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Emergence and Creativity

Creative Solutions to Governing Emergent Order in Complex Social Systems

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1. Introduction

Why is a roundabout more effective than a crossroad with traffic lights? Essentially, the difference is in the way we govern emergent order in these systems. Traffic lights are an example of how a complex problem is solved by a management solution that is both centralised and highly sophisticated. And yet, after implementation of all this sophistication, we still find ourselves waiting before a red traffic light while there is no other traffic in sight. A much more simple solution to this complex problem is a roundabout: a plain repetitive rule – in this case left-hand priority - ensures an effective traffic throughput.
In this article we will argue that similar issues arise in many complex social systems. How to organise the health care system? How to reduce packaging waste in supply chains? How to improve on traffic safety? Different as they may be, all these issues share a central question: ‘How can complex social systems be governed so as to show meaningful and purposeful behaviour?’

Traditionally we have been inclined to solve complex problems by improving the system’s central management and predictive power. Here, our reasoning is that this is a dead-end road. The self-evident alternative - leaving the system to itself - is equally flawed as this will lead to chaos, and the corresponding price to be paid is socially unacceptable. Yet, the roundabout example clearly shows that this kind of problem can be solved.
The question now is what principles underlie these solutions and how they can be applied to govern complex systems. On the basis of some examples of complex social systems we will demonstrate that creative and often counter-intuitive solutions are necessary in order to govern these systems toward meaningful and purposeful behaviour. This article stimulates a different approach in the governance of complex social system than we are traditionally inclined to take. It will not focus on ready-made solutions, but will try to indicate directions of possible solutions by means of real-world examples.

The structure of this article is as follows. Paragraph two focuses on the growing complexity of regulations and management in complex social systems. In paragraph three, some illustrations are given of simple interactive systems: roundabouts plus zipping on highways. Paragraph four briefly sketches the theoretical framework underlying the principles of emergence and governance of complex systems. Paragraph five offers a collection of examples from different social systems, such as finance, packaging in supply chains, sound pollution around a major airport and traffic, in which principles of emergent order have been successfully applied. The examples illustrate the creative solutions that have been found or are proposed to govern these systems towards meaningful and purposeful behaviour. In paragraph six we apply the principles of emergence to examples in health care, consumer privacy, air traffic and safety issues in an attempt to arrive at equally creative solutions.

2. The complexity of regulation

2.1 Increasing complexity

In a simple world most situations can be easily managed through a set of simple rules. The exceptions are few, the rule set can remain comparatively simple, and should new situations occur we simply adjust the rule set. The basic idea is that everything can be managed by rules, and that the rule set increases with the growing complexity of reality. Yet, by feeding sufficient energy into maintaining the rules we can retain control of the system behaviour.

However, in many fields the world is becoming increasingly complex. Now different systems, each with their own rule set, interact with each other. This means that these rule sets have to be connected, which exponentially increases their complexity. Also, the world changes at a pace much faster than with which we can adjust our rule sets. In the Netherlands changes in regulations cannot keep up with the pace of societal developments, which has rendered existing regulations simply inadequate. This problem has initially been solved by an increased tolerance towards rule violation. In some instances however, this policy of tolerance may produce severe problems and the resulting tragic incidents are known only too well. Often, after such incidents there is a call for a return to the old rules that we all know are too rigid, but at least seem to provide some feeling of security. On further consideration it often turns out that they have become so complex to be self-contradictory: what is mandatory under one rule, is forbidden under the other. We therefore have to conclude that the world’s growing complexity can no longer be captured in centrally imposed rule systems.

2.2 The autonomy of agents

Let’s take a look at our traffic and transport systems, for instance. Both the affluence and well-being of Western civilisation are closely linked to the freedom, openness and speed of traffic of people, goods and information. Security of the corresponding traffic and transport systems is no goal in itself, it is a condition if the agents within the system are to act freely. Should rules and regulations limit this freedom of action, the means have become more important than the goal. To the agents within the system - and therefore also for the system as a whole - this is unacceptable. Rather, the system has to ensure freedom and autonomy for the agents, under conditions of assured safety. Besides, the cost of this safety assurance should not outweigh the system's value creation.

Yet, it is exactly this freedom and this autonomy of agents that determines the vulnerability of traffic and transport systems. There are the risks of abuse and opportunism, safety risks, and the risks of unforeseen system behaviour such as delays and traffic jams. Besides, traffic and transport systems are increasingly becoming interconnected. Complexity theory has shown that increasing systems connectivity will lead to chaotic systems behaviour. This adds additional pressure to the management of these systems, since a change in one of the (sub)systems leads to reactions in other (sub)systems. Delays are a good example: road traffic jams make it more difficult for agents to catch their air traffic connection.

2.3 Non-linear dynamic behaviour

There is an increasing interaction between agents within the different traffic and transport systems, as agents - naturally - do not stay within the boundaries of one system. These interactions are usually fully unpredictable, at least at the individual agent level. While in theory the statistical 'law of large numbers' makes system behaviour more predictable, in practice statistics will yield only an average outcome that may be correct for the group as a whole. However, since agents are moving freely, it will be expressly wrong for any individual agent. It is not possible to determine the ideal speed on the roads by summing all separate cases and then averaging the outcome. That way, the speed in a town and on the highway would be the same, which of course is a ridiculous idea. And yet, many of our real-world regulation systems are precisely based on this idea, albeit in more refined models. But always the starting point is a static, predictable world.

How different reality is. Agents act in ways that are relevant to them at a certain moment, usually within the framework of what is permitted by rules and social habits. Research in traffic management has shown that on a crowded road a lower speed would result in a better throughput. Every driver, however, is continuously busy determining the speed of his own car, making use of the moment-specific possibilities of the road system. This causes non-linear dynamic behaviour that leads to traffic jams and delays, although every agent properly adheres to the rules. Apparently, non-linear dynamic systems behaviour cannot be managed through linear, static rule sets. What is more, these static rule sets may become the very cause of system congestion. When a system’s speed of change exceeds the adaptive power of the rule set, the system will almost by default become congested and will eventually break down completely.

2.4 The end of management

Many social systems are on the verge of such a breakdown. Our reasoning is that the rules that have to assure the proper function of these systems often contribute to their malfunctioning. This reasoning consists of three steps. First, as mentioned before, systems and their environment are becoming increasingly complex, to the extent that even smaller subsystems cannot be described easily and unambiguously. Secondly, even if an adequate description would be possible, there is the difficulty of unambiguously translating this description into rules and regulations. And finally, even if these could be formulated, the difficulties of maintaining these rules and regulations would be insurmountable.

The recognition of this often plunges individual agents as well as the governing body (often central government) into feelings of impotence and vulnerability. Individual agents are limited in their desired freedom by the system rules. At the same time, most agents find it socially unacceptable to dodge or break them. Oddly enough, the same goes for the regulating authority itself. It has to witness how its carefully composed rule structure increasingly causes the system to jam and to break down. This malfunctioning is imputed to this same authority. The only way out seems to be adding more and more rules, in order for the rule structure to cope with every eventuality of malfunction. Many regulating authorities, however, have by now discovered that adding more rules eventually means a dead end. Often the energy necessary to maintain the rules already exceeds the total system energy (e.g., economic value creation). The relation between regulating energy and solution energy has got out of hand completely.

The conclusion is obvious: many social systems (e.g., traffic and transport systems) can no longer be managed through a centrally imposed regulation. Solving this kind of problem requires exploration in a radically different direction.

3. Examples of simple interactive systems

3.1 The roundabout

A good example of a simple system that continuously adapts to complex situations is the roundabout, as mentioned in paragraph 1. On a crossroad with traffic lights the traffic flow is managed by the colour of the lights: red signals stop, green signals go. In-depth study of traffic flows across the crossroad is needed to enable programming of the lights. On crowded crossroads, the traffic lights are combined with smaller lights for pedestrians and cyclists and with special lanes for cornering traffic. Even more complex solutions are possible that include detection loops for cars and control buttons for cyclists and pedestrians. In short, traffic lights are a small miracle of information processing and central management. And yet, at three o'clock at night with no other traffic in sight we may find ourselves waiting before a red traffic light.

How different the situation is on a roundabout. Away with lights, away with control buttons and detection loops, away with computerised information systems. One simple repetitive rule - left-hand priority - does the job! Mind you: if traffic drives on the right, right-hand priority won’t work because this will congest the roundabout. On a roundabout traffic flows considerably smoother than on a crossroad with traffic lights. This has been determined by computer simulation (see figure 1), but can also be easily seen in practice. Safety is substantially improved as well. While on the crossroad the driver assumes security is assured by the system (the traffic lights), on the roundabout security is 'built into' the interaction between the agents.

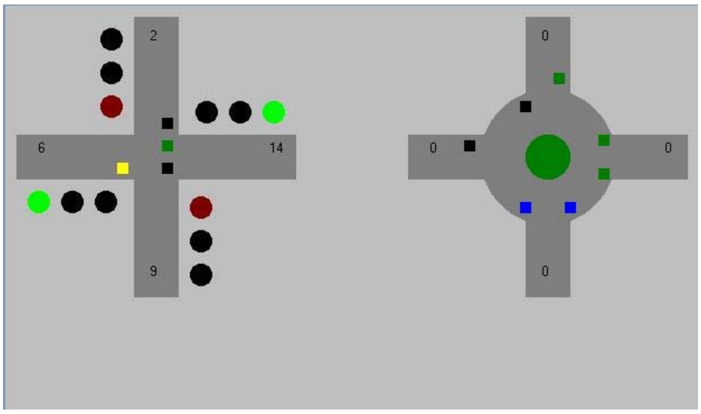

Figure 1: Crossroad versus Roundabout Simulation (the digits on the roads indicate the number of cars waiting)

A crossroad differs from a roundabout in the way we govern the interaction process between the agents. In case of a crossroad we keep adding management complexity, in an attempt to make a solution that is in itself inferior, cope with increasing heterogeneity and unpredictability of traffic flows. This means that the solution complexity dictates the needed complexity of the rule set. In case of a roundabout, complexity is captured in the process itself. It uses both the knowledge and ability of individual drivers: the user has become the boss. Because of the continuous interaction, the total process complexity is built up from a large number of very simple interactive processes. In other words: complexity appears as repetitive simplicity.

Such a roundabout system does not, however, emerge by itself. Although it had been used in the U.K. for many years, applications on the continent had always been very limited. With hindsight it is easy to see why, but arriving at the roundabout solution apparently is no self-evident process. Imagine a situation in which we are unfamiliar with the concept of a roundabout. Now someone might come up with the idea of substituting a conventional crossroad with the configuration of a roundabout. The effects will be predictable: drivers who want to turn left will take the shortest route, taking one quarter of the roundabout instead of three quarters. Furthermore, the existing traffic rule of right-hand priority will be maintained, causing congestion on the roundabout. The first effect we ruled out from the beginning by establishing the traffic rule of taking the roundabout counter clockwise. The second effect however, made us see roundabouts as an inferior solution for many years. The problem turned out to be one of governance: ever since we changed the priority rule - the roundabout now has left-hand priority - the roundabout solution has been working perfectly.

3.2 Zipping on highways

Another well-known problem is 'zipping' when highway lanes merge. In the Netherlands the results are disappointing, despite widespread publicity that explains the procedure. By contrast, in Germany zipping works well. The reason for this difference lies in the discipline Dutch and German drivers have. In the Netherlands, if a driver allows someone else to join the traffic stream, this generally results in more drivers slipping in in front of him. In Germany however, an offending driver who does not obey the rules of zipping is treated to a hooting concert, which ensures that he will behave next time. Good behaviour is rewarded with a better traffic flow for all.

In the Netherlands, posting waving policemen, placing traffic signs and national television campaigns have all been to no avail. Instruction, command and mass communication apparently do not work. The only remaining option is a better channelling of the traffic flows by changing the road configuration, as has been done with roundabouts. A radical option would be to place a fence at every access road, which has an opening that allows only one driver to pass at a time. This forces drivers in different lanes to merge through zipping. This way road configuration forces the direction of the drivers' energy. When drivers have adjusted their behaviour, the fences may be removed. The problem has become a governance problem that can only be solved by changing the interaction rules between the agents.

4. Theoretical framework

4.1 Emergent solutions

How do we make it possible for systems to arise that possess the desired behavioural characteristics and show emergent order? Emergent in the sense that ordered behaviour comes about by itself instead of being centrally imposed. An important lesson from past attempts at self-organising systems is that ‘it's not going to be all right by itself’. That is to say, if we just abolish existing central procedural regulations, a new adequate order will not emerge on its own, anyway not fast enough, not good enough, or only at a price that is simply too high. Now it can be argued that, should we leave traffic and transport systems to themselves, some form of safety behaviour will emerge. Yet this will not necessarily - worse: not even probably - be the safety behaviour that is socially desirable. The system behaviour could result in minimisation of social cost, with every agent being forced to bear all safety risks of his actions himself. Such a result would clearly be unacceptable in our society. Conceivably a catastrophe could force system behaviour into a more desirable direction, but such a catastrophe would be the social price to pay, and this seems equally undesirable.

Therefore, some form of guidance seems necessary. As mentioned before, since we know that central, hierarchical management is unfit for the job, this guidance will have to be of a radically different nature. For this type of guidance we use the term 'governance'. In traditional management thinking systems are changed first by ensuring system *stability* (e.g., by creating structures, teams or task forces), then formulating the desired system *direction* (e.g., making strategic plans), and finally trying to mobilise *energy* within the system to implement those plans. Governance of complex systems inverses this sequence: start building from the *energy* available within the system (i.e., agents who *want* something), then selectively give a *direction* to this energy without obstructing it, and finally make sure that the volatility of the system behaviour does not produce undesired results (*stability*).

4.2 Energy

Agent energy to realise a goal arises from the combination of know-how, ability and motivation. Many centrally managed systems try to mobilise agent energy in order to implement centrally planned strategic directions. While central management normally facilitates know-how and ability for the agents, the motivation aspect, which represents both the interests and motives of agents, is often neglected. When agents lack the inherent motivation to actually ‘do something’ (change, move), central management can only rely on money, power and enforced procedures to make the agents act. In this case the energy flows from central management level to local agent level. This management method becomes less and less effective as the power base of central management declines (e.g., when agents can easily leave the system) and the existing rules and procedures no longer represent the increasing complexity of the system and its environment.

The key to getting complex systems in motion is therefore in the governance of energy flows, especially as related to the aspect of agent motivation. The point is not to have more energy flow in from the central level, but to identify local agent energy (motivation) and to catalyse this energy by adding know-how and ability where necessary. In other words: energy has to flow from the agent level to the system level, not the other way round.

4.3 Direction

Once there is a basis of energy, the next question is what direction this energy has. Without direction, energy at agent level does not automatically lead to energy at system level, because in case of opposite energy flows they may cancel each other out. This can be observed in systems without any form of governance: they produce much ‘friction heat’, but little productive output. Therefore a common compass or common goal – to be defined by the system governor - is needed to direct energy in a productive way. With the help of such a compass the system can be guided into the desired direction, not by enforcing it upon all agents, but by selectively encouraging initiatives that produce the desired behaviour. The system goal should not be levelled or averaged over all agents; instead, diverging goals of different groups of agents should be simultaneously improved. System goals will therefore always be composed of multiple, antagonistic dimensions. However, realisation of one interest at the cost of another produces a non-zero sum game. Therefore, improvement in system performance can only be reached if one dimension is improved while the others are kept constant, or if multiple dimensions are improved simultaneously. In other words: only a non-zero sum game represents system improvement. Therefore, identifying the different antagonistic dimensions that constitute system performance is a crucial task of system governance.

4.4 Stability

Once a system has direction, the final question is how to realise stability within the system. Stability is related to exploitation behaviour, in that successful solutions attained at one location must be easily transferable throughout the system for effective application at other locations. This demands codification and self-organising transmission of best practices. In this respect system success is related to the degrees of its connectivity and concentration. Connectivity is a measure for the internal connectedness of the system, i.e. the density of relations between the agents. Concentration is a measure for the extent of system centralisation, in other words: whether multiple relations come together in one agent or in a few agents. Within a certain bandwidth of connectivity and concentration, the system will show a healthy level of dynamics. Our current capitalist financial system is a good example. While being quite volatile, it is capable of responding fairly smoothly to big economic shocks. However, experiments have shown that small deviations from the optimal volatility bandwidth can cause so-called phase transitions in the system behaviour. These might result in system states that are either too chaotic or too rigid. In the case of both high connectivity and low concentration avalanche-like motions can cause undesirable behaviour that spreads widely throughout the system. Conversely, the system can degrade to a state with low connectivity and high concentration. Such a state is known as hierarchy or bureaucracy, in which the diffusion of successful solutions is far too slow to keep up with the changing environment. Balancing connectivity and concentration to ensure smooth proliferation of knowledge is therefore an essential element of system governance.

4.5 Governance

Our conclusion is that *governance of energy, direction and stability* is an essential condition if meaningful and purposeful order is to emerge in complex social systems. A prerequisite is that the governance body is no party in the system itself. It is not an agent in the system, in the sense that it has no interest of its own; it represents the system interest. This also means that the governance body must be legitimised by the system. In many social systems therefore the government seems to be the proper party to play the governance role. This is no easy task. If the system functions smoothly, a laissez-faire policy is an attractive option for both the agents and the system governor. Should it collapse, both agents and governors are inclined to return to old-fashioned management and control. System governance maintains a constant balance between these two extremes. This requires not only courage (maintaining governance principles, also in hard times), but also creative solutions.

4.6 Translation into practice

In many fields the traditional belief that the system can be guided through central management, procedures and regulations is under increasing pressure. In recent years similar issues have developed in the fields of health care, environmental care, education, traffic and transport, and social security. Outside the public sector, organisations and companies also increasingly face situations in which the conventional steering power of management proves insufficient as a basis for self-ordering adaptive business processes. This is often related to a growing individualisation in their markets, which causes a rising heterogeneity and a lower predictability of demand, as well as to the globalisation of networks and markets in which these companies operate. The next two paragraphs present some creative solutions in a variety of social settings. In paragraph five, we focus on initiatives that have successfully been implemented, in paragraph six we present a number of conceptual proposals.

5. Successful creative solutions in complex social systems

5.1 Fraud with credit cards

One of the most telling examples of how principles of emergent order work is the way fraud with credit cards or electronic pay cards is treated in the financial sector. When a customer finds that fraud has been committed with one of his credit cards, it would be logical - based on normal judicial practice – to make this fraud his own responsibility, unless he can indisputably prove that it was caused through negligence or fault of the financial institution involved. In principle however, he would have to reclaim the damage from the perpetrator.
A long time ago however, the government and the financial institutions agreed that for the individual customer this is impracticable. Now in principle the financial institutions assume full responsibility and accept the damage, unless they can prove beyond dispute that the fraud was caused through negligence or fault of the customer. In fact, what has happened is that the burden of proof has been reversed for fraud with credit cards.

Originally the agreement was meant to protect powerless consumers against large financial institutions. What is more interesting however, is the effect this reversed burden of proof has on the behaviour of these institutions. As soon as a possible fraud situation is detected, alarm procedures within the financial institution are set in motion. After all, one incident could be the omen of systematic fraud on a much larger scale, and could indicate a leak in the financial system. Therefore all energy is mobilized to find the cause as soon as possible and to stop a possible leak. This way, the threat of an avalanche of fraud reports requires the institution to adjust the safety of the financial payment system continuously to changes in the environment. The role of the government in this process is being minimised: no checks, controls or punishments are necessary. After all, it is in the very self-interest of financial institutions to ensure minimal collateral damage. From this perspective, relieving the individual customer from the heavy burden of proof and recovery is only a by-effect. In fact, on the basis of this agreement, the individual customer has been invested with a power he would not have on the basis of conventional legal principles. Indirectly this power results in catalysing energy in the right places.

5.2 The packaging agreement

A similar example is the so-called packaging agreement. This agreement has been made between the government and the branches of industry that produce and/or use packaging materials. It aims to reduce packaging material in industrial chains. Contrary to conventional solutions, this agreement does not contain detailed norms and regulations regarding the nature, amount and kind of packaging materials involved. Instead, a radically different principle has been chosen.

The only thing agreed is that every player in the chain, including the end consumer, has the right to return used or superfluous packaging material to his supplier. The effect this roundabout-like interaction rule has is very interesting, since suppliers upstream in the chain may expect an avalanche of packaging material coming back to them. Even though they are authorised to forward this material to their own suppliers, the labour and cost involved increase exponentially as we move further up the supply chain. Players in the chain, especially in the front (e.g., the industry that produces the packaging material itself) will encounter immense problems unless they ensure that alternative means are available for their customers to dispose of the packaging material before.

This agreement has led to a chain-wide reorientation on the production and use of packaging material. The aim is not only to reduce secondary or superfluous material, but also to make processing and recycling of packaging material easier. This means a huge success, based on a very simple rule, again by shifting power to the end users and thereby channelling the energy flows of the suppliers.

5.3 Sound pollution around Schiphol Airport

The problem of sound pollution around Schiphol Airport is widely known. Meanwhile, a forest of measuring poles has sprouted and bulky volumes have been filled with elaborate norms and standards. Yet, all key parties involved are unhappy with the situation.
Once again, let us start with the basics of the problem. Flying is regarded a necessary evil, but at the same time it is an attainment that we gladly use for holiday or business. The noise that goes with air traffic causes discomfort to the people who live around the airport. This does not mean that these inhabitants are against flying *per se*. They fly to their holiday destination and many of them have a direct on indirect labour relation with Schiphol or with one of the airlines. In the air traffic system, there are three key parties: passengers, who want to fly and who pay for this; inhabitants, because they are the ones suffering inconvenience; airlines, because they are the owner of the aeroplanes and decide whether to fly or not. The energy flows are clear: passengers want to fly, airlines want to transport passengers profitably and inhabitants want peace.

The first step towards a solution is to turn the issue around, as in earlier examples. Here, this can be achieved by making the inhabitants around Schiphol the owner of the 'noise space' above their heads. They are free to do with that space as they wish, e.g., they may keep it and have quiet, or sell it to airlines and live with some noise level. This means that a price tag is attached to flying over certain areas, and that the airlines have to buy noise space from the inhabitants. If the inhabitants set their price too high, there will be no air traffic, but they will make no money either.

We conducted an experiment, in which these transactions were simulated in a game. It became clear that if inhabitants are given the ownership of their noise space, a market mechanism emerges which determines the price of sound pollution. With that, the need for bulky volumes with norms and regulations vanishes. The role of the government in this process is an interesting one. Far from taking a passive stand and leaving everything to the market mechanisms, the government retains a 'governing' (not managing!) role in enabling interactions between the players and in guarding the interaction rules. This way the government becomes the process governor rather than the process manager.

5.4 Liability in traffic accidents

Traffic safety is strongly linked to the way we as road users behave and to the responsibility we take for ourselves and for our fellow citizens. As technical and infrastructural facilities improve and our feelings of our own invulnerability or that of our fellow citizens increase correspondingly we will drive faster. Therefore it is highly questionable if this is the route to creating *sustainable safety*. Is there an alternative? Some current thinking joins the principles of emergence that have been described before en point to another direction.

First, there is the change in liability legislation on traffic accidents. Culpability used to lie with the road user who had caused an accident. However, since accidents frequently involve non-equivalent road users (e.g., a car driver and a cyclist), culpability for an important part has come to rest with the road user who is least vulnerable; in many cases this is the car driver. In other words, if a cyclist does not give way and consequently collides with a car, he may be legally guilty, but liability for the damage does not rest with him. Only when there is clear evidence of intentional action on his part will the liability return to the road user who is the weakest party. This resembles the situation of the agreement we described in the matter of liability for fraud with credit cards. Here too, the consequence most interesting is not which party will eventually pay for the damage, but rather the effect this has on the driving behaviour of car drivers. Inversed liability necessitates car drivers to be much more on the alert, even when obeying all traffic rules. It is hoped that this will eventually catalyse a durable behavioural change.

5.5 A village without traffic signs

This line of thought is taken even further in a small Dutch village. A few years ago it decided to remove all traffic signs instead of adding to them. Now there is one big sign at the village border, which pronounces that the village has no further traffic signs. All road users in the village are considered equal and must handle all traffic situations in mutual interaction. Strangely enough this does not reduce safety; on the contrary: traffic is much better organised and all road users are considerably more alert and anticipating. This radical change mobilises energy in the interaction between road users, not only between road users and traffic signs. With this the village has actually turned into one enormous roundabout instead of a centrally managed crossroad. From a perspective of emergence this principle - reducing the role of do’s and don’ts, and catalysing the energy in direct interaction between agents - is a very interesting one.

5.6 Safety at NASA

Let us now look at NASA, and how it tackled the problems that caused the fatal accident with the Challenger at the end of the 1980's. As it turned out later, this space shuttle crashed due to the assembly of an eroded O-ring, which caused the rocket to explode just after take-off, taking the lives of the entire crew. For years NASA refrained from further launches; its first priority was to prevent such an accident – in itself the consequence of a tiny omission in design and assembly – from ever happening again. Different approaches were studied in order to design a process that would produce a 'faultless' rocket through safe procedures, checks and prescriptions. This approach eventually got bogged down in a veritable moor of ineffectiveness.

The solution that was finally found - and that has been applied successfully for many years now - is of a completely different nature. When a NASA design engineer now reports a shuttle system or subsystem as 'ready', he (or she) must have a talk with the entire crew, before it can be approved and authorised for use. During this personal confrontation, the astronauts look the engineer straight in the eyes and ask him whether his system is safe. They discuss extensively the problems he has encountered during development, how these problems have been solved, and whether he can assure them that maximum safety for the crew has been realised. Again, as in earlier examples, the interesting part is not so much that out of these discussions even more improvements in design and assembly emerge. Rather, before he dares to face the astronauts, the engineer involved will do anything he can to ensure that his system indeed provides maximum security. It is not the standards, checks, tests, etc. - important and necessary though they may be - that ensure system quality; it is the energy of this personal confrontation. Eventual judgement and authorisation for use are based on the personal meeting between designer and crew.

6. Possible creative solutions for complex social systems

6.1 The health care system

Currently, the need for fundamental changes in the Dutch health care system is hotly debated. This debate is mostly driven by the growing dissatisfaction both policy makers and customers (read: the Dutch population) feel. Here, the system is probably not so much assessed in terms of its actual performance level, but rather by the growing discrepancy between actual and expected performance. What is more, we have arrived at a point where the percentage of every extra Euro invested in the health care system is turned into actual patient care is continuously dropping. The remainder is spent on overhead and management, necessary to keep the system going. The question now arises whether this will eventually result in a situation in which extra financial investments simply become ineffective, as they will only add to the complexity of system management.

The basic concept behind the current health care system is supply control, not unlike the way in which the former planned economies in Eastern Europe were regulated. Supply control assumes fulfilment of two basic conditions. First, management must have power over both users and suppliers, in such a way that it can regulate demand by limiting supply. Secondly, management needs reliable insight in the future developments of demand if it wants to predict system capacity and resource allocation reliably.

Looking for solutions
In a world that is becoming increasingly complex (read: more heterogeneous and less predictable), the possibility to separate the demand for health care into simple and orderly segments is constantly decreasing. Patients are articulate now, they are well informed and their purchasing power increases, and they make heavy demands on the system's performance. This means that the basic conditions for a supply-controlled system become increasingly irrelevant. In the debate on the future of the health care systems, two alternatives keep coming up as possible solutions. The first alternative implies a major simplification of the current system with no essential change, e.g., simplification of procedures and cuts in administration. The second implies that the current system be transformed into a market economy-like system in which Adam Smith’s 'invisible hand' governs the equilibrium of supply and demand, much as it does in our macro-economic system. We will demonstrate however that both approaches are in fact dead-end roads.

The advocates of the first approach implicitly assume that the rules and the regulatory management structures are due to proliferation and have led to avoidable extra cost. Is this really true? The deregulation programmes as implemented by the ministry of Economic Affairs during the past few years, were based on that same assumption. The fact, however, that their success was limited indicates that is extremely difficult to simplify procedures merely by abolishing rules and regulations. It must be borne in mind that

generally these rules and regulations have not appeared through some Kafka-like conspiracy of public servants. Rather, they express an increasingly complex environment in which general and uniform rules will do less and less justice to a variety of situations.
The essence of this problem is fairly simple. A plan economy supposes detailed management and prediction of capacity and resource allocation from a central point. The more complex the system and its environment are, the more complex the management process is, and the costlier its consequences are. It is therefore highly improbable that a final solution lies in this direction.

Will the market economy-like health care system be a credible alternative? Judging from the situation in the United States and the United Kingdom, there seems to be little hope. Apart from that, there are two major problems with a market-like health care system that is based on buying power. First, one may have doubts whether it is socially acceptable, let alone desirable, to subject the purchase of health care services to the principles of buying power. Apart from the question whether more buying power would result in better cardiac surgery, a market system assumes that the buyer is free whether or not to purchase the product. In health care, this choice is virtually non-existent: someone who is ill simply has to buy. Much as the provision of food cannot be solved by a market system during a famine, it is doubtful whether a market system would be the optimal mechanism to govern health care demand and supply.
Secondly, even if we pass over the previous point, it must be recognised that in a market economy transactions are based on actual, delivered performance. We, the consumers, buy products for the value they bring us, not because of the supplier's efforts to manufacture or deliver them. By contrast the health care system has been completely structured on the basis of supply capacity. We pay for the time the doctor's consultation takes, we pay for the rent of the surgery room, for laboratory analyses, etc. In this economic system the only way for suppliers to increase their income (which after all is the driving force of a market system) is to perform more of those actions, irrespective of the use they have for the eventual customer (read: patient). In other words, not only does the customer have no choice, the system will also focus on capacity maximisation, not *per se* on the well-being and quick recovery of its customers. Therefore, buying power as the guiding principle for the health care system typically is the wrong solution for the right problem. If we analyse the problem starting from the principles of emergence, we will immediately detect the major flaw in the system: the energy of the suppliers of health care and that of the users of health care (the patients) diverge. Sometimes they even oppose each other; certainly they differ more than is socially desirable.

A way out
Does this mean that we have reached the end of the dead-end road? We do not think so, and we will try to direct the way towards an alternative leading principle. Our aim is not to provide the definitive answer to the fundamental problems that face us, but to present a well-considered experimental line of reasoning that may serve as a basis for further thinking. If we abandon the concept of a planned economic system, we have to accept that the eventual system can only function through choices at micro level, i.e., choices made

in the interaction between individual user and health care suppliers. If buying power is no basis for these choices, then what concept would provide a basis to sustain mutual interest? After all, this mutual interest is the best guarantee for energy to be canalised in a socially desirable direction.

Let us go back to the beginning to build up our reasoning. The basic problems of the current health care system are the increasing heterogeneity and unpredictability of demand, and the impossibility to seal off the system from its environment. The system faces citizens who are increasingly competent and articulate and who try to impose their own personal moment- and incident-specific demands on the system. It appears that few of these demands are related to medical expertise or to co-deciding on diagnosis or methods of treatment; they rather focus on a possible choice between different alternatives, on the additional services, or on 'throughput time' (the healing process).
What exactly is the essential issue? The individual patient will want to revert from his state of illness to the best health level possible, without running too many risks. The collective of citizens - society - will want this realised with the most efficient deployment of resources.

To accommodate to heterogeneity, it is inevitable that individual patients can make individual choices. However, this implies that they also have to bear the consequences, since a choice without consequences precludes a sensible assessment. Should a supermarket offer its products free of charge, demand will be infinite; the same applies to health care. Yet, as we argued before, buying power is not the right basis for making choices in health care (it is for the supermarket, by the way). Which other exchange medium can the patient offer in his interaction with health care suppliers? We can think of only one: *his time*. In the current health care system, patients' time is considered given. It is in abundance and it is free; therefore waiting lists are 'free', there is no incentive to cure the patient swiftly and have him back to work quickly, and physicians can keep patients in the waiting rooms of the diagnosis and treatment trajectory at no extra cost.

And yet, both for the individual agent and society as a whole, time spent in the health care system represents large costs. This applies to the individual agent because recovery takes longer and sitting in a waiting room is no one's favourite pastime. It goes for society as well, as loss of time means longer sick leave, less possibility to treat the original illness, and increased chances of additional ailments. What is more, the system's complexity cost, waiting lists and unnecessary treatment can largely be attributed to throughput times that are many times longer than actual treatment time.
Therefore speed is desired, for the patient, his (or her) environment, his social-economic perspectives, and for society as a whole. Hence, performance of the system can be expresses in the speed and the use of resources with which the system is capable of treating health complaints. A higher speed at the same level of resource use indicates a better process, as does smaller resource use at the same speed. A higher speed together with less resource use represents an process which is exponentially better. However, higher speed with more resources does not constitute a better process, nor does a lower speed with fewer resources.

Suppose that we no longer reward suppliers of health care for making capacity available, but for ‘delivering’ a quick recovery. In that case behaviour of all agents will suddenly show the emergence of an energy flow that is totally different, in that it stimulates exactly the kind of behaviour which improves performance for both the individual patient and society as a whole. This makes it more attractive for health care suppliers to put their energy into process improvements rather than in haphazard emergency repairs. This will enable successful suppliers to continue on the road of success with vigour, while failing suppliers will be robbed of their means of investment - and rightly so.

The example discussed above clearly illustrates how important the role of the energy is of those directly involved in emergent systems. It also shows how crucial direction and mutual tuning of the energy of the different parties involved are when it comes to achieving meaningful and purposeful system behaviour. Another important aspect is that if systems are to show emergent order, their agents must possess an autonomous acting power that these systems do not have naturally available. Especially when the government has traditionally assumed the role of 'protector of the weak', it has created a situation in which bureaucracy has taken the place of the individual citizens, to exercise power on behalf of them. The following examples will focus on the shift from government protection to real 'empowerment'.

6.2 Privacy sensitive consumer information

Similarly, the ‘Economy of the 21st Century Report’, presented to the Secretary of Economic Affairs late 2001, has focused on the growing problem of consumer privacy threatened by the use of privacy-sensitive commercial information. The thought has arisen not to try and solve this problem through standards, regulations and punishments. Instead it would be conceivable that the consumer is declared owner of his own information. This way, commercial companies can only use the information with his or her specific consent, for which they will have to provide something in return. This proposal, too, seems to offer a potential for a radical change of energy flows. It can provide the basis for a system to use privacy-sensitive information in a way that is much more self-regulating.

6.3 Free flight for air traffic safety

An example in a different field is the 'free flight' principle. Every fairly modern aeroplane has been equipped with ACDS, the Automatic Collision Detection System. This system automatically comes into action when another plane is coming too close. Initially, the pilot is warned that a change of course is necessary to avoid collision. Should he take no action within a given time and the plane is still on collision course, the system will take action itself and change the plane's course abruptly just before eventual impact. The system communicates with the other plane's ACDS, to avoid that both planes will go into the same direction. This way a collision has become virtually impossible.

ACDS only provides in emergency situations, but we could easily envisage a more general application. Everyone who flies regularly knows the phenomenon: all passengers are aboard on time, nothing seems to be in the way of 'on-schedule' departure, but all the same there is a message from the captain: ‘A*ir traffic control has not yet given authorisation to leave because of crowded air traffic’*. And yet from the passenger’s seat the sky seems to be fairly empty. Surely in this three-dimensional environment it shouldn't be too difficult for planes to pass each other. The problem is, however, that air traffic control is work of man, and the complexity of this management task increases exponentially with the growing number of planes. Moreover, this task has to be executed very accurately since tolerances in the sky are very narrow and planes pass each other with minimal waste of space.

A group of aircraft designers in the United States have considered the logical possibility of applying ACDS on a more general scale. It works out like this: around every plane there is a virtual kind of 'rubber ball'. To some extent these rubber balls can touch and bump into each other. If a ball gets dented too much, ACDS takes action. This way, the space between the planes remains at a safe margin, and planes can find their way through mutual communication. Tests with this system, both simulated and real, have shown that the throughput in the air may be substantially improved (up to 30%). In other words, less management can lead to a better result.

This example clearly illustrates how system 'management' can be overrated. Tight system management that strictly follows procedures and sticks to rules results in congestion and unnecessary complexity. A solution in which the agents themselves regulate the system in mutual interaction is not only much simpler, but also shows better throughput performance. Moreover, 'free flight' allows for the safety of air traffic to be built into the system rather than around it, as no outside safety control measures or checks will be necessary. Since the system is inherently safe it is exemplifies a solution that contributes to better system performance: better throughput and a safety level at least as good as in the conventional process.

6.4 Safety on 80-kilometer roads

Let us apply this same principle to roads where the maximum speed is 80 kilometres, and that may produce some of the most dangerous traffic situations we know, in an attempt to provide a starting point for a durable safe solution. The idea is that every road user would have the right to have a conversation with another road user, if he feels that the latter has unjustly treated him or has threatened his safety, either by breaking the local traffic rules or through dangerous - though not illegal - behaviour. This conversation would have to take place under supervision of a mediator, and both parties would be required to be present.

This implies that all road users may be summoned to such a conversation if they do not proactively respect other road users’ interests. In that case they will be unpleasantly confronted with their own behaviour, but will also experience discomfort and time loss, which incidentally applies to all parties.

It can be imagined that the preventive power of this possible threat will be much greater than the possibility of being fined by a policeman. After all, in this situation all road users control one's behaviour. Since the plaintiffs also have to be present at the conversation, which is time-consuming and uncomfortable, they will only request a conversation if they have experienced serious trouble. Therefore only serious issues will be selected for conversation.

This system not only confronts road users with the consequences if they should break the rules, but they also have to accept that they may lack anticipation or the ability to take other road users' interests into account. It generates no seemingly safe solutions, but solutions that integrate road safety into the interactive behaviour between road users. Furthermore, it can foster durable safety without infrastructural separation of road users.

At first sight this idea might seem far-fetched. Not long ago, however, in a few towns an experiment was conducted in which children on their way to school stopped car drivers in 30-kilometer zones to point out that they were exceeding the speed limit or were driving faster than the children thought safe. The children asked the drivers straightforwardly why they drove so fast. Interviews with the car drivers that were reported later, made it clear how ashamed they felt in their confrontation with the children. Most of them hastened to promise that in future they would pay more attention to the children's interest. While this is no guarantee for a durable change in the drivers' behaviour, their psychological embarrassment will be enough to make a big and lasting impression. The possible solution for the 80-kilometer roads in fact applies the same principle and could therefore have much the same psychological effect as the experiment in the 30-kilometer areas.

7. Conclusion

Many social systems function in a sub-optimal way. Both the way they are currently being managed and their existing rule set are no longer adequate to cope with the growing complexity of their environment. Social systems have become so complex that they cannot longer be easily and unambiguously described. Apart from that, the difficulty remains to translate this description into rules and regulations unambiguously. And finally, maintaining these rules and regulations would run into insurmountable difficulties. A radically new approach is needed to escape this deadlock. We believe that the theory of emergent order, combined with principles of system governance, will provide an alternative.

In this article, we have provided some examples (a few already realised, others still conceptual) of social systems in which the principles of emergent order and system governance clearly provide part of the solution. At this stage, evidence of the effectiveness of these principles can only be fragmentary. All examples provided are different and address different aspects of the emergent order and system governance. Yet what they all have in common is that application of these principles requires unconventional and creative thinking.