasoned that during the intervention period organizations are able to change employees’ attitudes. However, once the active persuasion has stopped and the organization is left on its own devices, these changed attitudes need to be maintained and expand further in the organization. I know from experience that after a week of intensive training people can be completely convinced of the need to change their established ways of doing things. However, once they have been back at work for five minutes, all good intentions seem to fade, and they are likely to fall back into their old routine. Changing attitudes is simply not enough – sustaining the new attitude is what really counts.

In this simulation, a successful change was thus measured not by the number of agents that had acquired the new attitude after the intervention, but by the number that still had this new attitude at the end of the post-intervention period. When more than 75% of the agents had retained the new attitude by the end of the post-intervention period, the intervention was regarded as successful. Two types of simulation were performed; one in which we simulated a large-group intervention (LGI) (Bartunek, Balogun, & Do, 2011) and one in which we simulated a top-down approach.

With the top-down approach we found that the alignment of the departmental heads was an important driver of success. These simulations confirmed Kotter’s advice that for a change to be successful, it needed to be supported by about 80% of the senior management (Kotter, 2007a). This finding was similar to what we found in Chapter 4. Hence, the alignment of the departmental heads and thus the formation of a strong coalition is a powerful mechanisms for influencing both emergent and planned changes.

When a large-group intervention was simulated, many organizations adopted a new –i.e., shared – attitude during the intervention. In this simulation, as one might expect, a strong relation was found between the number of agents that switched to the desired attitude during the intervention phase and the probability that, at the end of the post-intervention period, the majority attitude would still be the desired attitude.
When these findings are extrapolated to organizations, we can first conclude that large-group interventions (LGI) are likely to be more effective than top-down interventions. The difference with this approach in terms of issue a meeting to announce a change is that after the announcement, the groups are left to themselves, whereas during an LGI the groups are guided/steered by a change agent during the first round of interaction. From this, one can speculate that it would be wise to keep group members together during an LGI. This helps to prevent the danger of discussion starting up again after the intervention, with the risk that group members who have acquired the new attitude will be persuaded back to their previous attitude. By comparison with an LGI a top-down intervention will be less time-consuming, less costly and – when a sufficient coalition can be achieved – still quite effective. Due to the time and resources needed to perform an LSI, this method can only be used on rare occasions. The situation in which it is best to use a large-group intervention is when there is no clear solution to the problem encountered in the organization and finding the right answers to deal with this is part of the intervention (Bartunek et al., 2011), or when the organization is in crisis and the need to change is very urgent. When the line of action is clear and simple, and the change is less critical, a top-down approach tend to be better. However, when performing a LGI it is best to start the intervention at the top and work downwards, since the influence of an employee decreases rapidly lower down the hierarchy.

With regard to the organizational factors involved in the post-intervention period, only two had a consistently positive influence: communication density in the groups and organizational persuasion. Higher communication density in the groups led to a greater percentage of agents with the preferred attitude. However, this effect was relatively small. By far the most influential factor was organizational persuasion. It should be noted that beforehand, organization persuasion stimulated the prevailing attitude, whereas after the intervention it stimulated the new, desired, attitude. This implies that the obstacles in the organizations that inhibited a change of attitude during the intervention phase also changed.

However, organizational persuasion also had a negative effect. What we observed was that organizations with a high level of organizational persuasion were quite homogeneous before the intervention. As in the dynamics of escalation of commitment, this high level of homogeneity meant that organizations were unable to change or, in case of an LGI, reverted to the previous attitude. On the other hand, when organizations with a high level of organizational persuasion did adopt the new, preferred, attitude, the same mechanism made these organizations quite homogeneous for the old attitude now made them homogeneous for the new. I realize that this complete inversion of the organizational persuasion may not happen in real-life organizations. In many organizations, it is likely that the
organizational persuasion may not change direction so abruptly. Although this was not simulated, it is obvious that when organizational persuasion remains as it is, and thus becomes negative in terms of encouraging the new attitude, organizations are very likely to return to their pre-intervention state.

It is clear that organizational persuasion is the key organizational factor in achieving a successful and lasting planned change and is very likely to be an important focus of attention for changes in real-life organizations. Our results demonstrated that changing the attitude of employees during the intervention phase is insufficient to make the change sustainable; the new way of working needs to be consistently maintained throughout the organization. Since organizational persuasion is determined by a large number of factors, this means that as many different aspects as possible of the organization should be brought into line with the new requirements, including systems, procedures, reward systems, norms, values, etc., since all these will be contributory factors.

Changing the organizational persuasion is not an easy task. First, as there are many different factors involved, there are no single actions that can change the level of organizational persuasion. Moreover, some aspects of organizational persuasion such as systems, processes, norms and values are notoriously difficult to change. Second, organizational persuasion will be experienced differently by each individual in the organization, because of their personal preferences (Cialdini & Goldstein, 2004; Krosnick et al., 1993; Oreg, 2003) and the differences between organizations in, for example, the type of work, climate, leadership or group norms. This will lead to substantial variation in the organizational persuasion experienced by each individual. It is thus likely that in real life there will be a relatively low level of organizational persuasion, and it is unlikely to change direction overnight. In the light of this, it seems that the high failure rate of organizational change is conceivably a result of the self-organizing features of the organization. Even when a large number of employees have changed their attitude, the previous attitude can easily emerge once again during the post-intervention phase, especially when there is insufficient organizational persuasion to ensure the new attitude is maintained. Due to the nature of organizational persuasion, our simulations support change models which emphasize the need for adjustments at all levels. In this respect, McKinsey’s 7S framework provides an excellent tool for analyzing whether the organizational persuasion is sufficiently aligned with the preferred attitude and behavior. In the 7S framework it is advised that to change an organization the staff, style (of management), skills, strategy, structure, systems and shared values should all be aligned with the desired change. This will indeed also bring the organizational persuasion into line with the change.

However, when a change process is embraced too enthusiastically and the organization becomes too homogeneous, there is the risk that the organization will
be unable to cope adequately with the next change that is needed. This because having a sufficient diversity of attitudes within an organization was found to be an important factor in spontaneous adaption as well as in successful new change processes. Therefore, a balance needs to be struck between convincing a sufficient number of employees to embrace the new way of working and ensuring that minority attitudes are not eliminated. It seems paradoxical that a successful change can be the cause of failure in the next change.

Our simulations suggest that a number of variables contribute to the success of a planned change. The variety in attitudes before the intervention and the effectiveness of the intervention itself both determine how many employees will have acquired the new attitude by the start of the post-intervention period. With respect to the employees that had the new attitude at the end of the intervention phase, it was found that it mattered which employees changed their attitude; the chances of success were greater when more employees higher up the hierarchy adopted the preferred attitude. It was shown that changing the attitude of departmental heads to align with the attitude of the CEO, was the most effective way of enhancing the success. Although agents lower down the hierarchy had a considerable impact as a group, the departmental heads were the most influential individuals. The number of employees with the new attitude at the start of the post-intervention period, together with the level of organizational persuasion and the communication density in the groups, determined the chance of a successful change. Figure 1 shows the change model derived from our simulations and how these factors contributed to a successful change.

Figure 1 Change model with the major factors influencing success at different phases of the change process.
7.2 New insights
In the previous sections, the main observations from our simulations were summarized and discussed chapter by chapter. Some of these observations confirmed conclusions from empirical studies conducted in real-life organizations. These results add to the validity of our model. However, the main objective of this thesis was to generate new insights and identify organizational factors that could enhance the influence of management on the emergence of a shared attitude and thus provide new strategies for coping better with the complexity of our current organizations. So what new insights emerged from our simulations? In the sections that follow, I will summarize the overall new insights derived from our simulations with regard to the dynamics of how a shared attitude emerges, the influence of organizational factors on this process, and the way in which our findings may help organizations to develop new successful strategies.

7.2.1 Dynamics of the emergence of a shared attitude
In almost all of the simulated organizations the outcome of the emergence of a shared attitude was already determined in the first round of interactions. Only in a few rare cases did the majority attitude in the organization alter to another attitude after the first iteration. Once an organization had taken a particular view, that view was unlikely to change spontaneously; the established patterns of attitudes in the organizations were thus quite stable.

The cause of this stability was that most organizational factors helped to stabilize the current attitude, and only a few had a destabilizing effect. In general, therefore, we found a strong tendency for organizations to preserve the status quo. These findings are in line with findings regarding escalation of commitment (Sleesman, Conlon, McNamara, & Miles, 2012b) and the low rate of success for organizational change in real-life organizations (Burnes, 2004; Greenwood & Hinings, 1996; Jacobs et al., 2013; Young, 2009). In both escalation of commitment and failed attempts at organizational change, organizations are unable to adapt to new circumstances (escalation of commitment) or respond to a clear demand from higher management (organizational change). In both cases, there are forces within the organization that prevent the organization from adapting or responding once a position has been taken.

The first iteration determined not only the direction taken but also the size of the final majority. We found that, overall, after the first iteration there was little further conversion to the preferred attitude, and in most cases the majority established after the first iteration increased by only 10–15 percent. Only in a few organizations was a more significant degree of change during the following iterations (see Chapter 4). In some cases, the number of agents with the preferred attitude even diminished a little.
Applying this to real-life organizations indicates that the result obtained early on in the change process is not only determinative of the direction of the change but also of the level of success, as measured by the number of agents with the new attitude. It seems that an equilibrium is already reached after a few rounds of interactions. Therefore, the results that can be obtained after the initial phase are limited. From this one can speculate that it may be of little use to design long change programs, since the result will be determined quite quickly. It might be more effective to use short bursts of different change efforts in which each activity is designed to contribute to the overall goal for change. When, innovation needs to be boosted, for example, there may be a need for change in various aspects of organizational life, such as a need for new competences, greater autonomy, less bureaucracy, etc. All these elements are likely to contribute to an innovative climate and can be addressed by short change programs.

Another observation that was common to all simulations was the intrinsic uncertainty over the outcomes. First, there was only a slight connection between the outcome and the initial distribution of attitudes. The uncertainty was at its most acute in the first iteration. During this iteration the greatest number of changes took place, and the majority attitude that would be typical of the organization was determined. The outcome of this first iteration was largely independent of the distribution of attitudes at the start. After the first iteration, however, the system became quite predictable. These dynamics have never been reported before but have major implications for organizational change, as discussed earlier.

With regard to the predictability of planned changes, we showed that, with a similar level of organizational persuasion, a variety of outcomes were generated. The range of outcomes was reduced when the level of organizational persuasion was increased and thus the level of uncertainty was reduced. Nevertheless, uncertainty is intrinsic to organizational change. Therefore, although organizations can enhance the chances of success by doing the right things and can control emergence to a certain extent, uncertainty remains an intrinsic feature of organizations.

### 7.2.2 The influence of organizational factors

An interesting new finding was the role of group conformity. This factor was designed to enhance homogeneity. However, although group conformity was explicitly programmed into the model, opposite effects were observed; group conformity led to more diversity in the organization as a whole and indirectly in the groups. This counter-intuitive observation can be explained by taking into account the interactions and the dynamics involved in the emergence of a shared attitude, as discussed earlier. These findings thus demonstrate the importance of the dynamics when studying the influence of single factors on complicated processes. It is now easy to see that studying group conformity in an isolated group will lead
to the conclusion that group conformity enhances the homogeneity of that group, as found in the literature (Mcgarty et al., 1992). However, when studying group conformity in a context of multiple, interacting groups, as found in most organizations, group conformity plays a quite different role.

We also found counter-intuitive results for authority. Authority was programmed to enhance the influence of superiors and the CEO, but this was certainly not always what we found. In a single group, authority will indeed enhance the influence of a superior. However, in an organization consisting of multiple groups in which there are superiors with different attitudes, authority may also enhance the influence of superiors whose view opposes that of the CEO and thus decrease the influence of the CEO. Both examples show how the effect of organizational factors can change when a transition is made from a single group to a more complex, multi-group setting. This thus demonstrates that outcomes of simple study designs cannot be automatically extrapolated to complex systems.

A major benefit of modeling is that several organizational factors can be compared in one study. In empirical studies usually only one factor is studied and its effects are hard to compare with the effects of other organizational factors. From our simulations, it is obvious that organizational persuasion was by far the most dominant factor. From the model, it thus became quite clear which factors contributed to the outcome, and what were the pathways by which they did so.

7.2.3 Strategies for organizations

Based on these findings, what strategies can we recommend to senior management? First, with regard to emerging processes, management is likely to be able to influence emerging processes. Emerging processes may thus not be as autonomous as may have been presumed. However, to influence emerging processes, senior management may have to be involved in the initial discussions within the organization. When these have already taken place, it is quite hard, perhaps even impossible, to change the direction in which the process is heading or the final result. For managers to be involved early on so that they can exert maximal influence on the process, short lines of communication are likely to be needed, together with a high level of informal contact and aligned representatives. In addition, we suggest it may be better to undertake the changes in series of short bursts, with each initiative emphasizing a different aspect of the desired goals, since people are less likely to change their attitude after the initial interactions.

According to the results obtained in our model, the best way to steer the organization is by getting the organizational persuasion to work in precisely the way that you anticipate or hope that it will. This provides a huge challenge, since organizational persuasion is hard to change. Both the number of factors that determine the level of organizational persuasion and the varying effects that these
factors will have on individuals add to the complexity of changing the organizational persuasion. The conclusion that the most dominant factor in steering emergence is also the one that is hardest to change is likely to contribute to the uncertainty involved in organizational change.

Although organizational persuasion is hard to change, its importance also emphasizes that managing a complex organization is not a matter of steering employees but rather a matter of creating the right conditions. Managers should place more emphasis on making it easier for employees to do the right thing, rather than actively trying to persuade them to do so. With regard to planned changes, it was shown that communication within groups enhanced the prevailing attitude. This finding suggested that a silent change might be more effective. However, regardless of the precautions taken by management, there will still be unexpected outcomes. These outcomes could be better or worse than expected, or could even be diametrically opposed to the outcomes envisaged. Given the intrinsic, we questioned how fair it is to blame or praise executives for the organization’s results. Chance is likely to play a far bigger role than anyone seems willing to acknowledge, whereas successes and failures are frequently attributed to the management’s ability, or lack of ability – more so than is warranted. It was shown that the correlation coefficient between good management practices and the success of a firm is about 0.3 (Bertrand & Schoar, 2003). Calculating the coefficient of determination ($r_{xy}^2$) from this correlation it can be shown that a good CEO is responsible for only about 9% of the overall results of the firm. This is still quite high but other factors will determine the remaining 91% of the results. Our simulations show that the uncertainty involved in emerging processes is like to play a major role in this other 81%.

Our findings also suggest that organizations need to have enough adaptive potential. Sufficient diversity in attitudes is preferable to complete homogeneity. We speculated that strong organizational cultures may be very beneficial at a given time but these same cultures may become a burden when adaption is needed that does not fit with the present culture. In this respect, a fine balance needs to be maintained between having a sufficient majority to support the current business model, but also enough diversity to enable the organization to adapt to changes in the environment that require a new business model.

For planned changes, we found that a top-down change could be quite effective, provided that management was sufficiently aligned. However, when change is urgently needed, an LGI provides the most efficient means of changing an organization (see Chapter 6). We also demonstrated that, for planned changes, the post-intervention period may significantly alter the outcomes of interventions. The key organizational parameters during this period were organizational persuasion and communication within the organization.
In the introduction I reasoned that a perspective in which organizations are seen as open systems and linked to this the critical theory of change fit best with our current complex organizations. Grieves (2010) commented that, due to the explicit nonlinearity of this perspective on organizations, the critical theory should be considered to be a change theory without an intervention strategy (Grieves, 2010: 33). Based on our findings that organizational change involves intrinsic uncertainty, we can agree in part with this conclusion. However, in this thesis we were able to identify several factors that may reduce such uncertainty. Therefore, even if we regard organizations as open, nonlinear systems, it is still possible to develop intervention strategies.

7.3 Future simulation research
For further research the current model can be used to answer new questions. However, the model can also be improved to mimic reality better, and the results of the model can be tested empirically to verify and complement the results obtained by our simulations. All three aspects will be addressed in the next paragraphs.

7.3.1 Exploring the model
A great benefit of modeling is that one can design better empirical studies. First, modeling makes it possible to explore how to design an empirical study. Second, some organizational aspects that are not so obvious in real life can be identified through simulations and explored further empirically. Various possibilities can still be tested with our current model. One is the influence of the organizational structure. We have speculated whether a flat organization would enhance the influence of the CEO. This and other effects of the organizational structure can be tested using the model. Furthermore, we used a semi-random pattern of communication that was based only on the organizational structure. With this model we could also simulate the effect of more defined patterns of communication such as groups that are largely cut off from communication with the rest of the organization, or the effect of established channels of communication within the organization.

Another field that is open to further exploration is the influence of personal parameters; which personal characteristics used in the model will enhance the influence of the CEO? Some preliminary data showed that the influence of the CEO was not enhanced by a high level of personal persuasion, as one might expect; instead, it was enhanced by a high communication index, indicating that it is better to be communicative than to be highly persuasive.

Given the importance of organizational persuasion, it is certainly interesting to see the effects of more extreme levels of personal resistance. Depending on the
CHAPTER 7

topic, some individuals might be impossible to persuade. It would be interesting to see what the effect on the dynamics is when individual or groups of highly resistant individuals are present in the organization; will change be impossible, or are more iterations needed before the trend is set? Will the organization become more chaotic, or will such individuals be ostracized?

7.3.2 Improving the model

Although the model is already considerably more complex than Nowak’s model (Nowak et al., 1990), there are still improvements to be made. However, not every addition is necessarily an improvement. One of the charms of a model is its simplicity, as it means that features may emerge that would remain unseen if more features were added. In our model it was shown that when there were high levels of organizational persuasion, other aspects such as the influence of the departmental heads were hidden. There are nevertheless some factors that could significantly improve the model.

An important improvement could be made in terms of the interaction patterns. With regard to the interactions, we incorporated a semi-random pattern of communication. In our model, communication was influenced only by the organizational structure. Although this is not an unreasonable assumption, more factors will influence communication. For instance, it is well known that people prefer to communicate with those who have similar opinions. In an organizational setting, one might argue that people have a limited choice as to whom they communicate with. This argument is valid for meetings that are part of standard business processes. However, in other interactions, it is likely that people will indeed prefer to communicate with like-minded colleagues. In this respect, programming in ties between friends and agents with similar professional backgrounds could help to improve the algorithm for the interaction patterns. In this line of reasoning, our current model is apolitical. The formation of groups or individuals with their own agenda and means of influencing others are not included, but their actual influence could be studied with some adjustments to our model.

It is also established that both weak and strong communication ties can be present in organizations (Friedkin, 1982) and there can be huge variation here, as these ties depend on the communication densities between groups or departments. Including an algorithm based on social networks that facilitates the simulation of strong and weak ties will open up new possibilities for studying the effects of these ties and will resemble reality more closely. It would be interesting to see whether the inclusion of this type of algorithm leads to more diversity in the organizations and to more agents changing attitude after the fifth iteration.

The algorithm we used to summarize all influences experienced by an agent could also be improved. It is well known that the first interactions have the strongest
impact (Latane & Wolf, 1981), whereas later interactions will have less impact, and may eventually have no effect whatsoever. In the current model, this effect is simulated by taking the square root of the sum of changes and dividing it by the total. This algorithm can be improved by using a sigmoid relation between the order of the agents interacted with and the modification of their influence. In such an algorithm, the persuasive or supportive power of the first agents interacted with will be added to the sum of persuasive or supportive influences, whereas subsequent influences will be reduced and finally will not add anything at all. With this approach it is essential that the sequence of interactions between agents should be randomized to take account of the fact that interactions in real life are also at least partly random. Such an algorithm would be closer to reality.

The current model simulated a closed system; no influences from outside the system were included. When simulating a short period this is fine, but when simulating longer periods it is inevitable that agents will change their attitude due to external influences. One way in which this might be achieved is to randomly change the attitudes of some of the agents in the system once in a while. Additionally, this would create an opportunity to study how external pressure on a certain group may or may not affect the whole organization. This is particularly important in enabling us to study how adaption takes place in a bottom-up scenario. Imagine that the service department is facing complaints from customers and, as a result, acquires a different attitude. It would be interesting to simulate and see whether this new attitude spreads throughout the organization and which factors might enhance or inhibit that process.

Another improvement would be to include some kind of scale to represent various shades of an opinion on a given subject. Including a scale here would better reflect real life, where people do not easily switch to a completely different attitude. Developing an algorithm for such a scale would allow us to study group polarization. During group polarization the number of individuals with a similar attitude increases, as was the case in our simulations, but opinions also tend to become more extreme (Haslam, 2001). This provides us with an interesting dilemma: is the level of extremity of a position an extra dimension of an attitude, or does each position on the scale, from moderate to very extreme, in fact constitute a different attitude? For day-to-day discussion the difference between the two does not matter, but for designing an algorithm it is essential. The last option seems to fit best with the current definition of attitudes and the three dimensions of attitude strength: relation to behavior, durability and attachment (Eaton et al., 2009).

With regard to behavior, the attitude strength, and particularly the effect it has on behavior, is an important aspect not yet fully incorporated into the model (Eaton et al., 2009). It is known that this relation may be different for different attitudes and probably different for each individual as well. Although an attitude might be given a
value on a graduated scale for its relation to behavior, its effect on behavior will differ for each person. Taking this a step further one can decompose attitudes into their cognitive, emotional and intentional components (Piderit, 2000). The cognitive dimension of attitudes refers to the beliefs of an individual regarding the attitude object, whereas the emotional dimension refers to the individual’s feelings regarding the attitude object. The third dimension refers to the individual’s evaluation of the attitude object, which is based on past experiences and the anticipated future implications. In Piridit’s model, ambivalence is found, as one may be positive on the cognitive scale and negative on the emotional scale. This ambivalence might provide a bridge to switch from one attitude to another. It would be challenging to include both Eaton and Piridit’s dimensions of into one model but it would allow us to study more aspects of the dynamics of opinion formation and behavior in groups.

### 7.3.3 Empirical validation

In this thesis I present an exploratory study that investigates the dynamics of attitude formation. We reasoned that, due to the large amount of data that needs to be generated for such studies, it would be practically impossible to obtain these data from empirical studies. However, some of the outcomes of our simulations can be studied empirically. Using computer simulation, we can narrow down the possible scenarios for the dynamics of attitude. Once these have been narrowed down, less data is needed to study, allowing empirical validation.

The importance of the first round of interaction and the observation that it determines the direction in which the organization is heading can be tested empirically. In an experimental setting a group of individuals can be asked to give their attitude to solutions regarding a number of organizational problems. Then the group can be given an assignment to solve which requires them to resolve one of these problems. In the first round of interactions each individual can asked to state what his or her preferred solution would be, and why. After this first round, the attitude of each individual is recorded. Then the debate can go on, with the attitudes being recorded again at regular intervals. Such an approach may provide data on the first and subsequent rounds of interaction. Repeating this set-up with a number of groups should enable us to confirm our findings.

Although empirical studies are extremely worthwhile, I would like to argue that computer simulation can also generate data that could never be obtained by empirical studies. I would therefore like to emphasize the need for organizational research to be complemented by computer simulation. In today’s highly complex organizations, which span continents and employ thousands of people, there are likely to be more and more emerging processes simply because there is no one who can oversee all activities. To control such complex organizations we cannot rely solely on our knowledge of planned changes; we need to understand emergence.
as well and incorporate it into the way we attempt to steer organizations. As this thesis demonstrates, emerging processes do influence planned changes and are an important source of uncertainty in organizational change. However, we have also demonstrated that emerging processes are not black boxes, uncontrollable and beyond the influence of management. We demonstrated that although there is an intrinsic uncertainty involved in emergence, emergence can, to a certain extent, be controlled. However, the only way to open the black boxes of emerging processes is by applying computer simulation to mimic the complexity of our organizations.
8

Summaries in English and Dutch
8.1 Summary

Although the perspective on organizations as open systems, has been known for decades, the consequences of this perspective has hardly been investigated. Organizations from the perspective of open systems, are characterized as self-organizing complex systems in which nonlinear processes determine the outcome. Nonlinearity in this respect means that there is no clear relation between cause and effect, a similar change can result in a variety of outcomes. A consequence of the nonlinear processes in organizations is that the outcomes of interventions cannot be predicted. Therefore, the perspective of organizations as open systems is regarded as a perspective without intervention strategies. In our study we will challenge this believe. By obtaining more insight in the dynamics of emerging processes and the factors that influence emergence it will be possible to design intervention strategies for nonlinear processes and to define the limits of what can be achieved with such interventions.

In our studies we focused on attitude formation in organizations. Attitudes are important because they are a major predictor of behavior. It is further demonstrated that a positive attitude towards an organizational change is a prerequisite for a successful organizational change. However, although attitudes can be measured relatively easily, to study the emergence of a shared attitude empirically in real life organizations is nearly impossible. To study emergence empirically, all interactions between all employees have to be monitored and scored during a period of time. And when the influence of organizational factors on this process needs to be determined, such a study has be done in a large number of organizations. Since these hurdles cannot be overcome, we used computer simulation. The computer model we used belongs to the category of the agent-based models. In our model every agent has a decision rule. Based on the interactions with other agents and organizational factors this decision rule determines whether an agent will keep its current attitude or change it. Due to the multiple interactions between the agents in the model, a stable pattern of attitude emerges with a majority that can be regarded as the organizational shared attitude. The larger the group supporting the preferred attitude, the more successful the change. With the data gathered during various round of interactions we were able to assess the influences of the following organizational factors on the outcome: the level of authority within the organization, the communication densities within groups, departments and the organization, the level of organizational persuasion and the level of group commitment within the organization.

In our model authority enhanced the personal influence superiors. The level of communication densities determined the frequency in which employees interacted with each other regarding the attitude. The level of organizational persuasion was
defined as the sum of all motivators and de-motivators in the organization regarding the attitude. The organizational persuasion always supported the preferred attitude and thus reduced the personal resistance to change ones attitude when this attitude was opposing the preferred attitude and it strengthened the resistance to change ones attitude when it matched the preferred attitude. The level of group commitment determined the pressure that individuals experienced to conform themselves to the majority attitude in the group. In our simulations we tested how each of these parameters enhanced or inhibited the influence of the CEO on the outcome of a shared attitude.

In our first study, we simulated a situation in which, from a random pattern of attitudes, a shared attitude emerged. This simulation therefore, resembled a reaction to a jolt in which an unexpected environmental change occurred that made it necessary to develop an organizational shared answer. In this first study we assessed the dynamics and the general features of the model. It was demonstrated that all virtual organizations indeed self-organized. In all organizations a stable pattern of attitude was formed in which a majority attitude and minority attitude could be defined. The process of attitude formation was shown to be very fast. Most attitude changes took place during the first interaction round and decreased rapidly in the next few iterations. After iteration 5, only a few attitude changes per iteration were observed. Nonlinearity was demonstrated by two features. First, the starting conditions were shown to be hardly predictive for the outcome. Second, when we allowed identical organizations with identical agents to repeatedly go through the process of attitude formation, a range of outcomes was found, showing that similar starting conditions generated a variety of outcomes. An important observation was that although the starting conditions were not predictive for the outcome, the outcome of the first iteration was highly predictive. It was demonstrated that the outcome of the first iteration in almost all cases determined the final outcome. This observation indicates that after the first iteration little can be done to change the course set in during this first iteration. As a consequence, to influence emerging processes one can only influence the outcome very early in the process.

From the same set of simulations we assessed whether management was able to influence the emergence of a shared attitude and which organizational factors would enhance this influence. We were able to demonstrate that management indeed could influence the emergence of a shared attitude. The influence of the CEO was shown to be predominantly enhanced by the level of organizational persuasion. The dominant strength of organizational persuasion on the influence of the CEO demonstrates the importance of lowering the resistance against a change. In addition the influence of the CEO was further enhanced by the alignment of the departmental heads, demonstrating the importance of a strong coalition.
In the second set of simulations we studied adaption and escalation of commitment. In this simulation a majority attitude was established first, then the environment changed and it became clear to all agents that the behavior associated with the old attitude was failing. This realization was simulated by lowering the resistance to change the old attitude in favor of the new attitude during each following iteration. Because of this, all agents in the system became very susceptible to change their attitude towards the new attitude. However, despite the “willingness” of each agent to change its attitude, escalation of commitment still occurred in 16% of the organizations. The simulation further demonstrated that adaption was stimulated only by the level of communication in the organization. Escalation of commitment was caused by too homogeneous organizations. Due to the high homogeneity, agents interacted insufficiently with agents having the new attitude because they were stuck in rounds of mutual conformation and thus unable to change.

In our third set of simulations we assessed the role of the post-intervention phase on the long-term success of an intervention. As common practice in organizational changes, the attitudes of employees were changed by means of an intervention. However, due to the nonlinearity of the process of self-organization during the post-intervention phase it is uncertain how the results of the intervention will further develop. We found that all results obtained during the intervention phase were modified during the post-intervention phase. This modification indeed caused that similar outcomes of an intervention resulted in a variety of outcomes at the end of the post-intervention phase. This finding yields further insights as to why so many organizational changes fail and that the uncertainty regarding the outcome of interventions is intrinsic to organizations being complex systems.

Based on our data we were able to identify some factors that may enhance the chance of success of intervention strategies. During the pre-intervention phase the size of the minority attitude present in the organizations had a positive effect. During the intervention, the final number of employees with a new attitude at the end of the intervention phase was positively correlated with the long term success of an organizational change. Especially the number of departmental heads that had obtained the preferred attitude during the intervention, was shown to be quite important for the long term outcome. During the post-intervention phase the level of organizational persuasion towards the new attitude was by far the most important organizational factor to obtain a successful change. Due to the fact that the organizational persuasion is determined by a large number of factors in the organization, it can be concluded that change models that emphasizes the necessity to adjust the organization at all levels in order to implement a change, will be the most effective.

By using computer simulations we were thus able to connect the micro level decisions made by individuals with the macro level of a shared organization
behavior. With this model we gained more insight into the emergence of a shared attitude in organizations, how to change this attitude and how to influence its emergence. Based on these insights, from the perspective of organizations as open systems, we were able to identify strategies that are able to reduce the intrinsic uncertainty associated with organizational changes.

Our contribution to the organizational change literature is that we were able to slightly open the black box of emergence. Emerging processes were always regarded as being autonomous and uncontrollable and thus beyond the influence of management. With our model we however demonstrated that management has the means to influence emerging processes and we were able to provide strategies that can enhance the influence of management on the emergence of a shared attitude. Nevertheless, in all simulations an intrinsic level of uncertainty regarding the outcome remained; similar efforts could always lead to different results.
8.2 Samenvatting

Hoewel het perspectief op organisaties als open systemen al decennia bekend is, zijn de consequenties hiervan nauwelijks onderzocht. Vanuit dit perspectief, worden organisaties gezien als zelforganiserende complexe systemen waarin niet-lineaire processen bepalend zijn voor het resultaat. We spreken van niet-lineair gedrag als er geen directe relatie is tussen oorzaak en gevolg, een identieke verandering in een niet lineair systeem kan verschillende uitkomsten genereren en het is niet te voorspellen welke uitkomst wordt gegenereerd. Als gevolg van dit niet-lineair gedrag is het onmogelijk om het effect van een interventie binnen een organisatie te voorspellen. Het perspectief van organisaties als open systemen wordt daarom als een perspectief zonder interventiestrategieën gezien. In dit onderzoek wordt dit bestreden. Door de dynamiek van zelforganiserende processen zichtbaar te maken zijn we instaat factoren te identificeren die deze processen kunnen beïnvloeden en wordt het wel degelijk mogelijk om interventiestrategieën te ontwerpen en de grenzen van deze interventiestrategieën te bepalen.

In onze studies hebben we ons gericht op de totstandkoming van een gedeelde attitude in organisaties. Attitudes zijn belangrijk omdat ze voor een groot deel ons gedrag bepalen. Niet voor niets is een door de organisatie gedeelde positieve attitude ten opzichte van een organisatieverandering, essentieel voor slagen van deze verandering. Echter om in een organisatie de vorming van een gedeelde attitude te bestuderen, zouden we alle interacties tussen alle werknemers gedurende een langere periode moeten volgen en vastleggen. Als we dan vervolgens de invloed van organisatiefactoren op dit proces willen bepalen, moet dit onderzoek in groot aantal verschillende organisaties worden uitgevoerd. Dit is praktisch onmogelijk. Als alternatief voor empirische studies hebben we daarom gebruik gemaakt van computersimulaties. Het computer model dat we hiervoor gebruikt hebben is een agent-based model. In ons model bepalen virtuele individuen op basis van een beslissregel hun attitude. Deze beslissingsregel bepaald op basis van de interacties met andere virtuele individuen in het model en de toegekende organisatorische factoren of een individu van attitude veranderd of niet. Het verrassende is dat al deze interacties tussen alle individuen in de tijd niet tot chaos leiden maar resulteert in stabiel patroon van attitudes, het systeem heeft zichzelf dus georganiseerd in dit patroon. In dit patroon van attitudes heeft een attitude de overhand, dit noemen we de gedeelde attitude van de organisatie. Op basis van de gegevens gedurende de verschillende interactierondes kunnen we inzicht krijgen in de dynamiek van dit proces en kunnen we afleiden wat de invloed is van de organisatiefactoren op het resultaat. De organisatiefactoren in het model zijn; het niveau van de autoriteit binnen de organisatie, de communicatiefrequentie binnen groepen, buiten de groepen maar binnen de afdeling en buiten de afdeling,
het niveau van de organisatiebeïnvloeding en het niveau van groepscommitment in de organisatie.

De factor autoriteit in het model versterkt de persoonlijke invloed van superieuren. De communicatie frequentie bepaald de frequentie waarmee medewerkers met elkaar interacteren betreffende een attitude. De organisatiebeïnvloeding is gedefinieerd als de som van alle motiverende en demotiverende krachten in de organisatie die van invloed zijn op de attitude. De organisatiebeïnvloeding in het model vermindert de weerstand tegen de verandering van de attitude als de attitude van het individu tegengesteld is aan de gewenste attitude maar het versterkt de weerstand wanneer de attitude van het individu gelijk is aan de gewenste attitude. Het niveau van de groepscommitment bepaalt de druk die mensen ervaren om zich aan de meerderheidsattitude van de groep aan te passen. In de verschillende simulaties wordt steeds nagegaan hoe elk van deze factoren de invloed van een CEO op het ontstaan van een nieuwe gedeelde attitude versterkt of remt.

In de eerste studie is een situatie gesimuleerd waarin we vanuit een willekeurig patroon van attitudes een gedeelde attitude hebben laten ontstaan. In deze studie is een reactie gesimuleerd op een onverwachte verandering in de omgeving waarbij ieder individu bij de start een eigen mening heeft en dus een attitude ten opzichte van de mening van de CEO. Door zelforganisatie zal na verloop van tijd een stabiel patroon van attitudes ontstaan en daarmee ook een door de organisatie gedeelde attitude. In deze eerste simulatie hebben we gekeken naar de dynamiek van het ontstaan van een gedeelde attitude en de algemene kenmerken van het model. We zagen dat alle virtuele organisaties zichzelf organiseerden en een stabiel patroon van attitudes vormden. In dit patroon was altijd een meerderheidsattitude maar ook altijd minderheidsattitude aanwezig. Hoe groter de groep die de attitude van de CEO ondersteunde, hoe groter het succes van de verandering. Met betrekking tot de dynamiek van het proces zagen we dat verreweg de meeste attitudeveranderingen tijdens de eerste interactieronde plaatsvonden. In de opvolgende interactieronden nam het aantal attitudeveranderingen snel af en na 5 interactieronden stabiliseerde het aantal attitudeveranderingen zich tot enkele attitudeveranderingen per ronde.

Niet-lineariteit werd op twee manieren aangetoond. Als eerste bleek dat de startwaarden nauwelijks voorspellend waren voor de einduitslag. Als tweede hebben we identieke organisaties met identieke virtuele individuen herhaaldelijk het proces van attitudevorming laten doorlopen. Ondanks dat in dit experiment de begin situatie exact hetzelfde was voor iedere organisatie, werd een reeks van verschillende resultaten gegenereerd. Uit beide bevindingen bleek daarom dat de beginsituatie niet voorspellend was voor de eindsituatie. Een andere belangrijke bevinding was dat, hoewel de beginvoorwaarden niet voorspellend waren voor de uitkomst, het resultaat van de eerste interactieronde juist zeer voorspellend was.
Zodra er zich een kleine meerderheid had gevormd tijdens de eerste interactieronde, tendeerde het systeem vrijwel altijd verder in die richting. Deze waarneming laat zien dat wanneer eenmaal de richting is bepaald, deze nauwelijks meer is om te keren. Op basis van deze waarneming concludeerde we dat om de attitude formatie te beïnvloeden het management in een zeer vroeg stadium van het proces aanwezig moeten zijn.

Als vervolg onderzochten we of de CEO invloed kon uitoefenen op de totstandkoming van een gemeenschappelijke attitude en welke organisatorische factoren de invloed van de CEO konden versterken. We konden aantonen dat de CEO wel degelijk invloed had op het ontstaan van een gedeelde attitude maar dat deze invloed zeker niet absoluut was. De invloed van de CEO bleek vooral te worden versterkt door het niveau van organisatiebeïnvloeding. De sterke invloed van de organisatiebeïnvloeding toont het belang aan om de weerstand tegen de gewenste attitude te verminderen. Naast de organisatiebeïnvloeding werd de invloed van de CEO versterkt door de steun van de staf, hoe meer afdelingshoofden de attitude van de CEO onderschreven des te groter was de kans op succes.

In een volgende simulatie is adaptie en escalatie van commitment bestudeerd. In deze simulatie werd eerst een gemeenschappelijk attitude gevormd. Nadat deze gevormd was werd het voor alle individuen in het model duidelijk dat het gedrag verbonden aan deze attitude niet productief was. Om dit te simuleren werd de weerstand tegen het veranderen van de oude attitude bij iedere interactieronde verlaagd. Ondanks dat gedurende de simulatie ieder individu in het model een grote bereidheid kreeg om van attitude te veranderen was 16% van de organisaties niet in staat zich aan te passen en vertoonden dus escalatie van commitment. Uit deze simulatie bleek verder dat het aanpassen aan de nieuwe situatie alleen door communicatie binnen de organisatie gestimuleerd werd, alle andere factoren waren niet van invloed. Verder bleek dat escalatie van commitment een direct gevolg was van een te homogene organisatie. Als de organisatie te homogeen is komen individuen onvoldoende in contact met individuen met een andere attitude en blijven de individuen hangen in interacties waarin de oude en falende attitude aan elkaar bevestigd wordt.

In onze laatste simulatie onderzochten we hoe het proces van zelforganisatie de resultaten van een interventie om attitudes van individuen te veranderen kan beïnvloeden. We veronderstelde dat door een geplande interventie de attitudes van een aantal medewerkers waren veranderd naar een gewenste attitude. In de praktijk gaan we er vanuit dat deze veranderingen zich verder in de organisatie zullen gaan verspreiden maar dit is op basis van de complexiteitstheorie niet vanzelfsprekend ook weten we niet hoe sterk de spreiding zal zijn. Uit de simulatie bleek dat alle resultaten van de interventies gedurende de post-interventie periode verder werden verspreid door zelforganisatie. Echter door het proces van zelforganisatie tijdens de
postinterventie periode resulteerde gelijksoortige resultaten van interventies in verschillende uitkomsten. Deze diversiteit van uitkomsten laat zien waarom zoveel organisatieveranderingen niet de verwachte resultaten opleveren. De onzekerheid over de uitkomst van organisatie veranderingen kan daarom verklaard worden door de aanwezigheid van niet-lineaire processen in organisaties. Op basis van de gegevens uit deze simulatie waren we echter wel in staat een aantal factoren te identificeren die de kans op succes kunnen vergroten. Tijdens de pre-interventie fase was de diversiteit van attitudes in de organisaties een factor die succes bevorderde. Tijdens de interventie was het totale aantal individuen dat zich een nieuwe attitude had verworven bepalend voor het succes en met name het aantal afdelingshoofden die zich de nieuwe attitude hadden toegeëigend was van grote invloed. Tijdens de post-interventie fase was de sterkte van de organisatiebeïnvloeding de meest dominante factor voor een succesvolle verandering. Omdat de mate van organisatiebeïnvloeding in werkelijkheid door een grote verscheidenheid van factoren bepaald wordt is het aannemelijk dat veranderingsmodellen die de noodzaak benadrukken om de organisatie op meerder niveaus aan te passen het meest effectief zijn.

Door het gebruik van computersimulaties hebben we het microniveau waar individuen hun attitude bepalen kunnen verbinden met het macro niveau van organisaties waarin er een gedeelde attitude betreffende een bepaald gedrag het functioneren van de organisatie beïnvloed. Door deze verbinding te leggen zijn we in staat gebleken om meer inzicht te krijgen hoe een gemeenschappelijke attitude in organisaties ontstaat en hoe deze kan worden beïnvloed. Op basis van deze inzichten hebben we een aantal factoren kunnen identificeren die ons in staat stellen om de intrinsieke onzekerheid verbonden aan organisatieveranderingen te verminderen.

De bijdrage aan de theorie over organisatieveranderingen is dat we interventie strategieën hebben kunnen identificeren waarmee we het emergente proces van attitude formatie kunnen beïnvloeden. Emergente processen worden vaak beschouwd als autonome en oncontroleerbare processen die buiten de invloed van managers lagen. Met de onze simulaties hebben we kunnen aantonen dat managers wel degelijk over middelen beschikken om emergente processen te beïnvloeden. Ondanks dat we verschillende factoren hebben kunnen identificeren waarmee het emergente proces van attitudevorming beïnvloed kan worden, was er in alle simulaties sprake van een intrinsieke onzekerheid betreffende de uitkomst, we konden nooit precies voorspellen wat de uitkomst zou worden.
9

Computer code
9 Computer code

In this section the basic program is provided. This program was used as the basis for all simulations and depending on the questions to be answered it was adjusted to the needs then required. The program is made in Excel using Visual Basic. The complete program therefore contains a Visual Basic macro in combination with Excel formulas.

In this section we will first provide the Visual Basic code and then the excel formulas corresponding with the fields given in the code. The Excel file consist of following 7 tabs:
1. Random, this tab contains all the initial parameters.
2. MeetingChance, this tab contains a matrix in which every agent is coupled to every other agent and the meeting chance is or each combination is randomly added to each combination.
3. Opinions, this tab is used to write intermediate attitudes to.
4. Changes, this tab is used to write intermediate changes of attitude to.
5. ResultW, in this tab the basis parameters of each virtual organization are written to as well as the percentages of workers with attitude 0 at each iteration.
6. ResultsC, in this tab the basis parameters of each virtual organization are written to as well as the number of attitude changes at each iteration.
9.1 Visual basis code

Sub Macro1()
    ' Macro1 Macro
    ' Add random numbers to organizational parameters
    ' Keyboard Shortcut: Ctrl+Shift+R
    ' Runs

    Dim Run As Integer
    Dim CounterR As Integer
    Dim CRun As Integer

    Run = Worksheets("Random").Range("Q3").Value
    CRun = 1

    For CounterR = 1 To Run
        ' Organizational parameters; adding random numbers
        ' Clear meeting chances
        Worksheets("MeetingChance").Activate
        Rows("1:520").Select
        Selection.ClearContents

        Worksheets("Opinions").Activate
        Rows("1:520").Select
        Selection.ClearContents

        Worksheets("Changes").Activate
        Rows("1:520").Select
        Selection.ClearContents

        Worksheets("Random").Activate
        Selection.ClearContents

        Worksheets("Opinions").Activate
        Columns("C:XX").Select
Selection.ClearContents

Worksheets("Random").Activate

' Counting the number of fields organizational parameters = A
A = (WorksheetFunction.CountA(Worksheets("Random").Range("a2:n2"))) - 1

' Adding random numbers to fields
Dim CounterA As Integer
Dim B As Integer
Dim E As Integer
Dim D As Integer

    B = 0
For CounterA = 0 To A
    Max = 0
    Min = 0
    Max = Worksheets("Random").Range("A3").Offset(2, B).Value
    Min = Worksheets("Random").Range("A3").Offset(1, B).Value
    Worksheets("Random").Range("A3").Offset(0, B).Value = ((Max - Min) * Rnd + Min)
    B = B + 1
Next CounterA

' Personal parameters; adding random numbers
' Counting the number of persons in the Y directions
D = (WorksheetFunction.CountA(Worksheets("Random").Range("a10:A511")))

' Adding random numbers to fields
' opinion
Dim CounterC As Integer
E = 0
Max = 0
Min = 0
For CounterC = 1 To D
    Worksheets("Random").Range("B10").Offset(E, 0).Value = Rnd
    If Worksheets("Random").Range("B10").Offset(E, 0).Value > 0.5 Then Worksheets("Random").Range("B10").Offset(E, 0).Value = 1 Else Worksheets("Random").Range("B10").Offset(E, 0).Value = 0
Next CounterC
Range("B10").Offset(E, 0).Value = 0
    E = E + 1
Next CounterC

'Expert power
E = 0
Max = 0
Min = 0
Max = Worksheets("Random").Range("c10").Offset(-2, 0).Value
Min = Worksheets("Random").Range("c10").Offset(-3, 0).Value
For CounterC = 1 To D
    Worksheets("Random").Range("c10").Offset(E, 0).Value = ((Max - Min) * Rnd + 
Min)
    E = E + 1
Next CounterC

'Personal supportive power
E = 0
Max = 0
Min = 0
Max = Worksheets("Random").Range("d10").Offset(-2, 0).Value
Min = Worksheets("Random").Range("d10").Offset(-3, 0).Value
For CounterC = 1 To D
    Worksheets("Random").Range("d10").Offset(E, 0).Value = ((Max - Min) * Rnd + 
Min)
    E = E + 1
Next CounterC

'Personal persuasive power
E = 0
Max = 0
Min = 0
Max = Worksheets("Random").Range("e10").Offset(-2, 0).Value
Min = Worksheets("Random").Range("e10").Offset(-3, 0).Value
For CounterC = 1 To D
    Worksheets("Random").Range("e10").Offset(E, 0).Value = ((Max - Min) * Rnd + 
Min)
    E = E + 1
Next CounterC
'Personal resistance
E = 0
Max = 0
Min = 0
Max = Worksheets("Random").Range("f10").Offset(-2, 0).Value
Min = Worksheets("Random").Range("f10").Offset(-3, 0).Value
For CounterC = 1 To D
    Worksheets("Random").Range("f10").Offset(E, 0).Value = ((Max - Min) * Rnd +
Min)
    E = E + 1
Next CounterC

'Extroversion
E = 0
For CounterC = 1 To D
    Worksheets("Random").Range("K10").Offset(E, 0).Value = Rnd
    E = E + 1
Next CounterC

'Norm towards authority
E = 0
Max = Worksheets("Random").Range("L8").Value
Min = Worksheets("Random").Range("L7").Value
For CounterC = 1 To D
    Worksheets("Random").Range("L10").Offset(E, 0).Value = ((Max - Min) * Rnd +
Min)
    E = E + 1
Next CounterC

'salience groups
'Primary group
E = 0
Max = Worksheets("Random").Range("X6").Value
Min = Worksheets("Random").Range("X7").Value
For CounterC = 1 To D
    Worksheets("Random").Range("X10").Offset(E, 0).Value = ((Max - Min) * Rnd +
Min)
    E = E + 1
Next CounterC
'Group type A
E = 0
Max = Worksheets("Random").Range("y6").Value
Min = Worksheets("Random").Range("y7").Value
For CounterC = 1 To D
    Worksheets("Random").Range("Y10").Offset(E, 0).Value = ((Max - Min) * Rnd + Min)
    E = E + 1
Next CounterC

'Group type B
E = 0
Max = Worksheets("Random").Range("z6").Value
Min = Worksheets("Random").Range("z7").Value
For CounterC = 1 To D
    Worksheets("Random").Range("Z10").Offset(E, 0).Value = ((Max - Min) * Rnd + Min)
    E = E + 1
Next CounterC

'Group type C
E = 0
Max = Worksheets("Random").Range("aa6").Value
Min = Worksheets("Random").Range("aa7").Value
For CounterC = 1 To D
    Worksheets("Random").Range("AA10").Offset(E, 0).Value = ((Max - Min) * Rnd + Min)
    E = E + 1
Next CounterC

'Group type D
E = 0
Max = Worksheets("Random").Range("ab6").Value
Min = Worksheets("Random").Range("ab7").Value
For CounterC = 1 To D
    Worksheets("Random").Range("AB10").Offset(E, 0).Value = ((Max - Min) * Rnd + Min)
    E = E + 1
Next CounterC
'Organization
E = 0
Max = Worksheets("Random").Range("ac6").Value
Min = Worksheets("Random").Range("ac7").Value
For CounterC = 1 To D
    Worksheets("Random").Range("AC10").Offset(E, 0).Value = ((Max - Min) * Rnd + Min)
    E = E + 1
Next CounterC

'Copy initial opinions to worksheet opinions and to new opinion
Worksheets("Random").Range("B10:B511").Copy Worksheets("Random").Range("N10")
Worksheets("Random").Range("B10:B511").Copy Worksheets("Opinions").Range("A1")

'Copy parameters to result section
Worksheets("Random").Range("A3:M3").Copy Worksheets("ResultsW").Range("A2:M2").Offset(5000, 0).End(xlUp).Offset(1, 0)
Worksheets("Random").Range("AF15:AK15").Select
    Selection.Copy
    Sheets("ResultsW").Select
    Range("N2:S2").Offset(5000, 0).End(xlUp).Offset(1, 0).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False
Worksheets("Random").Activate

Worksheets("Random").Range("A3:M3").Copy Worksheets("ResultsC").Range("A2:M2").Offset(5000, 0).End(xlUp).Offset(1, 0)
Worksheets("Random").Range("AF15:AK15").Select
    Selection.Copy
    Sheets("ResultsC").Select
    Range("N2:S2").Offset(5000, 0).End(xlUp).Offset(1, 0).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False
Worksheets("Random").Activate

Worksheets("Random").Range("A3").Copy Worksheets("ResultsG").Range("a2").
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Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("B3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("C3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("D3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("E3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("F3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("G3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("H3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("I3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("J3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("K3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("L3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("M3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)
Worksheets("Random").Range("N3").Copy
Offset(0, 5000).End(xlToLeft).Offset(0, 2)

Worksheets("Random").Range("AF18").Select
  Selection.Copy
  Sheets("ResultsG").Select
  Range("A16").Offset(0, 5000).End(xlToLeft).Offset(0, 2).Select
Worksheets("Random").Activate

Worksheets("Random").Range("AG18").Select
  Selection.Copy
  Sheets("ResultsG").Select
  Range("A17").Offset(0, 5000).End(xlToLeft).Offset(0, 2).Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
 :=False, Transpose:=False
Worksheets("Random").Activate
Worksheets("Random").Range("AH18").Select
Selection.Copy
Sheets("ResultsG").Select
Range("A18").Offset(0, 5000).End(xlToLeft).Offset(0, 2).Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
 :=False, Transpose:=False
Worksheets("Random").Activate
Worksheets("Random").Range("AI18").Select
Selection.Copy
Sheets("ResultsG").Select
Range("A19").Offset(0, 5000).End(xlToLeft).Offset(0, 2).Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
 :=False, Transpose:=False
Worksheets("Random").Activate
Worksheets("Random").Range("AJ18").Select
Selection.Copy
Sheets("ResultsG").Select
Range("A20").Offset(0, 5000).End(xlToLeft).Offset(0, 2).Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
 :=False, Transpose:=False
Worksheets("Random").Activate
Worksheets("Random").Range("AQ10:AQ29").Select
Selection.Copy
Sheets("ResultsG").Select
Range("B21").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
 :=False, Transpose:=False
Worksheets("Random").Activate
Worksheets("Random").Range("AV10:AV29").Select
Selection.Copy
Sheets("ResultsG").Select
Range("B41").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
 :=False, Transpose:=False
Sheets("Random").Select
Worksheets("Random").Activate

Worksheets("Random").Range("ba10:ba29").Select
    Selection.Copy
    Sheets("ResultsG").Select
    Range("B61").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
    Sheets("Random").Select
Worksheets("Random").Activate

Worksheets("Random").Range("bf10:bf29").Select
    Selection.Copy
    Sheets("ResultsG").Select
    Range("B81").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
    Sheets("Random").Select
Worksheets("Random").Activate

Worksheets("Random").Range("bk10:bk29").Select
    Selection.Copy
    Sheets("ResultsG").Select
    Range("B101").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
    Sheets("Random").Select
Worksheets("Random").Activate

Worksheets("Random").Range("CE3").Value = CRun

' start iterations IT = number of iterations programmed, ITC = number of iterations performed

Dim counteriterations As Integer
Dim IT As Integer
Dim ITC As Integer

IT = Worksheets("Random").Range("p3").Value
ITC = 1
For counteriterations = 1 To IT

'Write the actual iteration to CE4
Worksheets("Random").Range("CE4").Value = ITC

' Prepare table for meeting chance for each iteration
Dim CounterY As Integer
Dim CounterX As Integer
Dim C As Integer
Dim F As Integer

' For each person add chance on a meeting
Worksheets("MeetingChance").Activate
E = 0
For CounterY = 1 To D
    ' Add chances in X direction
    B = E
    C = (D - E - 1)
    For CounterX = 1 To C
        Worksheets("MeetingChance").Range("B10").Offset(E, B).Value = Rnd
        B = B + 1
    Next CounterX
    E = E + 1
Next CounterY

' Duplicate chances to lower part of table
E = 0
For CounterY = 1 To D
    B = E
    C = (D - E - 1)
    For CounterX = 1 To C
        Worksheets("MeetingChance").Range("B10").Offset(E, B).Copy Worksheets("MeetingChance").Range("a11").Offset(B, E)
        B = B + 1
    Next CounterX
    E = E + 1
Next CounterY
‘fill diagonal with 0
E = 0
For CounterY = 1 To D
    Worksheets("MeetingChance").Range("A10").Offset(E, E).Value = 0
    E = E + 1
Next CounterY

‘Influence per iteration

‘Target = CounterY F = counter for target
Worksheets("Random").Activate

F = 0

Dim CounterZ As Integer
Dim CounterQ As Integer

For CounterZ = 1 To D

‘Opinion target

‘opinion = OT (opinion target) and personal resistance = RT (resistance target)to change OC = Opinion counterpart
Dim OT As Integer
Dim OC As Integer
OT = Worksheets("Random").Range(”N10”).Offset(F, 0).Value
RT = Worksheets("Random").Range("F10").Offset(F, 0).Value

‘ChT = level of extroversion target
ChT = Worksheets("Random").Range("K10").Offset(F, 0).Value

‘counter for number of supportive interactions
CS = 0

‘counter for number of persuasive interactions
CP = 0

‘Influence of counterparts supportive and persuasive
SICP = 0
PICP = 0
'Counterpart = CounterX, C= counter for counterpart
C = 0

For CounterQ = 1 To D

'OC = opinion counterpart
OC = Worksheets("Random").Range("N10").Offset(C, 0).Value

'ChC = level of extroversion counterpart
ChC = Worksheets("Random").Range("K10").Offset(C, 0).Value

'determine chance on meeting

'ChM = chance on meeting
ChM = Worksheets("MeetingChance").Range("A10").Offset(C, F).Value

'Ch = total chance product of
Ch = ChT * ChC * ChM * 100

'Determine whether an interaction takes place or not. M =1 then chance is above one of the thresholds
Dim M As Integer
M = 0
'Primary group
If Worksheets("Random").Range("Q10").Offset(F, 0).Value = Worksheets("Random").Range("Q10").Offset(C, 0).Value And Worksheets("Random").Range("Q10").Offset(F, 0).Value > 0 Then
    If Ch > Worksheets("Random").Range("C3").Value Then M = 1
End If

'Group type A
If M = 0 Then
    If Worksheets("Random").Range("R10").Offset(F, 0).Value = Worksheets("Random").Range("R10").Offset(C, 0).Value And Worksheets("Random").Range("R10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("D3").Value Then M = 1
    End If
End If
'Group type B
If M = 0 Then
    If Worksheets("Random").Range("S10").Offset(F, 0).Value = Worksheets("Random").Range("S10").Offset(C, 0).Value And Worksheets("Random").Range("S10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("E3").Value Then M = 1
    End If
End If

'Group type C
If M = 0 Then
    If Worksheets("Random").Range("T10").Offset(F, 0).Value = Worksheets("Random").Range("T10").Offset(C, 0).Value And Worksheets("Random").Range("T10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("F3").Value Then M = 1
    End If
End If

'Group type D
If M = 0 Then
    If Worksheets("Random").Range("U10").Offset(F, 0).Value = Worksheets("Random").Range("U10").Offset(C, 0).Value And Worksheets("Random").Range("U10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("G3").Value Then M = 1
    End If
End If

'Department
If M = 0 Then
    If Worksheets("Random").Range("V10").Offset(F, 0).Value = Worksheets("Random").Range("V10").Offset(C, 0).Value And Worksheets("Random").Range("V10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("H3").Value Then M = 1
    End If
End If

'Division
If M = 0 Then
    If Worksheets("Random").Range("W10").Offset(F, 0).Value = Worksheets("Random").Range("W10").Offset(C, 0).Value And Worksheets("Random").Range("W10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("I3").Value Then M = 1
    End If
End If

' Group type B
If M = 0 Then
    If Worksheets("Random").Range("S10").Offset(F, 0).Value = Worksheets("Random").Range("S10").Offset(C, 0).Value And Worksheets("Random").Range("S10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("E3").Value Then M = 1
    End If
End If

' Group type C
If M = 0 Then
    If Worksheets("Random").Range("T10").Offset(F, 0).Value = Worksheets("Random").Range("T10").Offset(C, 0).Value And Worksheets("Random").Range("T10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("F3").Value Then M = 1
    End If
End If

' Group type D
If M = 0 Then
    If Worksheets("Random").Range("U10").Offset(F, 0).Value = Worksheets("Random").Range("U10").Offset(C, 0).Value And Worksheets("Random").Range("U10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("G3").Value Then M = 1
    End If
End If

'Department
If M = 0 Then
    If Worksheets("Random").Range("V10").Offset(F, 0).Value = Worksheets("Random").Range("V10").Offset(C, 0).Value And Worksheets("Random").Range("V10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("H3").Value Then M = 1
    End If
End If

'Division
If M = 0 Then
    If Worksheets("Random").Range("W10").Offset(F, 0).Value = Worksheets("Random").Range("W10").Offset(C, 0).Value And Worksheets("Random").Range("W10").Offset(F, 0).Value > 0 Then
        If Ch > Worksheets("Random").Range("I3").Value Then M = 1
    End If
End If
'Worksheets("Data2").Range("A1").Offset(F, C).Value = M

'Calculate factor target persuasion factor counterpart PFC

'Calculate distance = DIS with regard to conterpart
'First check whether people are in the same group DIS =1, department DIS =2 or
division DIS= 3 or else DIS = 4
Dim DIS As Integer
If (Worksheets("Random").Range("Q10").Offset(C, 0).Value > 0) And (Work-
sheets("Random").Range("Q10").Offset(F, 0).Value = Worksheets("Random").
Range("Q10").Offset(F, 0).Value) Then
    DIS = 1
Else
    If (Worksheets("Random").Range("R10").Offset(C, 0).Value > 0) And (Work-
sheets("Random").Range("R10").Offset(F, 0).Value = Worksheets("Random").
Range("R10").Offset(F, 0).Value) Then
        DIS = 1
    Else
        If (Worksheets("Random").Range("S10").Offset(C, 0).Value > 0) And (Work-
sheets("Random").Range("S10").Offset(F, 0).Value = Worksheets("Random").
Range("S10").Offset(F, 0).Value) Then
            DIS = 1
        Else
            If (Worksheets("Random").Range("T10").Offset(C, 0).Value > 0) And (Work-
sheets("Random").Range("T10").Offset(F, 0).Value = Worksheets("Random").
Range("T10").Offset(F, 0).Value) Then
                DIS = 1
            Else
                If (Worksheets("Random").Range("U10").Offset(C, 0).Value > 0) And
(Worksheets("Random").Range("U10").Offset(C, 0).Value = Worksheets("Random").
Range("U10").Offset(F, 0).Value) Then
                    DIS = 1
                Else
If (Worksheets("Random").Range("V10").Offset(C, 0).Value > 0) And (Worksheets("Random").Range("V10").Offset(C, 0).Value = Worksheets("Random").Range("V10").Offset(F, 0).Value) Then
    DIS = 2
Else
    If (Worksheets("Random").Range("W10").Offset(C, 0).Value > 0) And (Worksheets("Random").Range("W10").Offset(C, 0).Value = Worksheets("Random").Range("W10").Offset(F, 0).Value) Then
        DIS = 3
    Else
        DIS = 4
    End If
End If
End If
End If
End If
End If
End If
End If
End If
End If

' Calculate authority level in line
' Define values for level and line
NA = Worksheets("Random").Range("L10").Offset(F, 0).Value
LEVT = Worksheets("Random").Range("P10").Offset(F, 0).Value
LEVC = Worksheets("Random").Range("P10").Offset(C, 0).Value
DEPT = Worksheets("Random").Range("V10").Offset(F, 0).Value
DEPC = Worksheets("Random").Range("V10").Offset(C, 0).Value
GRPT = Worksheets("Random").Range("Q10").Offset(F, 0).Value
GRPC = Worksheets("Random").Range("Q10").Offset(C, 0).Value

AUTL = 1

If LEVT = 1 Then AUTL = Worksheets("Random").Range("B3").Value / 10
If LEVC = 1 Then AUTL = Worksheets("Random").Range("A3").Value * NA

If LEVT = 2 And DEPT = DEPC Then AUTL = Worksheets("Random").Range("B3").Value / 10
If LEVC = 2 And DEPT = DEPC Then AUTL = Worksheets("Random").Range("A3").Value * NA
If LEVT = 3 And GRPT = GRPC Then AUTL = Worksheets("Random").Range("B3").Value / 10
If LEVC = 3 And GRPT = GRPC Then AUTL = Worksheets("Random").Range("A3").Value * NA
'Worksheets("Data1").Range("A1").Offset(F, C).Value = AUTL

'calculate the influence factor of the counterpart and the total sum of persuasive and supportive forces

'IFC = influence counterpart, SICP = Supportive influences Counter parts (sum of supportive forces) Cs = counter number of supportive counter parts
OT = Worksheets("Random").Range("N10").Offset(F, 0).Value
If OT = OC Then
    IFC = ((Worksheets("Random").Range("D10").Offset(C, 0).Value) * AUTL * M) / (DIS * DIS)
    Else
    IFC = ((Worksheets("Random").Range("E10").Offset(C, 0).Value) * AUTL * M) / (DIS * DIS)
End If

'Worksheets("Data3").Range("A1").Offset(F, C).Value = IFC
If OT = OC Then
    CS = CS + M
    Else
    CP = CP + M
End If

'Is IFC Persuasive or supportive
If OT = OC Then
    SICP = SICP + IFC
    Else
    PICP = PICP + IFC
End If

'Worksheets("Data6").Range("A1").Offset(C, 1).Value = CP
'Worksheets("Data6").Range("A1").Offset(C, 2).Value = PICP
C = C + 1
Next CounterQ

'calculate the new opinion of target

'Worksheets("Data7").Range("A1").Offset(F, 1).Value = SICP
'Worksheets("Data7").Range("A1").Offset(F, 2).Value = PICP

'Add group comformity
If (Worksheets("Random").Range("N10").Offset(F, 0).Value) = 0 Then
    SICP = SICP + Worksheets("Random").Range("CC10").Offset(F, 0).Value + Worksheets("Random").Range("CH10").Offset(F, 0).Value
    PICP = PICP + Worksheets("Random").Range("CB10").Offset(F, 0).Value + Worksheets("Random").Range("CG10").Offset(F, 0).Value
End If

If (Worksheets("Random").Range("N10").Offset(F, 0).Value) = 1 Then
    SICP = SICP + Worksheets("Random").Range("CB10").Offset(F, 0).Value + Worksheets("Random").Range("CG10").Offset(F, 0).Value
    PICP = PICP + Worksheets("Random").Range("CC10").Offset(F, 0).Value + Worksheets("Random").Range("CH10").Offset(F, 0).Value
End If

'Calculate the resistance factor RF

'Calculate the increase in resistance per ittetration = IRF
IRF = ITC * Worksheets("Random").Range("S3").Value

'Calculate the new resistance factor for target
RF = RT + IRF
If RF > Worksheets("Random").Range("R3").Value Then

RF = Worksheets("Random").Range("R3").Value
End If

'Worksheets("Data7").Range("A1").Offset(F, 7).Value = RF

'Calculate the resistance using the initial opinion of the CEO
If (Worksheets("Random").Range("N10").Offset(F, 0).Value) = (Worksheets("Random").Range("B10").Value) Then
    RF = RF + Worksheets("Random").Range("K3").Value
Else
    RF = RF - Worksheets("Random").Range("K3").Value
End If

'Set borders for RF
If RF > Worksheets("Random").Range("R3").Value Then RF = Worksheets("Random").Range("R3").Value
If RF < Worksheets("Random").Range("T3").Value Then RF = Worksheets("Random").Range("T3").Value

'Worksheets("Data7").Range("A1").Offset(F, 8).Value = RF

'New opinion
IF CS > 0 THEN SUP = SICP * RF * (Sqr(CS)/ CS) ELSE SUP = SICP * RF
IF CP > 0 THEN PER = PICP * (Sqr(CP)/ CP) ELSE PER = PICP

Dim Change As Integer
Change = 0
If PER > SUP Then Change = 1

'Worksheets("Data7").Range("A1").Offset(F, 10).Value = PER
'Worksheets("Data7").Range("A1").Offset(F, 11).Value = SUP
'Worksheets("Data7").Range("A1").Offset(F, 12).Value = Change

Worksheets("Changes").Range("A1").Offset(F, 500).End(xlToLeft).Offset(0, 1).Value = Change
Worksheets("Random").Range("CE10").Offset(F, 0).Value = Change
Dim Opinion As Integer
Opinion = Worksheets("Random").Range("N10").Offset(F, 0).Value

'Worksheets("Data8").Range("A1").Offset(F, 10).Value = Opinion

If Change = 1 Then
    If Opinion = 0 Then
        Opinion = 1
    Else
        Opinion = 0
    End If
End If

Worksheets("Random").Range("N10").Offset(F, 0).Value = Opinion
'Worksheets("Data8").Range("A1").Offset(F, 11).Value = Opinion

F = F + 1

Next CounterZ

'Worksheets("Random").Range("n10:n511").Copy Worksheets("Opinions").Range("A1").Offset(0, 500).End(xlToLeft).Offset(0, 1)

'Write % of level 4 in favour of 0 to ResultsW
Worksheets("Random").Range("AI18").Select
    Selection.Copy
Sheets("ResultsW").Select
    Range("T1").Offset(5000, ITC).End(xlUp).Offset(1, 0).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
    :=False, Transpose:=False
Worksheets("Random").Activate

'Write number of changes to ResultsC
Worksheets("Random").Range("CE8").Select
    Selection.Copy
Sheets("ResultsC").Select
    Range("T1").Offset(5000, ITC).End(xlUp).Offset(1, 0).Select
    Selection.PasteSpecial Paste:=xlPasteValues, Operation:=xlNone, SkipBlanks _
:=False, Transpose:=False
Worksheets("Random").Activate

'Write opinions to opinion sheet used only for making a movie
'Worksheets("Random").Range("N10:N511").Copy Worksheets("Opinions").Range("B1").Offset(0, ITC)

ITC = ITC + 1
Worksheets("Random").Activate

Next counteriterations

'Write homogeneity groups to resultsG
Worksheets("Random").Range("AQ10:AQ29").Select
  Selection.Copy
  Sheets("ResultsG").Select
  Range("B21").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
Worksheets("Random").Activate

Worksheets("Random").Range("AV10:AV29").Select
  Selection.Copy
  Sheets("ResultsG").Select
  Range("B41").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
  Sheets("Random").Select
  Worksheets("Random").Activate

Worksheets("Random").Range("ba10:ba29").Select
  Selection.Copy
  Sheets("ResultsG").Select
  Range("B61").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
  Sheets("Random").Select
  Worksheets("Random").Activate

Worksheets("Random").Range("bf10:bf29").Select
CHAPTER 9

Selection.Copy
Sheets("ResultsG").Select
Range("B81").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
Sheets("Random").Select
Worksheets("Random").Activate

Worksheets("Random").Range("bk10:bk29").Select
    Selection.Copy
Sheets("ResultsG").Select
Range("B101").Offset(0, 5000).End(xlToLeft).Offset(0, 1).Select
Sheets("Random").Select
Worksheets("Random").Activate

CRun = CRun + 1

Next CounterR

End Sub
9.2 Excel data
Data to be filled in manually on tab “Random”:
1. A3; minimal level of Authority
2. A4; maximal level of Authority
3. B3; minimal level of influence subordinate on superior (not used; set on 1)
4. B4; maximal level of influence subordinate on superior (not used; set on 1)
5. C-G3; minimal threshold various ingroups (no differentiation used)
6. C-G4; maximal threshold various ingroups (no differentiation used)
7. H3; minimal threshold department
8. H4; maximal threshold department
9. I3; minimal threshold organization
10. I4; maximal threshold organization
11. J3; minimal threshold company (not used)
12. J4; maximal threshold company (not used)
13. K3; minimal level of Organizational persuasion
14. K4; maximal level of Organizational persuasion
15. L3; minimal level of group conformity
16. L4; maximal level of group conformity
17. M3; minimal level of conformity to organization (not used)
18. M4; maximal level of conformity to organization (not used)
19. P3; number of iterations
20. Q3; number of runs
21. R3; maximal resistance
22. S3; increase in resistance at every iteration
23. T3; minimal resistance
24. A10 to A onwards; agents in the simulation
25. P10 to A onwards; hierarchy level of the agent
26. Q10 to A onwards; ingroup number
27. R10 to A onwards; second ingroup number
28. S-U10 to A onwards; other ingroup numbers (not used)
29. V10 to A onwards; Department number
30. W10 to A onwards; organization number (similar for all agents)
31. X6; maximal level of personal salience for the primary ingroup
32. X7; minimal level of personal salience for the primary ingroup
33. Y6; maximal level of personal salience for the secondary ingroup
34. Y7; minimal level of personal salience for the secondary ingroup
The following data were generated in the Random tab by Excel:

1. Calculation of the distribution of attitudes per hierarchical level; 1=CEO, 2=departmental heads, 3=group leaders, 4=workers.
   a. AF10, N total level 1; =AANTAL.ALS(P10:P510;1)
   b. AF11, N attitude 0 level 1; =AANTALLEN.ALS($N10:$N510;0;$P10:$P510;1)
   c. AF11, N attitude 1 level 1; =AANTALLEN.ALS($N10:$N510;1;$P10:$P510;1)
   d. AF15, % attitude 0 level 1; =ALS(AF11=0;0;((AF11/AF$10)*100))
   e. AF16, % attitude 1 level 1; =ALS(AF12=0;0;((AF12/AF$10)*100))
   f. AF18, % attitude 0 level 1; =AF15
   g. AG10, N total level 2; =AANTAL.ALS(P10:P510;2)
   h. AG11, N attitude 0 level 2; =AANTALLEN.ALS($N10:$N510;0;$P10:$P510;2)
   i. AG11, N attitude 1 level 2; =AANTALLEN.ALS($N10:$N510;1;$P10:$P510;2)
   j. AG15, % attitude 0 level 2; =ALS(AF11=0;0;((AF11/AF$10)*100))
   k. AG16, % attitude 1 level 2; =ALS(AF12=0;0;((AF12/AF$10)*100))
   l. AG18, % attitude 0 level 2; =AG15
   m. AH10, N total level 3; =AANTAL.ALS(P10:P510;3)
   n. AH11, N attitude 0 level 3; =AANTALLEN.ALS($N10:$N510;0;$P10:$P510;3)
   o. AH11, N attitude 1 level 3; =AANTALLEN.ALS($N10:$N510;1;$P10:$P510;3)
   p. AH15, % attitude 0 level 3; =ALS(AF11=0;0;((AF11/AF$10)*100))
   q. AH16, % attitude 1 level 3; =ALS(AF12=0;0;((AF12/AF$10)*100))
   r. AH18, % attitude 0 level 3; =AH15
   s. AI10, N total level 4; =AANTAL.ALS(P10:P510;4)
   t. AI11, N attitude 0 level 4; =AANTALLEN.ALS($N10:$N510;0;$P10:$P510;4)
   u. AI11, N attitude 1 level 4; =AANTALLEN.ALS($N10:$N510;1;$P10:$P510;4)
   v. AI15, % attitude 0 level 4; =ALS(AF11=0;0;((AF11/AF$10)*100))
   w. AI16, % attitude 1 level 4; =ALS(AF12=0;0;((AF12/AF$10)*100))
   x. AI18, % attitude 0 level 4; =AI15

2. Calculation of the influence per person for group conformity
   a. AM10 to end, personal persuasion*communication index; =ALS(P10=0;0;(E10/P10))

3. Calculation of the conformity strength for attitude 1 and 0 of the primary group
   a. AO10 to 29, Sum persuasion for attitude 1 per primary group; =SOMMEN.ALS($AMS$10:$AMS$511;$Q$10:$Q$511;1;$NS$10:$NS$511;1)
   b. AO10 to 29, Sum persuasion for attitude 0 per primary group; =SOMMEN.ALS($AMS$10:$AMS$511;$Q$10:$Q$511;1;$NS$10:$NS$511;0)
   c. AQ10 to 29, Factor persuasion for attitude 1 per primary group;
=ALS(AO10>0;(AO10/(AO10+AP10));0)
d. AR10 to 29, Factor persuasion for attitude 0 per primary group;
=CLS(AP10>0;(AP10/(AO10+AP10));0)

4. Calculation of the conformity strength for attitude 1 and 0 of the secondary
group
a. AT10 to 29, Sum persuasion for attitude 1 per secondary group; =SOMMEN.ALS($AM$10:$AM$511;$R$10:$R$511;1;$N$10:$N$511;1)
b. AU10 to 29, Sum persuasion for attitude 0 per secondary group; =SOMMEN.ALS($AM$10:$AM$511;$R$10:$R$511;1;$N$10:$N$511;0)
c. AV10 to 29, Factor persuasion for attitude 1 per secondary group;
=ALS(AT10>0;(AT10/(AT10+AU10));0)
d. AW10 to 29, Factor persuasion for attitude 0 per secondary group;
=ALS(AU10>0;(AU10/(AT10+AU10));0)

5. Calculation of the conformity strength for attitude 1 and 0 per individual
a. BO10 to end, conformity agent j to attitude 1 from primary group; 
=ALS(Q10=1;AQ$10;ALS(Q10=2;AQ$11;ALS(Q10=3;AQ$12;ALS(Q10=4;AQ$13;ALS(Q10=5;AQ$14;ALS(Q10=6;AQ$15;ALS(Q10=7;AQ$16;ALS(Q10=8;AQ$17;ALS(Q10=9;AQ$18;ALS(Q10=10;AQ$19;ALS(Q10=11;AQ$20;ALS(Q10=12;AQ$21;ALS(Q10=13;AQ$22;ALS(Q10=14;AQ$23;ALS(Q10=15;AQ$24;ALS(Q10=16;AQ$25;ALS(Q10=17;AQ$26;ALS(Q10=18;AQ$27;ALS(Q10=19;AQ$28;AQ$29))))))))))))))*X10*$L$3
b. BP10 to end, conformity agent j to attitude 0 from primary group; 
=ALS(Q10=1;AR$10;ALS(Q10=2;AR$11;ALS(Q10=3;AR$12;ALS(Q10=4;AR$13;ALS(Q10=5;AR$14;ALS(Q10=6;AR$15;ALS(Q10=7;AR$16;ALS(Q10=8;AR$17;ALS(Q10=9;AR$18;ALS(Q10=10;AR$19;ALS(Q10=11;AR$20;ALS(Q10=12;AR$21;ALS(Q10=13;AR$22;ALS(Q10=14;AR$23;ALS(Q10=15;AR$24;ALS(Q10=16;AR$25;ALS(Q10=17;AR$26;ALS(Q10=18;AR$27;ALS(Q10=19;AR$28;AR$29)))))))))))))))*X10*$L$3
c. BQ10 to end, conformity agent j to attitude 1 from secondary group; 
=ALS(R10=1;AV$10;ALS(R10=2;AV$11;ALS(R10=3;AV$12;ALS(R10=4;AV$13;ALS(R10=5;AV$14;ALS(R10=6;AV$15;ALS(R10=7;AV$16;ALS(R10=8;AV$17;ALS(R10=9;AV$18;ALS(R10=10;AV$19;ALS(R10=11;AV$20;ALS(R10=12;AV$21;ALS(R10=13;AV$22;ALS(R10=14;AV$23;ALS(R10=15;AV$24;ALS(R10=16;AV$25;ALS(R10=17;AV$26;ALS(R10=18;AV$27;ALS(R10=19;AV$28;AV$29)))))))))))))))))*Y10*$L$3
d. BR10 to end, conformity agent j to attitude 0 from secondary group; 
=ALS(R10=1;AW$10;ALS(R10=2;AW$11;ALS(R10=3;AW$12;ALS(R10=4;AW$13;ALS(R10=5;AW$14;ALS(R10=6;AW$15;ALS(R10=7;AW$16;ALS(R10=8;AW$17;ALS(R10=9;AW$18;ALS(R10=10;AW$19;ALS(R10=11;AW$20;ALS(R10=12;AW$21;ALS(R10=13;AW$22;ALS(R10=14;AW$23;ALS(R10=15;AW$24;ALS(R10=16;AW$25;ALS(R10=17;AW$26;ALS(R10=18;AW$27;ALS(R10=19;AW$28;AW$29)))))))))))))))*Y10*$L$3
e. $BY_{10}$ to end, sum of conformity for agent $j$ for attitude 1 based on ingroups;  
   $=ALS(CA_{10}=0;0;(SOM(BO_{10};BQ_{10};BS_{10};BU_{10};BW_{10})))$

f. $BY_{10}$ to end, sum of conformity for agent $j$ for attitude 1 based on ingroups;  
   $=ALS(CA_{10}=0;0;(SOM(BP_{10};BR_{10};BT_{10};BV_{10};BX_{10})))$

g. $CA_{10}$ to end, calculation of the number of groups agent $j$ belongs to;  
   $=5-(AANTAL.ALS(Q_{10}:U_{10};0))$

h. $CB_{10}$ to end, conformity experienced by agent 1 for attitude 1 corrected for the 
   number of groups;  
   $=(ALS(CA_{10}=0;0;(BY_{10}/CA_{10}))$

i. $CC_{10}$ to end, conformity experienced by agent 1 for attitude 0 corrected for 
   the number of groups;  
   $=(ALS(CA_{10}=0;0;(BZ_{10}/CA_{10}))$
10 References


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CHAPTER 10


CHAPTER 10


11

Dankwoord
CHAPTER 11
11 Dankwoord

En dan is het zover, de leescommissie is akkoord en het is tijd om terug te kijken. Dat hier een boekje ligt is zeker niet alleen de verdienste van de promovendus, zonder de hulp van anderen was dit niet geworden wat het nu is.

Op de eerste plaats zijn daar natuurlijk mijn begeleiders die mij in de afgelopen jaren hebben ondersteund. Peter van den Besselaar, jij was slechts kort onderdeel van het team, je overzag het complete plaatje en stelde de fundamentele vragen. Ik weet bijna zeker dat een paar van deze vragen terug zullen komen tijdens de verdediging.

Peter Groenewegen, jij was mijn promotor, degene die de potentie zag in mijn onderzoeksvoorstel en mij de kans gaf om dit verder te exploreren. Als ik het eerste concept artikel bekijk dat ik in de voorgesprekken aan je heb gegeven en dit vergelijk met wat er nu voor ons ligt, dan heb je me toen veel vertrouwen gegeven want dat eerste stukje was beslist geen hoogstandje. Jij hebt als een echte promotor het einddoel altijd in zicht gehouden. Jij stippelde de grote lijnen uit en zette ons weer op het spoor wanneer we teveel in detail verzanden. Verder ben je ook de man van de geweldige volzinnen, deze kwamen moeiteloos uit je pen.

Dick de Gilder, jij was de constante factor die met een kritische vasthoudendheid bleef corrigeren. Voor mij ben jij de ideale leraar. Minutieus ging je door mijn teksten heen om de laatste denkfouten, inconsistenties en grammatica te corrigeren. Ik ben zeer dankbaar voor je begeleiding en alle uren die je hierin hebt gestoken. Wat mij altijd bij zal blijven is als je tijdens onze discussies op een punt kwam dat je introduceerde met hmmmm...... Je kon er dan op rekenen dat je een inconsistentie had ontdekt die niet overeenkwam met voorafgaande observaties of de literatuur. Met al deze hmmmm’s heb jij dit onderzoek naar een hoger niveau getild.

Ook wil het Radboudumc en in het bijzonder de afdelingen waar ik de afgelopen periode als manager heb gewerkt bedanken voor de studie-uren die ik hieraan mocht besteden. Met dit onderzoek heb ik de mogelijkheid gehad om me verder te verdiepen in de groepsdynamiek waardoor ik mij als manager verder heb kunnen ontwikkelen.

Als laatste wil ik mijn vrouw Josephine bedanken, de stille kracht die altijd achter mij staat.
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Curriculum Vitae
CHAPTER 12
12 Curriculum Vitae

Peter van Woensel is op 6 september 1959 geboren te Kaatsheuvel, als snel verhuisde het gezin van Woensel naar Breda waar hij het basis- en voortgezet onderwijs volgde. Tijdens het voortgezet onderwijs besloot hij naar het Korps Mariniers te gaan en heeft daar zes jaar doorgebracht. Na de basistraining tot marinier ging hij naar de vervolgopleiding tot ziekenverpleger en werd daarna bij het moderne vijfkamp team van het korps mariniers geplaatst. Dit was de rode draad door de periode bij de mariniers die werd onderbroken door een artic- en bergtraining, onderofficier opleiding en een plaatsing op de Hr.Ms. Zuiderkruis. Als lid van de nationale ploeg voor moderne vijfkamp heeft hij tweemaal deelgenomen aan de wereldkampioenschappen moderne vijfkamp.

Na de fysieke uitdaging van het Korps Mariniers was het tijd voor een intellectuele uitdaging. Het VWO werd gehaald waarna hij Moleculaire Wetenschappen ging studeren aan de Landbouw Universiteit in Wageningen. Hier studeerde hij in 1988 cum laude af met als hoofdvakken moleculaire biologie en moleculaire fysica.

Tijdens zijn eerste baan bij het Centraal Diergeneeskundig Instituut (CDI) in Lelystad begon hij zijn research carrière. Achter de gesloten barrières van het CDI onderzocht hij de invloed van endogene retrovirussen in kippen op een infectie met een verwant exogeen retrovirus dit in combinatie met een praktijkvraag waarom het maar niet lukte een commerciële toom kippen leukosevirus vrij te maken. Na anderhalf jaar kon hij aantonen dat endogene virussen geen invloed hadden op een infectie met een verwant exogeen virus. Tevens bleek dat de positieve toom kippen het gevolg was van een vals-positieve test.

Na deze periode ging hij aan de slag als moleculair bioloog bij Intervet. De eerste opdracht was opzetten van de PCR techniek en daarna werd hij al snel projectleider virologie en werd hij de expert op varkens en paarden vaccins. De voornaamste producten die hij hier ontwikkelde waren het Porcilis PRRSV, een vaccin tegen het Porcine Reproductive and Respiratory Syndrome virus en het Porcilis PCV een vaccin tegen het Porcine Circo Virus.

In 2000 werd hij als research coördinator op het hoofdkantoor van AKZO-Nobel aangesteld. In deze rol adviseerde hij de raad van bestuur over technische en maatschappelijke ontwikkelingen in de farmaceutische sector en de ontwikkelingen bij concurrerende bedrijven. In deze periode is zijn interesse ontstaan voor bedrijfsprocessen en management en is hij begonnen aan zijn tweede master, Strategy and Organization. Drie jaar later is hij teruggekeerd naar Intervet als afdelingshoofd virologische research.
Toen hij in 2008 heeft zijn master Strategy and Organization had afgerond heeft hij de overstap gemaakt naar het Radboudumc, waar hij als manager bij de afdelingen Celbiologie, Biochemie, CMBI en Tumor Immunologie is gaan werken. Drie jaar later is hij in eenzelfde functie bij afdeling Genetica begonnen. Aan afdeling Genetica is na enige tijd afdeling Tumor Immunologie weer toegevoegd en onlangs is ook de afdeling Pathologie toegevoegd aan zijn portfolio. In deze functie op deze afdelingen wordt zijn achtergrond life sciences gecombineerd met management wetenschappen.
Publicaties


UITNODIGING
Voor het bijwonen van
de openbare verdediging
van het proefschrift
ATTITUDE FORMATION IN ORGANIZATIONS; THE GHOST IN THE MACHINE
op vrijdag 7 september 2018
om 11.45 uur precies
in de aula van de universiteit,
De Boelelaan 1105 te Amsterdam
Receptie ter plaatse na afloop
Peter van Woensel
peter.vanwoensel@gmail.com