Towards a New Paradigm in Food Retail: Applying the Principles of Emergent Order to Marketing and Supply Chain

Ton van Asseldonk, Leon Berger and Erik den Hartigh*

*) Ton van Asseldonk is managing partner with TVA developments bv, Leon Berger and Erik den Hartigh are consultants with TVA developments bv

Abstract

Food retailers seem to be stuck at this moment. What hinders them is that their market isn't growing, their customers are becoming ever more heterogeneous and unpredictable, and competition from Out-Of-Home food suppliers is increasing. Consequently, volume growth alone is no option, and existing efficiency and differentiation approaches present them with conflicting difficulties that can no longer be overcome by traditional means. Difficulties which are a symptom of a more general conclusion that the industrial economic model has reached its limits. What is needed is a radically different paradigm.
This article explores such a paradigm, a paradigm that is based on the principles of emergent order. Applying these principles to business processes such as marketing and the supply chain will create opportunities for profitably handling unpredictable customer demand in retail settings.

1. The Food Retailer's Dilemma

1.1 Introduction

Retailers find it very hard to tell what an individual customer will buy tomorrow. Until now they were saved to some extent by the statistical 'law of large numbers', but its validity is coming to an end, at least in food retail. Predicting aggregate sales is getting more difficult, as individual customers' shopping pattern is becoming more heterogeneous. Food retailers find the position even worse since the money spent on food is not keeping up with inflation. For them the only way to gain market share is to snatch it away from their competitors. Not much imagination is needed to see that all this will make the required return on equity investment (greatly valued by the shareholders) suffer.

In order to remedy this we will start with a simple analysis of the market, that shows in some more detail the increase of heterogeneity as well as the resulting unpredictability. Section 2 will outline the far reaching consequences on the theoretical framework (business model) companies are currently using to structure their business processes; it will also illustrate why this framework will ultimately fail. In section 3 we will propose an alternative in the form of the principle of emergent (interactive dynamic) process ordering. Sections 4 and 5 will apply this new approach to the fields of marketing and supply chain configuration and management respectively. A path will be suggested that may lead to better solutions, which are stable yet highly adaptive to changes in the marketplace. The final section 6 offers an overall conclusion.

1.2 Three options to make money

Companies can generally make money in three ways: through growth of volume, of efficiency or of differentiation. First, they could sell more products and if a profit is made on each product, total profits will increase. Secondly, they could produce more efficiently than competitors do and therefore earn more money per product sold, due to cost leadership. Thirdly, they could ask a higher price for their products in the market and therefore earn more money per product sold, due to differentiation.

In the food sector the first option – a larger sales volume - is no longer sufficient since food expenditures are not keeping up with inflation (see figure 1), with the exception of food service which shows a annual growth rate of 2.75%[1]. This has been a long-term trend that started in the early fifties[2] already.

[Figure 1: Food expenditures as a percentage of personal income]

For the food retailer enlarging volume by trying to keep pace with the market is therefore no longer an option. In general there are two ways to increase volume: either taking market share away from competitors or

[1] From: Just-food.com/store/samples/profitabilityinfoodservice.pdf
[2] From: Agecon.tamu.edu/iama/2000congress/Congress/Kinsey_Jean.pdf

bringing in new articles that originally fell outside the scope of food retail. The first way is likely to entail price wars, which for all players eventually is a change for the worse. The second way is frequently used by food retailers nowadays, who add products such as computers, crockery or even bicycles to their assortment. Of course this approach also confronts them with new competitors, generally in markets unfamiliar to a food retailer.

Sometimes a third alternative is shown. This third option is to increase volume is by creating more sales channels. However, this can be regarded as a variation of taking market share away from other retailers as it does not increase total market size. In that sense it is not an 'easy way out', but failing to exploit this opportunity might have the dire consequence of losing part of the market share to competitors. The addition of new channels as such could have the added benefit of making shopping easier, and it is assumed that the customer is prepared to pay for convenience nowadays. In the long run this will probably be true, but right now the customer is only prepared to pay a small bonus for the extra services. Furthermore, the additional cost for the food retailer definitely exceeds the additional income - after all, this is a new game.

The conclusion can only be that none of these opportunities will create a substantial increase in total volume over the industry as a whole. Besides, they will make the business of running a food store even more complicated since the choice provided has become more ample. Cost will go up, and who is going to pay for it?

1.3 Heterogeneity and unpredictability

The introduction of new articles and even of new assortment groups increases the number of products that a customer can buy. Usually only a small portion of the current assortment is replaced, whilst new products are added. While the amount of new products per year decreases[3] (see figure 2), it is still high enough to cause substantial trouble in the supply chain. Every new article is a further burden on the supply chain, destroying economies of scale. We will come back to this later in this article.

[Figure 2: Annual number of new food and grocery products]

On the whole, the choice offered to the customer is increasing. This has serious repercussions for the exploitation of economies of scale in the supply chain. When more products are available sales per product will go down, destroying the advantages of scale currently available. Worse even, it will also be more difficult, if not downright impossible, to segment customers into relatively homogeneous groups. For more ethnic groups are living together inside the same area; single person households are still on the way up; what kind of products will be consumed at what time is even less to be predicted; health foods constitute a new trend (although it is still hard to tell its long-term success), natural –biological - foods are getting popular as a silent protest against GMO-food. All together this moves the food retail branch into 'segments' consisting of only a few customers. Segmentation - based on some homogeneity among those customers is a dead end street:

[3] From: Agecon.tamu.edu/iama/2000congress/Congress/Kinsey_Jean.pdf

they just won't settle for standardized products. What is needed is a new paradigm, based not on the similarities among customers but rather on their heterogeneity.

One an important last trend strongly influences traditional food retail: the increase of the out-of-home (OOH) market. In the US this market has now reached 50% of total food consumption[4] (see figure 3). It is expected that by 2010 some 55% of all food will be consumed away from home[5].

[Figure 3: Increase of the out-of-home market]

The growing amount of money spent outside traditional food retail directly influences its volume. Besides, it makes it even harder to predict what customers will buy. Twenty years ago the choice was at least restricted to the products within the store; nowadays, there is a 50% chance that the customer will not visit the store at all. Most likely this development is the result of a moment-specific customer decision that varies every single day and is virtually impossible to predict.

From all of these trends together it may be concluded that increasing heterogeneity leads to a higher unpredictability. More options are open to the customer; statistics have reached their limits and predicting tomorrow's sales will become ever less possible. As we have seen, growth through increasing volume is no option. Also, the task of more efficiency in a market that is moving away from homogeneous economies of scale is equally formidable. Price increases are difficult to implement as new competitors enter the market. It seems as if no options are left. What is needed is a radically different approach.

2. The End of the Industrial Economy

2.1 The industrial paradox

If we consider the trends sketched in the previous paragraph, it is well conceivable that we are approaching the end of the traditional industrial economy. Many of our production processes are approaching the limit of their industrial efficiency. Many companies operate in (almost) saturated markets. Differentiation is the only way out to higher levels of value creation. It is true that in the short run electronic data interchange, business process redesign and effective customer response provide some potential where costs are concerned. However, this is just stretching the elasticity of current solutions. Just as a rubber band, when stretched too far it will eventually break down. The current volume growth of the market of 1-3% is in many cases not sufficient as a basis for growth in terms of financial results. The shops are full and the effect of more wealth is not that people eat more, they eat differently. The same is true for customer electronics, cars and many other mass products and services. The real basis from which to

[4] From: Annual report of SYSCO, based upon Technomic data.
[5] From: National Restaurant Association ©, *Restaurant Industry 2010: The Road Ahead*, 1999.

create more value can only emerge from a better connection with client needs, which entails a stronger orientation on the individuality of that client.

The essence of the industrial paradox is in the trade-off between the cost efficiency of the business processes and the ability to rapidly serve a heterogeneous and unpredictable demand from the market, or speed of response to customer demand (see figure 4).

[Figure 4: The Industrial Paradox]

Two established ways of organizing businesses can be linked to this diagram. The first one is the craft-type company. Here, the individual wish of the client is the starting point of activities and supply heterogeneity is therefore maximal. However, the supply chain is hardly a process, let alone a coherent one. Productivity and level of re-use of knowledge in investments are low and consequently the costs are high.

At the other extreme is the industrial company as we know it now. It is the exact opposite of the craft-type company, as it shows a very high level of coherence between processes, a very high productivity and re-use, and therefore low supply chain costs. The price we pay for this, however, is a loss of heterogeneity (to the point of full homogeneity in the case of T-Ford production). Technology has enabled us to move from this homogeneity to a much higher level of heterogeneity at affordable marginal cost, although the basic principle remains the same: specials are expensive, mass is cheap. For heterogeneity at affordable cost though, there is always a price to be paid, be it in the form of longer delivery times, intermediate stocks, or rationalized assortments. Industrial processes are fundamentally inadequate to deal with heterogeneity at affordable cost.

2.2 Breakdown of communication

Underlying this inadequacy is the breakdown of the communication channels, as bandwidth and/or transmission speed of the corporate control mechanism are inadequate. For fulfilling client needs, business functions have to be activated and organized into a meaningful chain of actions that will produce the desired product. In an industrial organization these chains of actions build processes throughout the whole organization, and the coordination of these processes is achieved by a top-down ‘programming’ of functions. The synergy in the organization, in other words the meaning of these connections, is created through instructions passed down by the cascade of management. In organizations that want to retain their industrial basic structure, but are facing increasing external unpredictable heterogeneity, a problem emerges with respect to the programmability of these interactions, which pass through the hierarchy as messages and finally arrive at the operational level (see figure 5).

[Figure 5: Breakdown of Communications]

In principle there are two possibilities to increase the flow of information through the hierarchy. The first one, which is indicated on the vertical axis, is to increase transmission speed, in other words to increase the speed at which decisions are taken and their results passed down into the

organization. The other possibility, indicated on the horizontal axis, is to increase the bandwidth of communication, i.e. to increase the number of messages that are simultaneously passed down the hierarchy. The type of decision-making that is based on high speed can be found, for example, in dealing rooms, where relatively simple decisions and instructions are formulated and then communicated very rapidly. At the other extreme, along the bandwidth axis, we encounter decision-making based on the shelves of handbooks that contain messages and instructions for every potential situation. This is the extreme form of creating 'slack' in an organization: be prepared for every situation.

In large complex organizations there is, however, a limit to transmission speed and bandwidth that can be created. On the vertical axis the ultimate transmission speed is determined by the ability to pass information to the decision taker, i.e. to translate the information into actions and subsequently pass down the instructions. The speed of this process is finite: at a given moment it can no longer keep pace with the external variance. On the horizontal axis an over-wide bandwidth leads to information overflow at the receiver. Out of an avalanche of messages he can no longer find the one message that is of importance to him.

As heterogeneity increases, the limits of programming business processes top-down are reached. The problem cannot be resolved in terms of bandwidth or response speed, because neither the decision-maker nor the receivers are capable of translating the heterogeneity and dynamics of the environment into actions. At that point, the traditional way to interrelate business functions fails. It is this failure that is at the core of the need for different organizational models, which are more oriented towards self-organization and less towards programmatic procedural control.

2.3 Complexity costs

The inadequacy of industrial processes performing under conditions of heterogeneity and unpredictability causes 'friction losses', that appear as complexity costs. Complexity costs are simply all additional costs that a company incurs to create heterogeneity of products and services, if one compares it to the situation in which the total volume is created in only one version. In other words, what would a Ford Focus cost if it were to be produced in one color and one version only, like its predecessor the T-Ford, while the total sales volume would be maintained? Admittedly, the above definition is a bit extreme, which makes it difficult to use in an operational environment, as such an Explorer would not command a high sales volume in the current market. But it can be used as a starting point for reasoning.

Complexity costs are neither identical to failure costs, nor to quality costs, nor to overhead costs, nor to under-utilization costs or to inefficiencies. They are present in all business functions. From administration to production preparation, from management to shop floor, from purchasing to sales. And they are present in the cost of employment as well as in infrastructure and purchase of materials.

[Figure 6: Costs of Complexity]

Figure 6 shows the typical relation between the cost per unit of product versus the batch size for an industrial supply chain process. Typically, such curves go up steeply beyond a certain point: the 'complexity border'. The flat part of the curve represents the level of the manufacturing and supply costs for large homogenous batches. In highly competitive markets important players cannot afford substantial cost disadvantages at this so-called cost-parity level. This is the cost level where the cheapest (commodity) supplier in the market operates under the conditions of full competition. For batch sizes on the left side of the complexity border, the cost per unit of product increases sharply. Further fragmentation of the sales volume pushes an increasing part of the volume to the left of the complexity border and causes a rapid increase in costs, both directly as well as indirectly.

2.4 Industrial structures do not work

Current industrial processes are essentially inadequate for coping with unpredictable heterogeneity, and many solutions suggested in literature will ultimately meet their own limitations. Stockholding is becoming unaffordable from an economic point of view (at any rate it is very risky), delivery time will have to become shorter rather than longer (on the penalty of losing demanding customers) and technology is not only expensive, but adds additional complexity to the underlying processes. The first two aspects are widely known. In many areas solutions are developed to reduce stocks (e.g. Efficient Consumer Response in the food sector) and to obtain acceleration in the supply chain (e.g. time-based management). However, one aspect receives too little attention: the consequences of the ever-increasing complexity for the costs of direct and indirect processes in increasingly heterogeneous organizations. And in the end here lies the key to the creation of business processes which can deliver specials at cost parity.

Although by means of Business Process Redesign unnecessary process interfaces and integrated supply chains are addressed, such processes touch the effect of unpredictable heterogeneity only sideways. As long as predictability remains, BPR will achieve important improvements, but it is especially the increasing unpredictability which leads to uncontrollable complexity costs. It proves that in practice these costs are not only very substantial, but cannot be detected from within the existing paradigms, too. It is therefore worthwhile to focus on this problem, make these costs visible and formulate new principles to eliminate these costs rather then reduce them. Or worse, charge them to the customer.

> Box: Industrial or Tailored Kitchen?
> Consider buying a kitchen for you new house. Nowadays the leading industrial manufacturers offer a wide range of configurations, colors, types of materials, built-in equipment and options. After a long and careful choice process, you decide on you ideal kitchen, completely specified to your individual taste. What happens then? Your order is passed on by the salesman to the industrial manufacturer. In the best traditions of economies of scale, this manufacturer issues orders to suppliers or to his own production stations to deliver or manufacture every single item of this specific kitchen. Because of economies of scale, most processes are batch-oriented, so often the delivery time for specific, non-standard items will be quite long. Because the kitchen

has to complete, all the other items have to wait for the slowest process. At the end of the delivery time, at a certain prespecified day, all those different items have to be joined together at the customer's house. Statistically it can be calculated that the chances that everything will be there and everything will fit and function perfectly is close to zero. Specific items will have to be repaired on the spot or back-ordered. Highly skilled craftsmen will spend lots of time fitting all the separate pieces together, a process that often requires loads of improvisation. When all has been fixed and last item has been delivered, it turns out that the price to pay for your industrial kitchen is about the same amount as it would have cost you to have the local carpenter make a kitchen to measure for you. In other words, the entire efficiency gain from organizing kitchen production in an industrial way is outweighed by the complexity costs of delivering the kitchen to the customer's specification. If the local carpenter can do it for the same price, then why did we build those factories in the first place?

Box: Retail Logistics
Company X, a large player in the food retail industry, has a large-scale logistics operation which, according to all concerned in the sector, represents the state of the art. Goods flow at great frequency to a vast number of outlets and all planning and administration processes, which belong to such a sophisticated set-up, function smoothly. This logistics operation was one of the key issues in a large-scale strategic transformation project; therefore the structure of the existing process was of great importance. We were greatly surprised when the bottom line of this sophisticated logistic system indicated that the company employed as many trucks as there were outlets. The question whether a situation in which every outlet had its own truck could lead to an adequate supply of goods, caused great confusion amongst the staff concerned. After some calculations on the spot, this appeared to be quite possible. We were fascinated by this paradox in 'lost productivity gains' of such large-scale industrial organization. Subsequently the total cost build-up in the underlying processes was analyzed. The results of this analysis were rather shocking. The direct transport, transfer and storage costs were lower than those of the primitive version in which every location takes care of its own logistics. Yet the gain at this higher productivity level was completely eroded by the substantial indirect cost. Information technology, planning, administration, management and fault repairs have, in this very complex process, rapidly taken away the fruits of an initially good idea. Somewhere in the past and invisible for the people concerned, consequences of complexity have crossed the border of economic logic. The gains in industrial productivity have been eroded completely by the complexity of the supply chain processes, and, especially, supply chain process control.

During an evolution of successive incremental improvements, somewhere we seem to be passing the line were logic at a micro level creates absurdity at the macro level (see the examples in the boxes Industrial or Tailored Kitchen? and Retail Logistics). It is quite likely that our normal approach to organizing resources (i.e., based on procedural planning) is the most

effective and efficient way to yield output in a predictable and homogeneous world. Predictable and homogeneous because of the inherent nature of the system or - more commonly - because suppliers can wield sufficient power over their customers to mold the world into predictable homogeneity.

Yet we are increasingly confronted with issues of organizing resources which seem to be incompatible with this concept of central planning and control, because in mass-individualized consumer markets the demands are intrinsically heterogeneous and unpredictable and the dynamics exceed the ability to respond credibly from a central point. When management instruments of the past are applied to such issues they seem to be yielding rapidly decreasing returns, producing (in an engineering view) ever more 'heat' at the expense of 'movement'. The issues seem to revolve around the question of how to:

> *'Create a system (organization) which in an unpredictable environment is capable of adaptation and renewal, in order to achieve meaning, coherence and continuity for itself, without using central planning and control'.*

The underlying problem is one of 'order', and with that of the communication structure governing the behavior of functional entities in the process chains. The only way to increase heterogeneity under conditions of unpredictability, while retaining the cost-parity of industrially organized processes, is to change the fundamentals on which the interaction between various steps in the process is achieved, and the way these processes respond to changes in the external environment.

The complexity border, seen in this way, therefore marks the end of the industrial revolution. The revolution which has brought us the wealth in modern societies, but is now no longer capable of sustaining a further growth of wealth, by addressing the differences in the market place rather than the similarities on which industrial order has been built. Replacing the industrial paradigms by the paradigms based on interactive behavior and self-organization will likely create an impact, not just within companies but in society at large, which is comparable in terms of importance and scope to the changes from our traditional craft economy to an industrial economy.

3. Emergent Order

3.1 Breaking through the paradox

The critical distinguishing characteristic of our perspective is in the way this meaning and purpose ('order') comes about. In our view, supply systems that have to be both efficient and responsive should function along mechanisms of so-called 'networked order'. Compare for example a crossroad and a roundabout. On the crossroad, traffic flow is controlled by traffic lights. To program these traffic lights, intensive study and measurement of traffic flows is needed. In complicated situations, the standard program is combined with detectors below the tarmac, push buttons for pedestrians and cyclists. Fail-safe protections have to be designed against 'all-green' situations etc. In

short, traffic lights are a small miracle of information processing and central planning and control.

Quite different the situation is at a roundabout. There is no central computer system, but only one simple, interactive rule: left-hand traffic has priority. Away with the information systems, away with traffic lights, away with detectors and push buttons. Throughput is dramatically better than on a crossroad with traffic lights, because it is 'flow' instead of 'batch'. Irritations of useless waiting are absent and safety has increased.

[Figure 7: Crossroad and Roundabout]

The essential difference between the traffic lights and the roundabout is in the way the process is ordered. Order from traffic lights is an expression of linear structural order, which is forced upon the system by the designer's external power. It makes us think of an organization structure which is rigidly designed to handle the organization's existing processes. When these processes change, or in this case traffic flows change, it has to be reprogrammed. Contrarily, the roundabout is characterized by networked order. Here the complexity of the traffic flows is caught in the process itself. Because of continuous interactivity between the individual agents, the complexity of the process is built from the collection of small, simple interactions. Complex traffic movements are guided by the repetition of one simple rule. Understanding the concept of networked order is the key to management of organizations as complex adaptive systems.

This does not mean that this kind of order is for free. For displaying orderly behavior and sustaining its own future above the statistical lucky chance, any complex adaptive social system requires energy to be bundled in a meaningful direction while remaining open and adaptive to external changes. How can this be achieved without central control?

From our experience with strategic transformation processes in large, complex business systems we found that there are three basic dimensions determining the success of such processes:

- Energy
- Direction
- Stability

These are necessary conditions for an organization to sustain itself (survive) and be successful in a competitive environment. Without Energy inflow, the organization will not be able to learn and adapt (explore) and will not be able to move against the stream of competition. Without Direction, the organization will be unfocused, not unlike many ecological systems. Without Stability it will not be capable to economically exploit its resources in any effective way.

3.2 Energy

To escape the red queen effect, i.e., to survive and improve in a competitive environment that continuously pushes it back, an organization needs to be

able to move against the dominant stream of competition. It needs a capability of creating disequilibrium by exploring new ideas and solutions. A system will therefore need energy inflow. Energy inflow stems from the combination of motivation, know-how and ability of the individual agents (see figure 8). While know-how and ability may be facilitated by the system towards its agents, motivation has to be inherent to the agents. Without motivated agents, there will be no energy flow and there is no basis for survival or success.

[Figure 8: Know-how, Ability, Motivation]

Essentially, agent motivation is based on some form of self-interest, whether financial, social, or even altruistic. More precise, self-interest is a hygiene factor for agent motivation. It is almost certainly impossible to motivate people to do something diametrically against their self-interest. As an example, in the early days of self-organizing teams in car manufacturing, it became evident to the workers that their successful improvements only reduced the number of colleagues on the manufacturing line. And by discovering that achieving the corporate goal was contrary to their own personal interest, exploration stopped and projects failed. Self-interest in itself will not lead to exploration. Any form of exploration will require interactivity of the agent with his environment. People will interact with each other both within the system and with the environment if it serves their self-interest. There has to be a balance of effort spent and rewards received both at the individual as at the group level (see figure 9).

[Figure 9: Energy from Interaction and Self-interest]

Processes of interaction aimed at discovering new, improved, business 'rules' are characterized by the fact that they are repetitive. It is a continuous, ongoing activity and not a one-off event and it carries a certain amount of risk to invest energy without guaranteed pay-off. In some cases it may even involve a penalty as a result of non-cooperation from other players and/or trespassing the conventions of the community. Robert Axelrod[6] has extensively experimented with such sequential non-zero-sum game situations, many of which can be characterized as sequenced prisoner dilemmas (see figure 10). Understanding how the nature of sequential interactions in hostile environments can lead to emergent cooperation strongly resembles observations in change and transformation in business processes.

[Figure 10: Payoff Matrix]

3.3 Direction

The second dimension of emergent transformation processes is 'direction'. Interactions between people, based on their own self-interest pursued in absence of a common goal might lead to diverging experiences with respect to successful versus non-successful behavior. That is not in itself a bad thing, because it will allow the organization to explore a large number of new

[6] Robert Axelrod: *The Evolution of Cooperation*, Basic Books, New York, 1984; *The Complexity of Cooperation*, Princeton University Press, Princeton NJ, 1997.

'rules' and ideas. As a number of these will be successful, this exploration will allow the organization to move against the dominant stream. The results at organization level however could easily become very unfocused, unless there is a common measure of success against which these experiences can be measured. However, there will always be a trade-off between performance in terms of new ideas (exploration) and the cost (efficiency) of achieving this performance (see figure 11). It will be easy to generate large numbers of - potentially successful - new solutions, provided an enormous amount of resources is available. Also, it is easy to be very resource-efficient when performance is less important. Improvement means breaking through this trade-off.

[Figure 11: Performance-Efficiency]

A clear and verifiable definition of goals of with respect to both 'performance' as well as 'efficiency' is a means to steer the exploration process, to steer the available energy into meaningful activities. Defining goals therefore, which represent both the interest of the organization as well as the self-interest of the agents is mandatory in order to create sustained exploration and to extract knowledge from masses of parallel experiences, successes and failures, as a base for future proliferation. This goal setting is an important task of management in emergent transformation processes.

3.4 Stability

The third dimension of emergent transformation processes is stability. When new ideas and solutions are successful with respect to the goals of the organization and the agents within the organization, they may be successfully exploited. Exploitation requires standardizing and communicating routines throughout the organization. With respect to the exploitation loop the knowledge acquired from exploration needs to be proliferated throughout the business system in order to benefit effectively on a larger scale. However, experience is always embedded in context, and communicating the 'whole story' is a very ineffective way of communicating knowledge. It is by extracting or codifying the key of success or failure that building blocks of knowledge emerge, which could be used by others in different contexts to their own benefits. This principle of 'codification' is highly developed in e.g. management sciences, where case studies are used in order to condense the key elements of management success. That principle needs to be introduced within the business system itself, in order to create building blocks for proliferation, and then in the end obviously mechanisms are required to proliferate these building blocks to potential other users in the business system (see figure 12).

[Figure 12: Codification and Recombination]

There are however also risks to this process. Firstly, there are different ways that the proliferation within a system may grow out of hand. E.g., ideas and solutions might proliferate that are not relevant to the company goals. Also, some new ideas and solutions may become so successful that the systems runs into a mode of over-exploitation at the cost of exploration. This may eventually harm the long-term survival of the system. Management has a role in checking positive feedback mechanisms that may induce this kind of

system behavior. Yet another aspect is the risk for over- and under-complexity. It is a popular belief that networked structures exists because of the ability or even necessity for all agents to relate to all other agents. Yet it can be shown that a high connectivity factor of a system (the average number of links any agent in the network has), combined with a low concentration factor (there are no concentration points) leads to a very rich 'solution space' but and increasing inability to find a suitable solution (see figure 13). In other words, if the degrees of freedom in relation to new solutions are larger than the complexity of the problem itself, the payback will rapidly decay as opposite to the conventional Taylorist situation. This, in turn, is an example of under-complexity, in which the 'solution space' of the organization is too small for the complexity of the outside world. Here, there is a low connectivity factor, combined with a high concentration factor. To avoid over- or undercomplexity, management has also a role in steering the connectivity and concentration of the system.

[Figure 13: Connectivity and Concentration]

3.5 Governance

How can we grow systems as described above that show the desired behavior and that show emergent order? Emergent in the sense that orderly behavior comes about by itself instead of being centrally imposed. An important lesson from attempts with self-organizing systems in the past is that it's not going to be all right by itself. That is to say, when we just abolish existing central procedural regulations, a new adequate order will not emerge by itself. In any way, not fast enough, not well enough, or only at a price that is simply to high to pay (e.g., bankruptcy). Therefor, some form of guidance seems to be necessary. As we know that central, hierarchical management is unfit for the job, this guidance will have to radically different. We use the term "governance" to indicate this. In traditional management thinking systems are changed by first ensuring system stability (by creating structures as, e.g., teams, task forces), then formulating the desired system direction (e.g., making strategic plans), and finally trying to mobilize energy within the system to implement those plans. Governance of complex systems turns this upside down (see figure 14): start building from the energy available within the system (agents who want something), then selectively giving direction to this energy without obstructing it, and then making sure that the volatility of the system behavior does not product undesired results (stability).

[Figure 14: A Hierarchy of Emergent Order Principles]

4. Application to business processes

In the previous paragraph we have illustrated interactive dynamic (emergent) order as an alternative principle governing the relationship between entities in business processes. The application of this principle to business processes is the subject of the last two paragraphs, implementing the principle in both marketing processes and the supply chain. Our aim is not to develop a complete new theory concerning marketing or supply chain processes, but to demonstrate that the increasing heterogeneity and unpredictability reduces

the applicability of theories based on a linear view of the business processes and their external environment, to demonstrate that these markets indeed show order and are not chaotic, and to show that this interactive order can be used in active business processes though this will bear consequences on the way these processes are currently organized.

4.1 Marketing

The full implication of heterogeneity in the area of marketing would lead us on the road to 'segmentation of one'. Reality would actually be even worse, since a particular customer could be different throughout different product area's and different moments (dining expensively today, but eating hamburgers tomorrow). Segments could be defined as one person at a particular time and in a particular place. Even at a first glance, the extrapolation of current marketing process to enable the above seems a ridiculous route. Apparently the industrial paradox is also applicable to the marketing process itself. To find a new approach we will use the current marketing philosophy as a basis and by emphasizing its shortcomings in a heterogeneous world explore the new requirements and possibilities.

4.2 The current marketing approach

Before the vast industrialization of the western world, in a time when most products were created by craftsmen, no explicit marketing process existed. There was no such thing as customer segmentation. Conscious marketing only started in the early 20th century, but it was only from the 1960's on that companies started thinking in product-market combinations (fueled by the theories of Ansoff[7]) and that large-scale marketing research was used to find the right combination. The assumption behind product-market combinations is that customer behavior can be segmented into relatively homogeneous groups. Segments are created, possibly using customer input through panels and question forms. Generally, in those times customers were reasonably happy with the results of these segmentation exercises. While they almost never got *exactly* what they wanted, they could certainly live with the solutions that were provided, for reasons that general welfare was much lower and also because there were no reasonable alternatives available. Marketing efforts were based on marketing research and the main purpose of this marketing research was finding similarities between customers and using these similarities to make predictions for the entire population. While it has been substantially refined, this principle is still the basis of most modern market research. The customers have changed, however. Nowadays they have more and more money to spend, and the bottom layers of the 'Maslow pyramid'[8] are fulfilled. While on the lower level of the pyramid the needs are in general homogeneous, on the higher levels the customers will start to act more differentiated, and move away from these similarities. The implication is that the described marketing research approach that was looking for similarities will fail, because those similarities a no longer the basis for customer behavior.

[7] H.Igor Ansoff: A Model for Diversification, *Management Science* 4, July, 1958 (pp.392-414); *Corporate Strategy: An Analytical Approach to Business Policy for Growth and Expansion*, New York, McGraw-Hill, 1965.
[8] Abraham H. Maslow: *Motivation and Personality*, Harper and Row, New York, 1954.

4.3 From prediction to experiment

A totally different approach is to jut let your gut feel work and just try out new propositions in a (small-scale) real-life environment. Marketing then becomes 'a laboratory of experiments', and decisions are based on simple trial and error. The result is a set of well tested propositions that were very hard to predict using a standard marketing approach. But can we follow such an approach in a real complex environment? The first step is to redefine the way order exists within the complex market environment.

Complete heterogeneity - every customer different on every aspect - would imply a totally chaotic market. Despite the fact that we qualify customer behavior as erratic and unpredictable, this is not what reality shows us however. Customers are different, but markets are not completely chaotic. Apparently some form of order exists. In this context three phenomena are important: (1) occurrence of positive feedback loops, (2) limited entropy in customer behavior, and (3) a finite dimensionality in customer/supplier topology. We will discuss all three of them briefly.

Positive feedback loops and increasing returns are by now well-known phenomena.[9] Forrester's[10] work on System Dynamics shows that non-linear phenomena in the form of various kinds of feedback loops are central to behavior in complex systems, and that marketing and business processes in general are such complex systems. The battle of the video recorders is a well-known example of how order evolves from the initial chaos of the various incompatible video recorder types. Marketing efforts by Sony (marketing the Betamax video system), stating that their product was technologically superior, did not help them. The positive feedback loops among customers did override any other attempt. Customers bought VHS recorders because more prerecorded tapes were available for VHS, more video rental shops with VHS tapes in stock were emerging. As a result, more people bought and rented VHS tapes, and therefore also bought VHS recorders. It was a continuous loop that was not consciously steered by the suppliers of the VHS technology.[11] Order was in an emergent way created by the system itself. This example also shows that customer heterogeneity does not necessarily lead to greater variation in all areas. It is a well-known ICT paradox that to create systems that can handle heterogeneous input, the usage of standards is essential. Maybe every customer wants a slightly different video recorder, but they definitely want to be able to rent and exchange tapes.

[9] See e.g. W. Brian Arthur: Increasing Returns and the New World of Business, *Harvard Business Review*, July-August, 1996 (pp.100-109).

[10] Jay Forrester: Industrial Dynamics: A Major Breakthrough for Decision Makers, *Harvard Business Review*, July-August, 1958 (pp.37-66).

[11] Rather, the battle between the suppliers was fought on traditional dimensions, such as product quality, technological superiority, and control of distribution channels (see Michael Cusumano, Yiorgos Mylonadis & Richard S. Rosenbloom: Strategic Maneuvering and Mass-Market Dynamics: The Triumph of VHS over Beta, *Business History Review* 66, Spring, 1992 (pp.51-94).

The second and third phenomena, limited customer entropy and a finite solution dimensionality, have been studied in food retail.[12] The starting point of marketing should be to create a 'solution space' that contains the specific requirement of a - every - potential customer. If we combine all these specific requirements with the products suppliers (can) deliver, the amount of possibilities will be enormous. Therefore it will become impossible to predict what customers will do. Forecasting sales figures will be a nightmare. The alternative approach is to skip the prediction of sales but measure continuously what customers are doing in this vast space of solutions that is provided to them. Stop predicting the unpredictable and start measuring reality. When this is done it appears that only a relatively small part of this huge solution space is actually being used (see figure 15). Again, there seems to be some form of hidden order, the result does not seem to be fully chaotic. In the retail study we did, only about 30% of the available search paths were used. This shows certain richness in customer behavior, but not complete chaos.

[Figure 15: Self-ordering of Paths]

In fact, further analysis of the data has shown that the complexity of customer behavior (for this example) could be expressed in a 10-dimensional space and therefore in a 10-digit number. We concluded that customers are considerably more complex than the traditional marketing segmentation processes can handle, but they are nowhere near as chaotic as might be observed from their apparent behavior. The entropy or their behavior is limited and the behavior is ordered to some extent. The required solution space is large, but manageable.

Heterogeneity does not lead to complete chaos. Order exists within the system. Still the most common reaction of marketing professionals when they encounter this heterogeneous customer is to increase the number of propositions (by adding more products or more options per product - see figure 2). Sadly enough this is mostly not what the customer requires. He does not care about the availability of 40 more colors when he is looking for a dark blue car. Quoting Pine, Peppers and Rogers: *"Customers […] do not want more choices. They want exactly what they want - when, where and how they want it […]."*[13] This statement could lead to ideas about one-to-one marketing and usage of very large databases to get an even better prediction of what (specific) customers want. But we are discussing customers that themselves have often no clue what they will buy when they walk into the retail stores. They might decide on the spot that they will have their meal from the microwave, out-of-home, or that they will cook an extensive homemade meal. If the customer himself does not know what he will do tonight, is it then reasonable to assume that the supplier would be able to predict his behavior on beforehand? But this makes life rather difficult. On the one hand we cannot put in every possible product because the customer would be overwhelmed by the solution space (and costs for stocking all

[12] Ton van Asseldonk: *Mass Individualisation: Business Strategies Applying Networked Order to Create Economic Value in Heterogeneous and Unpredictable Markets*, Veldhoven, TVA Management.

[13] B. Joseph Pine II, Don Peppers & Martha Rogers: Do you want to keep your customers forever?, *Harvard Business Review*, March-April, 1995 (pp.103-114).

these products would be enormous as well), and on the other hand we cannot predict what his exact requirements will be.

4.4 Governing experiment

As stated, a different marketing approach is needed. Marketing processes should change from segmentation and prediction exercises based upon customer similarities and homogeneity towards well-constructed processes of experimentation using the differences between the various customers. The trophy is the 'hidden order' in the complexity of the customers' buying patterns. Then stop predicting what is inherently unpredictable and ensure your company is able to react fast on changes in the discovered patterns.

In a retail store this could be done by running experiments in a small sample set of outlets. Different outlets could be used for different experiments. The other outlets will then learn from these 'laboratory' shops. The success of the experiment is based upon real interaction with the customer. The codification of these 'best practices' is done on a small scale, but the proliferation of the result to the other outlets needs to be fast. The approach will only work when successful experiments can be very rapidly implemented in the other stores as well.

The start of the experiments does not have to be controlled by central management; outlets could also start experiments themselves. This is a perfect way of using local energy of the local staff. It does not require lots of management energy when staff is allowed to implement their own ideas. However, 'governance' of this process by management is a necessity. The first concern of management then is to enable the local energy to flow without too much management interference. The second concern is the way the success is measured, which is of crucial importance because this sets the direction the company is going. These measurements ('direction') have to be set by management just like the 'left-goes-first' rule has been set on the roundabout (see paragraph 2). The third concern of management is governance of the stability of the system. If every single idea would lead to experimentation too much effort would be put into exploration, and exploitation - and with that current operational results - would suffer. Conversely, if too small a number of experiments would run (under-exploration) it could harm the long-term success of the company. The main task for marketing will be defining the measurements for the experiments and governing which experiments are allowed.

5. Supply Chain

The required fast reaction due to marketing and merchandising developments, as described above, has serious implications for the supply chain. The supply chain needs to be able to handle both the heterogeneity in customer buying patterns as well as the required swift rollout as a result of marketing experimentation. But the traditional supply chain and its management tools are mainly based upon exploiting economies of scale instead of accommodating heterogeneity. Examples have been shown already in paragraph 2 (see box Industrial or Tailored Kitchen and box Retail Logistics). Now we will in more detail consider the implications for the

supply chain and the way the supply chain needs to be managed or controlled.

As we have seen, a modern customer expects a rich solution space. Also, it will be impossible to predict the customer's requirements within the specificity of the place and the moment. Still, our supply chain has to cope with this problem. It needs to be able to handle a rich solution space, preferably configured under the control of the customer himself. The usual way to configure supply chain nowadays is based upon planning. Planning that is based on the assumption of reliable demand forecasts. If this assumption turns out to be invalid, as it does in the view of the world outline in paragraph 1, we need a reasonable alternative.

The last major steps in the theory of supply chain development and improvement are based upon the ideas of mass-customization. The basic idea behind this - although it is obviously much more complex than we can describe here - is that of a modular approach towards the supply chain process itself and towards the products the supply chain has produce and deliver. This modularity, based on small but very standardized building blocks, allows for very late assembly of the final product. In the extreme, the parts are delivered to the customer, who does the assembly himself. Taking into account the previously described industrial paradox, mass-customization is a way to move the complexity border for the supply chain to the left (see figure 6: Costs of complexity), not by providing a supply chain solution that is in itself more capable of handling unpredictability, but by using smaller components and greater standardization to combine economies of scale with a richer solution of end products.

Another development in retail supply chain is the initiative around CPFR (Collaborative Planning, Forecasting and Replenishment[14], other comparable initiatives exist). The idea of CPFR is that exchange of information between supply chain partners creates a better forecasting and planning module, thereby preventing excessive distortions in this supply chain. This means that the so-called 'Forrester effects' (positive feedback that cause very large and chaotic fluctuations upstream in the supply chain) will be decreased. In itself the idea of better information exchange is very helpful in the creation of a more stable supply chain, but this stability is still based upon the notion of refinement of forecasting and predictability.

Real solutions need to start from another angle. The starting point of such a solution should be based upon the *un*predictability and heterogeneity, and the supply chain needs to be able to handle this without excessive cost. Economies of scale will be the wrong answer. Rather, the ability to handle one product for the same price-per-product as a thousand products is the way to proceed. Planning will be impossible, since the (long-term) demand is by definition unknown. Therefore we need a supply chain that is in itself very adaptive, created out of small components that are able to interact with each other. The idea of small process components is in itself identical to the mass-customization proposal. The distinctive characteristic is that the configuration of the supply chain is based upon the continuous interaction of these components, not upon planning and control from above. This implies

[14] See: www.cpfr.org for a further description.

the supply chain is not fixed but will continuously find the best configuration itself, adaptive to the changing environment. Admittedly, not many examples of this approach exist in the real world yet, although the New York cab system fits the description quite nicely (see box New York Cabs).

> Box: New York Cabs
> The past basis for the New York cab control center was a central dispatcher that redirected every call to a specific driver. An example of strict central control. This central controller needed to keep track of all the dynamics of the cabs driving around the city, to ensure that when a burst of demand broke out somewhere, enough cabs were available close by this outburst. Obviously the drivers themselves were well aware of the 'hot spots' during the evening. However, the central system was slowly breaking down due to the unpredictability of the demand. More and more planning was introduced to cope with the problem, but results were getting worse. Then the system was radically changed. Instead of redirecting every call, possible rides were announced on the board radio, and the first cabdriver responding got the call. Emergent order was visible through the movement of the cabdrivers over town. When the time was around ten o'clock, the time Broadway musicals tend to end, all empty cabdrivers moved slowly in the direction of Broadway. Nobody ordered them to do so, but it was obviously in their self-interest. Less management and less (advanced) planning made the system better.

The supply chain that can handle the heterogeneity of the modern customer has to be adaptive and needs to be able to configure itself instantly and to reconfigure itself continuously. It will be a network of small nodes and products will find a way through these nodes (see figure 16).

[Figure 16: From Production Sequence to Flow System]

The route a product will follow will be unknown at the start of the journey, the best route can only be found along the way (this principle is used heavily in telecommunication networks, often based on the simple rules of ant colonies on their search to food). No detailed planning is needed, although some general planning is required on the amount of resources. The goods in the supply chain will find the best route available by communicating their destination and asking every next node if it brings them closer to it. The best answer provides the next step in this dynamic route. A simple example -only one step in routing - is the way airplanes are handled on their arrival at the airport (see box Gate-handling on Airports).

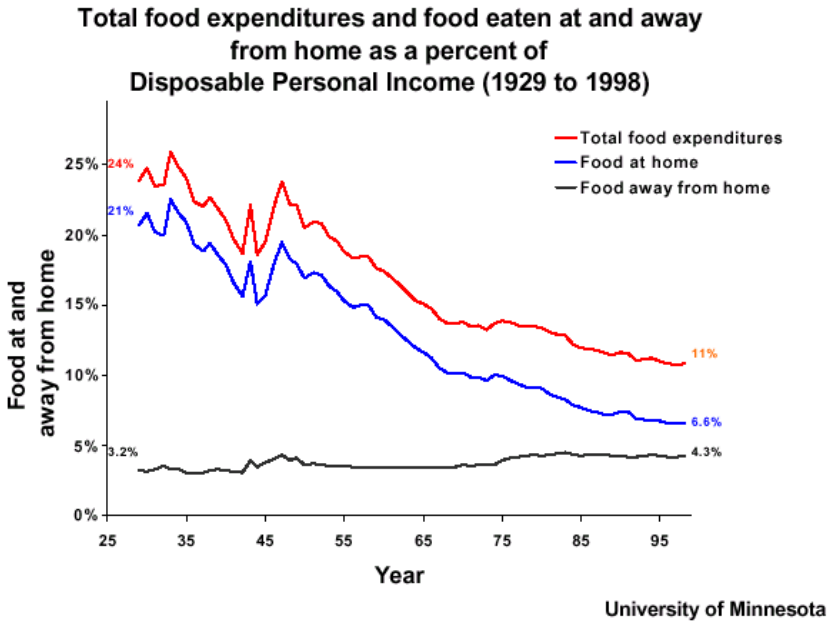
> Box: Gate-handling on Airports
> Currently on airports a schedule is made on beforehand to link an incoming airplane to a gate. During the day there are all kinds of delays and roughly 35% of the planes are eventually coupled to another gate than the one originally planned. The exception has become the rule, which makes planning in advance in fact ridiculous. When we introduce some simple constraints (not every plane can get on every gate, there is always a preference for certain gates, etc.), we could handle the gate-allocation on the flight when the plane arrives. In line with the theory, the plane will ask every available gate its 'cost'

(or whatever measure for 'cost' is used) and pick the best alternative. This simple interactive principle does away with all planning and re-planning cost. The only thing we need to plan at some point is the total number of gates we need to handle the total number of airplanes during the day.

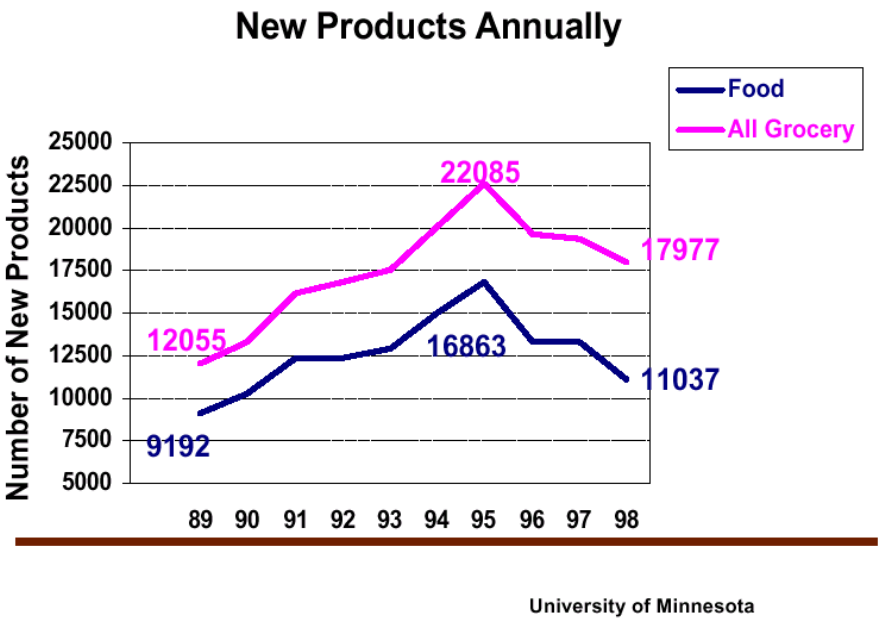
Supply chain solutions that cope with unpredictability and heterogeneity are based upon emergent order. The energy is created inside the system through interaction of the players, the direction is clear - the product has a defined end state. The supply chain is not managed anymore but governed in a much lower frequency. Like the roundabout it will be able to cope with many unexpected change and recover form errors itself. Order created from within! The supply chain doesn't care about the number of different products anymore, and it will be able to fulfill the heterogeneous customer as well as the previously described marketing demands.

6. Conclusion

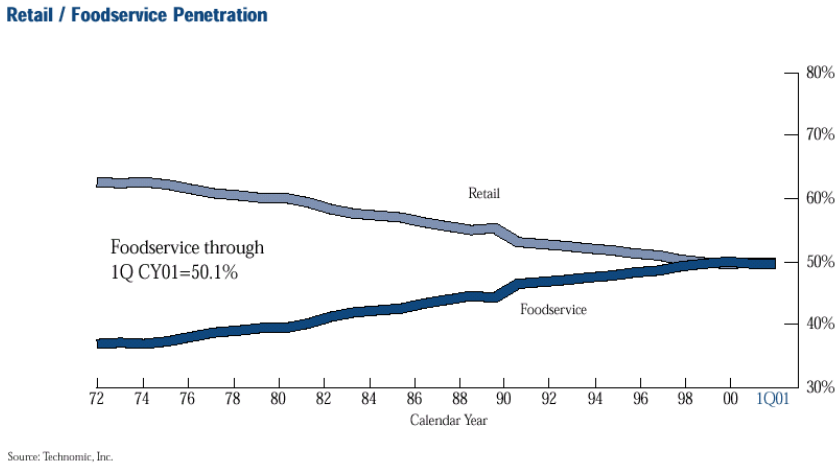
We showed that customer demand is becoming more heterogeneous and less predictable. As a consequence of this, and because the food market is not growing fast enough, food retailers are stuck. They cannot grow in volume, and it becomes increasingly difficult to earn money through efficiency or differentiation. Their business processes are not able to cope with these changes and have to be reinvented. Improving current processes does not solve the problem since central control cannot manage the required level of change anymore. The industrial paradigm has reached its limits: order can not longer be brought to the system by central management. Simply taking away all the management, planning and control will lead to chaos, but even left to itself some form of order exists within these kind of systems (like in nature itself). A period of chaos, however, is not acceptable for a company, as it may go bankrupt in the process. Therefore, other ways to get to better results are needed. A better approach is to create systems that are essentially self-organizing and are adaptive to their environment. The ordering of these systems has to be based on interaction, not by creating communication between all nodes in the system, but by governing the conditions that allows the system to function. Energy comes from within the system. Management as a system governor provides some direction and ensures stability. This will allow for marketing and supply chain systems that are not chaotic, but can still handle the unpredictable demand of the customer in a profitable way.



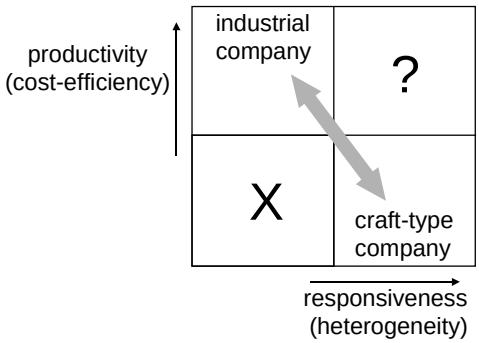
[Figure 1: Food Expenditures as a Percentage of Personal Income]



[Figure 2: Annual Number of New Food and Grocery Products]

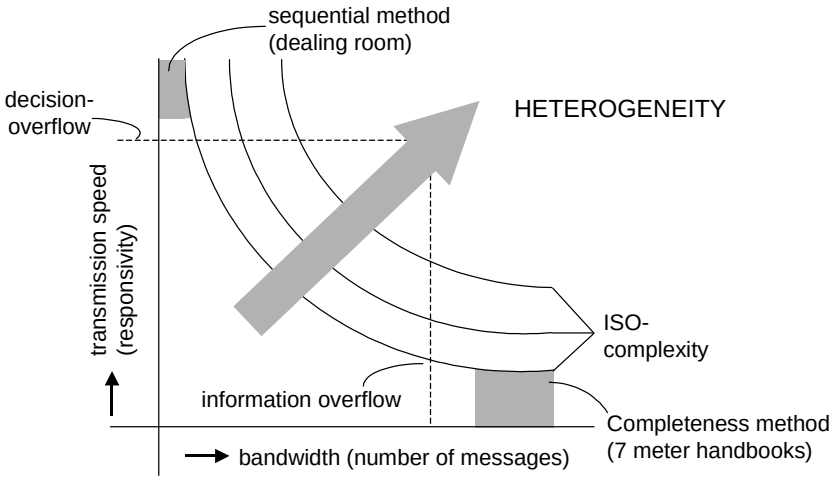


[Figure 3: The Growth of the Out-Of-Home Market]

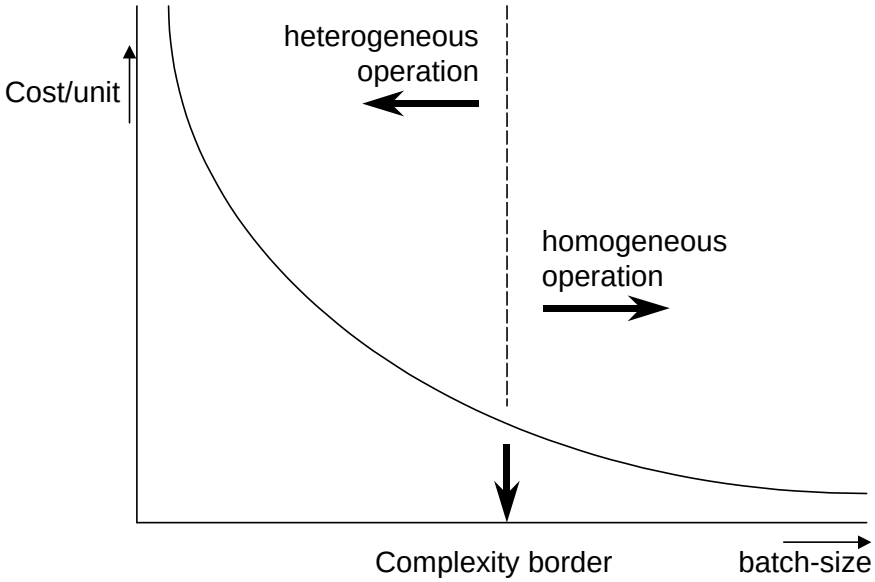


[Figure 4: The Industrial Paradox]

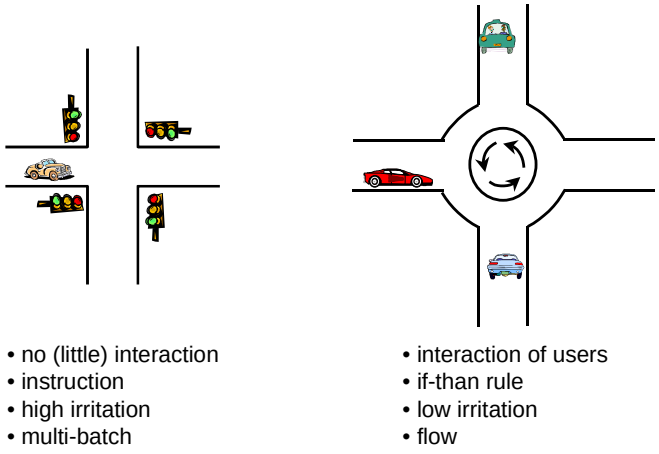
Breakdown of communication



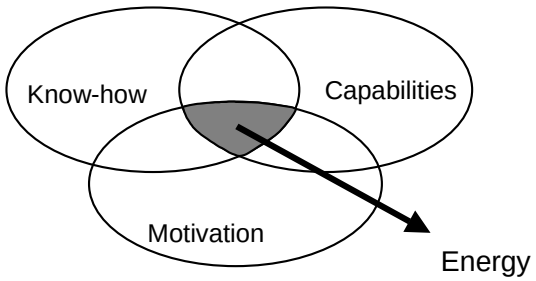
[Figure 5: Breakdown of Communications]



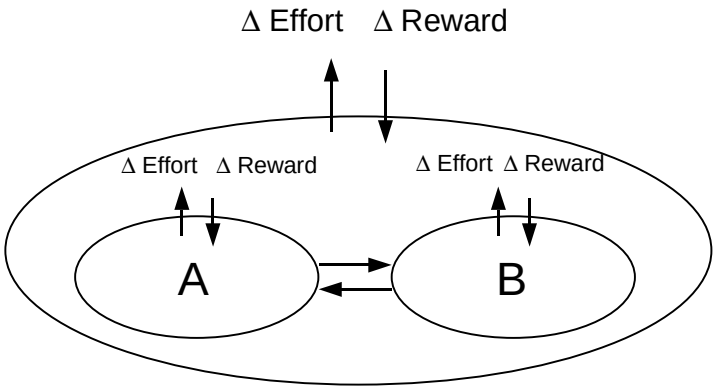
[Figure 6: Costs of Complexity]



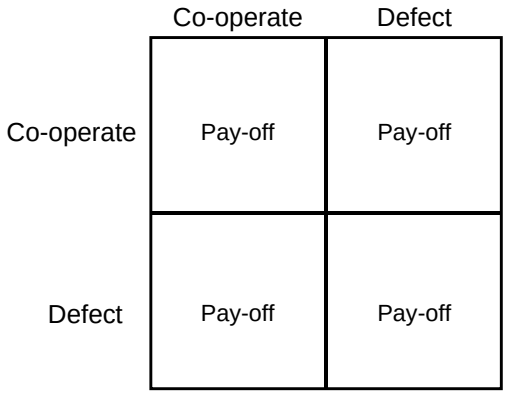
[Figure 7: Crossroad and Roundabout]



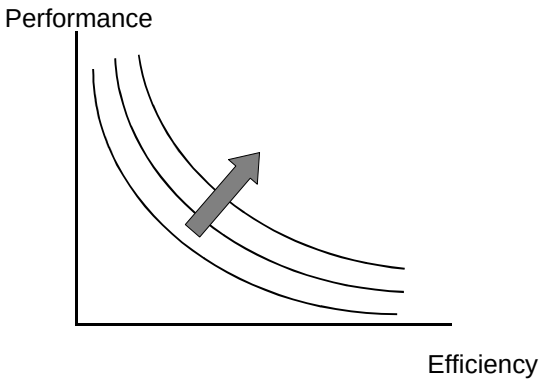
[Figure 8: Know-how, Ability, Motivation]



[Figure 9: Energy from Interaction and Self-interest]



[Figure 10: Payoff Matrix]

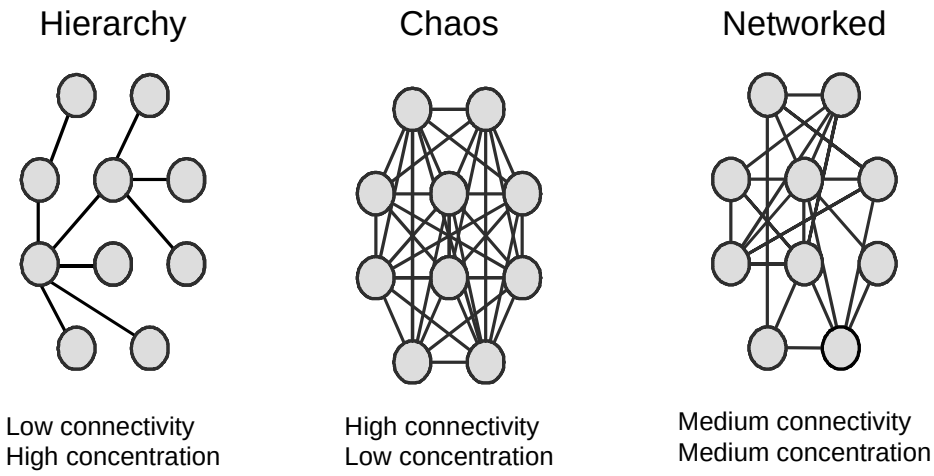


[Figure 11: Performance-Efficiency]

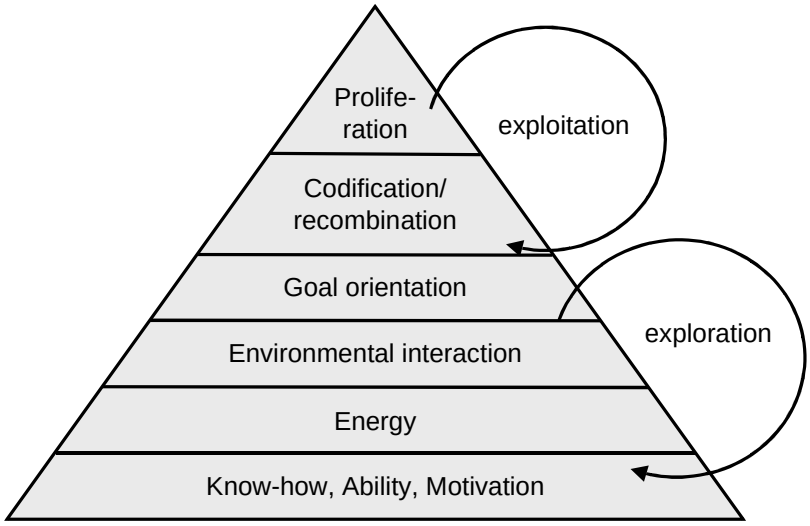
IF (event A and event B and not event C)

THEN (action X)

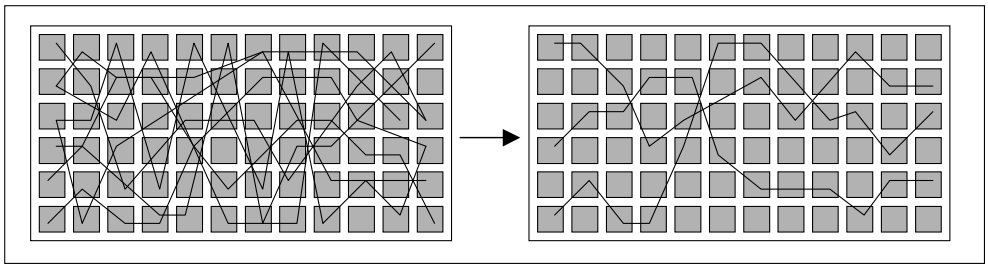
[Figure12: Codification and Recombination]



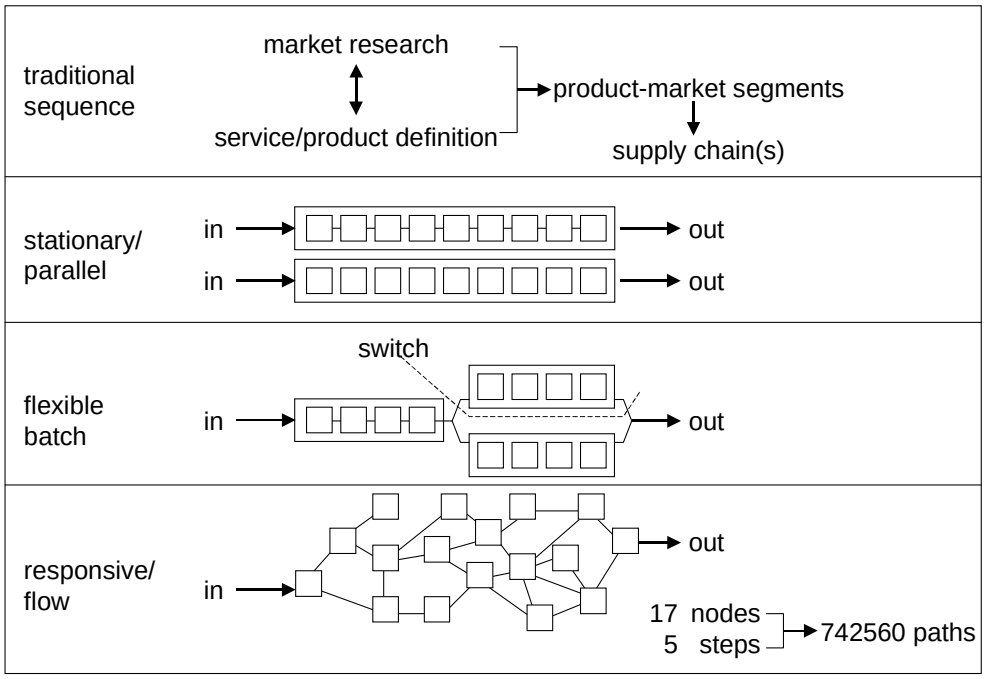
[Figure 13: Connectivity and Concentration]



[Figure 14: A Hierarchy of Emergent Order Principles]



[Figure 15: Self-ordering of Paths]



[Figure 16: From Production Sequence to Flow System]