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HOW TO MANAGE COMPLEXITY?

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1. Frame for Action

For many years now science has been examining people and how we deal with those situations that are characterized by uncertainty, complexity, intransparency, self-driven dynamics and interlaced entanglement. The aim is to analyse how thought and action interact.

Scientists observe how individuals gather information and make decisions. Based on their conclusions, they try to perceive what people think and feel as a result.

Scientists undertake these studies in order to develop a theory about the human psyche. On one hand this allows them to understand better how people think and act, while on the other it creates the opportunity to train and improve the ways of thought and deed.

Almost all only moderately complex situations indicate the features mentioned, even if it will only be a slight complexity. As soon as you find yourself in a situation like this, you will be confronted with these sorts of characteristics.

For the business owner, who would like to improve the financial situation of his company, his field of action is his company and its relations to other areas of business. For an engineer who would like to switch on a complicated machine, this reflects his complex field of action.

An educator's field of action might be deciding how to introduce a particular topic to children. A mayor facing the fact that his community is close to complete financial disaster, has the community inhabitants as well as the authorities, administrators, and economy as his complex field of action. The computer programmer who is faced with the challenge of running some software also has the computer itself as a complex field of action.

A normal person is confronted with complex situations throughout their life and responds accordingly, makes changes to the situation etc. The complexity of the situations will not necessarily be experienced with comparable complexity in one's own course of action, neither in the way of dealing or perceiving it. How a situation is dealt with and perceived may be relatively simple.

We can observe this in, for example, a programmer who is of the opinion that he can find and correct errors in his programming by shouting loudly, hitting his keyboard and shaking the monitor.

2. The Definition of this Work

The processes taking place within complex systems effect each other in a way which cannot be resolved with a simple linear "if-when" rule. Taking this into account complexity stands for multi-causality, multi-variability, multi-dimensionality and openness. Within complex systems one may find a high level of uncertainty, which technically will lead to instability. These variations are, at the same time, the cause for the system's ability to show self-adaptiveness and flexibility.

All entrepreneurial activities take place in a complex environment, and at the same time they themselves build up complexity. Even when we regard these complex relations as initially confusing, the level of complexity must not be reduced too greatly:

“A more complex organism is likely to be able to deal with the most varying environmental conditions. Variation and primary selection do not lead to a tendency for even higher complexity. Contrastly a more complex organism that can adapt to various environments is more likely to survive continuing phases of selection than varieties that have solely adapted to the first changes in their environment.”

To master complexity and also given the opportunity to increase it, it is not necessary for the methods to become ever more "complicated".

Often it is typical for complex processes, which through repeated usage (and their non-linear effect on each other) of simple, although carefully selected, rules to become complex structures and behaviours. ("self-organization")

In order to deal with complexity effectively, we should follow our instincts for processes as a whole, rather than just react upon lists of figures we get from linear calculations, since this mostly disregards non-linear interactions in the first place.

This is also the point where the ability of making centralized decisions in a business unit actually ends. Decisions made within complex systems must be made in continually changing conditions. One can even calculate mathematically that it is not possible to separate between the decision process and the actual realization, since the decision-making-process occurs under unstable conditions.

Complex situations exist from self-mediatory activities of their various components. For example, you might find them occurring in multi-agent systems and in control systems for production and planning, which also show more competencies in decentralized areas. The link between the acting components must present a structured link, which means that one component must never be vital for the very true existence and self-perception of any other component.

However, one cannot say that complex systems are only built up through unstructured accumulation of various components. Although these systems show a great variety from within, they normally are controlled by so-called ordering parameters, such as profit maximization and business visions. These parameters should not come from the "outside" or from "above", they only can work as stabilizing factors if they were created from within the system. The stability of the process cannot be assured through an equilibrium in the system but through the respective ordering parameters.

The assumption that reality is mere complexity, might have the effect that only abstract patterns and links can be recognized and the respective qualitative peculiarities may be missed.

Developments that occur specifically on the various levels of tangibility of any given real structure are of importance, as it is not possible to recognize those on an abstract level. Comprehensive reasoning as opposed to mere interpretation demands the reflection of tangible common knowledge of any of the given research levels.

3. Structure Concepts

Human courses of action which are targeted to reach a goal, require the knowledge of the actual context in which the actions will take place, plus the knowledge of cause-effect-connections which define the consequences of theses actions.

It is necessary then for humans to put structure on the world which is surrounding them, as well as on the things they see, experiences they have, and also experiences and actions made by other humans. If possible, humans should use a vast organizational pattern for their experiences and actions.

"Mankind's increasing activities to control nature characterize our modern times, as well as our more autonomous approach towards the rules of living together. This course of action requires not only a vast, but also a detailed structure of our world, in order that we are able to deal with the consequences for actions more adequately. If it had not been for the 'true' structure of our world – even if it has not yet been fully accomplished – we could not have yet gained all the technical achievements ever since the times of the Enlightenment. These achievements were only made possible by using the human mind as the source of action."

Three elementary concepts for the structure of our world exist:

Concept of space: To structure the actual space surrounding us, we use a system of co-ordinates. This means that any purposeful movement is explained by defining the distance and height in this space co-ordinate system.

Concept of time: The creation of this concept caused more difficulties than the concept of space, because humans do not possess a specific sense to perceive time. Besides, to really measure the component 'time' we need to follow the physical demand for space itself.

The fact that we are able to perceive a time pattern is only possible, due to the fact that we rely upon our mind's ability to memorize past experiences. "This also allows us to base future actions upon experiences and decisions made in the past."

Without conscious measurement of time and the knowledge of historical periods, the discovery of the cause-effect-connection would not have been possible. We would not be able to make plans, have thoughts about the future itself without this concept. Instead we would just be following our instincts.

The Principle of Causality: Along with the two concepts regarding the structures of the world mentioned previously, on which we can experience through our senses and the memory, the concept of causality allows a more detailed debate with the environment.

This third concept also allows a more detailed debate on our environment. The description of when and where a situation took place is no longer only of principal interest, instead the question 'why' it occurred presents the most relevant approach. The principle of causality brings about the more pro-active concept that we no longer regard events as coincidental, instead that we are now able to take a certain amount of actions into consideration, even if initially we were not familiar with all components.

A connection is as a result then present when a configuration of events in the time-space-continuum is proven and only if we can set up a valid "if-then" equation. The principle of causality, i.e. thinking in "cause-effect" connections, is therefore defined as a meta-rule (thought heuristics) which allows us, at least partially, to oppose chaos and random action by planning and orderly actions.

Management tasks are often present as inadequately defined decision functions. Inadequately defined decision-making (problems) requires, as a result of the necessity to make use of heuristic proceedings, also taking into account scant resources (budget, staff and time), to look for the right solution for a problem. With the help of heuristic principles one can search for attributes to solve certain kinds of problems, although the perfect solution for any given case cannot be guaranteed. Heuristic principles are rules and theories, e.g. analogies, formulation of additional restrictions, factoring, forward/backward movement, used for problem solving and on average will reduce the time spent on the solution finding process.

3.1. The Need for Affiliation

According to Schachter's studies, complex and badly-structured problems can lead to a higher need for affiliation to be able to perform socially comparative processes. A situation like this may be experienced rather problematically when

- a person perceives a situation occurring in their environment, in which the characteristics of the situation are assumed to be changeable.

- the person willingly wants to change the situation, and the achievement of the required status is not directly possible, whereby one must also consider if a possible solution can not be reached at all, or whether it is necessary to make several modifications in order to achieve the desired status.

The need for affiliation appears, to a high extent, to be a specific phenomenon: “In difficult situations we do not socialize with just anybody, but we prefer the company of people who share the same personal situation (s. ISAHP2001).”

Schachter’s study refers to following reasons for this behaviour:

- Desire to find the solution to a problem in the status of ‘dyad’ or in a collective. (Increases risk-readiness to ‘flee’ the situation).
- Desire for more information regarding the structurization of the initial status, the final status, and the operator’s space.
- Desire for direct reduction of fear (shared sanctions due to the anticipated aim deviations).
- Desire for indirect reduction of fear (goal change by competitive relations in the group)
- Desire for social comparative processes

However there are often problems which are considered new or unknown to the groups or people who seem to be suitable to perform as reference people. In cases like this the group has to ‘acquire’ a common opinion in the first place, which we also have achieved here in Bern during this conference, so now I’d like to take the opportunity to specifically thank Prof. Dellmann.

Festinger claims that all possible opinions (definitions, connections) can be ordered in a hypothetical continuum. At one extreme of this continuum are opinions based on physical reality and at the other extreme are opinions based on social reality.

To be able to compare opinions of the social area the social comparative processes are of great importance. As a result of this process three different forms are possible:

- Agreement between reference groups/person, as well as between the individual who is being compared with them.
- Status of agreement within the reference group/persons, but discrepancy exists between them and the individual of comparison, or
- No disagreement within the reference group. If the divergence of opinions is problematic for the group this will start and stimulate conformance processes.

3.2. The Significance of Attribution for the Management of Complexity

The broad concept of cognition, i.e. “human approaches to the world”, includes

- the cognition of everyday life
- the aesthetic realization
- the valuing realization
- the scientific realization of the world

“The most complex form of realization of the world is the cognition of everyday life. Mostly this is a complex which consists of an aesthetic world representation, of value schemes and of academic cognitions, or the mere reference to scientific results.”

To achieve statements about the management of complexity, amateur causal perceptions are being used (= observations and/or measurements on a basic level), according to the operative and operational conditions. They can be found in relative clauses, in clause systems, as well as in clause sequences which hold theoretical terms.

The layman's causal perception is referred to as attribution, as Heider states. “Attribution theorists over and over compare the "average man/woman on the street’, with a scientist: They collect data and build their conclusions upon certain rules (meaning, they create attributions). According to these conclusions, they then set a course of action.”

Heider and Kelley present the view that attributions are not equivalents to an end in themselves, but arise from the desire to make predictions and then be able to control the world (compare Structure Concepts). The formation of attribution may be 'explained' by means of several research approaches:

Through Kelley's Principle of Covariation: "The effect will be affiliated to the condition which exists when the effect exists, and if this condition is absent then the effect is absent." So the observer interprets experienced conditions or correlations as causal relations. Depending on what kind of context may be found between the actions, which associating cause should be discovered, Kelley differentiates between consensus, distinctiveness and consistency. Depending on their intensity which effects the observer they either will then cause a stimulus-related, a person-related, or a circumstance-related attribution.

But this may indeed lead us to deceptive correlations as we know from the coherence hypothesis, an example for this is the German expression "The more storks, the more babies".

Through the Application of Causal Schemes (Orvis, Kelley): If during the course of the attribution process, the observer can not process information on consensus, distinctiveness, and consistence due to lack of time or lack of information, we refer to these conditions as "uncompleted causal analyses".

In cases like this (compare conditions under time pressure) we revert to causal problems to cut short the attribution process. I.e. the entire attribution process will then be replaced by known assumptions about the possible reasons for a certain action. In addition to this first causal scheme ('appendix-scheme') also the second kind of causal scheme is of relevance for us. Based upon the supposition about coaction of two or more causal factors, we understand this scheme as a relation to a certain category of effects. Their application only occurs in a course of attribution processes, when we only have one single occurrence of an action. Due to this occurrence of action neither consensus, distinctiveness, nor consistence information is available for the attributing individual.

Through the Principle of Weakening (Kelly): "The role of a specific cause will be weakened during the process of the creation of a specific effect, in the case of the existence of multiple reasons."

Through the Theory of Corresponding Inferences (Jones/Davis): This theory is concentrated on attributions of individuals and contains the hypothesis that " the perceived freedom of choice is a prerequisite for the dispositioned attribution – i.e. a person's observed attitude is a result of internal causes.

Through the Hypothesis of Remarkableness (Duval): "There is a tendency to attribute increased causal effects to those aspects of an occurrence, which are able to focus the attention on themselves."

Through the Ajzen's and Fishbein's Bayes Approach: Ajzen and Fishbein claim that the relevant 'transfer effect' in attribution theory lies in the utilization of the inference dimension, and not as occurring up till now in the attribution dimension. (H/D). The inference dimension is defined as the difference between the hypotheses of a posteri- and a priori probability. So the inference dimension does not stand for the certainty of attribution, as stated in the Bayes-approach, but instead points out the shiftings of the initial probability of the hypotheses, which are caused by the appearance of new pieces of information (compare Multiple interviews during the run of a Delphi).

Through Bein's Theory of Self-Perception: "Individuals sometimes get their 'knowledge' from their own attitudes, feelings and other inner states, by observating their own behaviour and/or the conditions underlying this behaviour."

Through Seligmann's Theory of Acquired Helplessness: " If the probability, that a certain occurrence "S" follows a certain behaviour "R", is equivalent to the probability that this occurrence "S" appears without behaviour "R" – i.e. if p (S 1 R) = p (S 1 non R) – then the occurrence is independent from the behaviour (there is no contingency). If the occurrence "S" is independent from all forms of behaviour "R", then occurrence "S" is out of control."

Through Weiner's Performance Theory: Weiner allocates the causal factors introduced by Heider and Kelley (skill, effort, task difficulty, and chance) to two theoretical dimensions: stability and place of control. In addition to that Weiner suggests to add the factor controllability as a third dimension to this theory. This dimension is mainly relevant for interpersonal judgements which most notably are necessary when dealing with majority or minority opinions in the course of problem solving processes.

4. Terms of Complexity

Complexity has become a fashionable term. It seems as if a layman's causal perception as well as science itself are developing according to a changing sequence of guiding terms.

I would like to specify several application settings for the term complexity. – I will start with the social utilization of complexity as a term, then move on towards the scientific utilization, and finally introduce a philosophical approach on complexity, as developed and practised by the French science theorist, philosopher, and mathematician Michel Serres.

4.1. Complexity as a Social Term

As far as society is concerned, complexity is mainly associated with problems. I. e., we only refer to complexity during everyday life situations, when we speak about problems which cannot be easily solved. In this sense complexity stands for the confrontation with uncertainty. Frequently this leads to the willingness to push problem-solving activities, as well as the means for it, or at least it may lead to the search for patterns for a problem-solving process. This also offers the opportunity to encounter a common interest phenomenon: the correlation of complexity and strategy.

4.2. Complexity as a Scientific Term

Science offers such a great amount of complexity terms that it seems impossible to bring them all together. This is the reason why the following statement to a certain extent appears rather simplified. Roughly said, we talk about a quantitative and a qualitative complexity term.

What we regard as the quantitative approach is the definition of complexity with respect to a high unknown number. No doubt this is also tangent to another criteria of complexity: the high amount of elements and their relation to one another.
In a way the determination of qualitative complexity correlates to the quantitative determination. Not only can we refer to anything in the form of a large quantity as being complex, but the term complexity also comes to our mind when we take into account its structure or internal organization of links.

In that sense we may ‘translate’ complexity with the terms interwoven, entanglement and interlocking.

This feature of complexity also has consequences, which is the reason for a frequent identification of the term complexity with information deficit. The predictability of a certain system has its limitations, because not all factors are assessable. Complexity here forms an obstacle for cognition. The reasons for this can be varied: referring to materialism, logic, and structure.

Also autology (self-respectiveness) might be a possible agent for complexity. In that sense scientific experience turns into something unpredictable and this development is well apreciated by its proponents. Complexity as a paradigm stands for the current opening of science and the new ways in heuristics, and it also creates hope for a new dialogue with nature – as described by Stenger and Prigogine – and intended collaboration between all scientific fields.

4.3. Complexity as a Philosophical Term

Serres’ approach is user-oriented. According to Serres the concepts of ‘use’ and ‘produce’ simply mean to look for a pathway without cutting short the path: “On one hand, if you cut short the path or leave out a piece, you will find people who speak about their worlds in a very exact manner, although they have completely forgotten about history and culture. However on the other hand, you will have people who practise human sciences without having the slightest knowledge about the world and its changes.” As a compensation to this state you need an educated third party. People with a duplex education bring along their own pathways between the several cultures of science, as well as their experiences made on this path.
The term complexity shows, in an exemplary and also in a pragmatic way, the harmonization between the two fields of human sciences and exact sciences.

Complexity and strategy apparently are linked to each other: if we strategically reduce complex problem definitions, problems will occur which again will be transferred to the account of complexity. This is a rather questionable (yet remarkable) phenomenon. Therefore one may understand Serres' intentions, when he uses one of La Fontaine's fables to paraphrase: "Oh, how happy we were, Margot, do you remember when so-called problems were still unsolved…?"

5. The Pattern of Thought

We all have patterns of thought in our minds that we have been building all of our lives. For example we learn to recognise and name aspects of experience - both tangible aspects like 'car' or 'factory' and intangible aspects like 'passion' or 'development'. These patterns of experience also include non-nameable and sometimes extremely complex patterns, of which we are barely aware, but which may be vital to our wellbeing. For instance we may make decisions about investment in development without being able to put our finger on why we believe it is necessary or why it will work out well.

Many of the deeper patterns are fixed and forgotten – for instance, how to ride a bicycle. We forget why we behave in certain ways and sometimes the way we behave is more driven by forgotten patterns than by current circumstances. In other areas we are constantly shifting patterns and experimenting with re-arrangements – we continue to learn.

As we try to deal with ever more complex and dynamic situations it is helpful to get ideas out of our heads and into a medium where we can explore their content and their relationships. This is particularly valuable where several minds need to engage with a common issue - especially where specialist competencies need to be brought together to deal with an intractable problem. In our complex modern world we often need the diverse contributions of a variety of minds.

There are many ways we can do this. Usually these will involve visual representation to transcend the limitations of language and communication. Literally these could be pictures (or a Powerpoint slide show), or may be 'maps'. As in geography, maps will tend to have more precision than pictures and the knowledge may be more easily recovered. Mapping our thinking can be done directly onto paper or other medium as in 'mind-mapping' or use can be made of techniques which allow individual ideas to be moved around to try out different spatial relationships and interconnections. MagNotes – dry-wipe magnetic hexagons - are ideal, although even common Post-it notes can be used within limitations. This is very intuitive and, without any tuition, most people will distinguish subtle differences of meaning by moving ideas even very slightly in relation to one another. With practice and a little rigour in relation to the writing of the notes, powerful intuitions and insights can be generated.

Just as early explorers made enormous strides by representing locational and environmental experience as pictorial maps of information (which revealed not only what was known but, even more important, what was not known) so we can represent visually information in the terrain of our minds. We do not only have pictures in our minds but also can easily relate to visual representations of thought patterns. How often do you see someone gesturing or sketching to illustrate their thinking - we use the expression 'a picture is worth a thousand words' to describe the richness of pictorial representation. A map is a representation of the whole of what is known and can also be comprehended as a whole.

There are many techniques for making thought maps and the following technique, VISUAL CONCEPT, is one of the most powerful and intuitive tools available today.

When we try to communicate ideas we use pictures. We use our hands to create pictures, we draw in the sand or we move objects around the table express our ideas. Even subtle nuances can be expressed by the relative position of the objects we use to communicate. Of course this is not surprising as we all have physical bodies through which we relate to the world and, indeed, through which we have discovered everything we know and experience.

In the computer world of today we speak of 'object orientated programming' which is the way computer environments are evolving to match more closely the inner world of our minds. VISUAL CONCEPT is a tool which makes it very easy to extend the pattern recognition capability natural to our mind, and to develop a fluency in visual thinking that can be used to structure your knowledge, to express your ideas, to solve problems

and to communicate clearly through writing and speaking - anything from short presentations to theses and books.

Nowadays we talk a lot these days about information technology, but how useful is it for us? Is information all that we want? Is more information better? Information is part of a logical hierarchy. As humans we want to give meaning to our experience by using various processes and stages which then ultimately transform raw experience into wisdom. Things are - whether we take notice of them or not. As we notice and observe we turn these proto-facts into FACTS. By collecting facts we can generate DATA which can then be collated to provide us with INFORMATION. Information needs to be contrasted and compared and assimilated into a context, in order to become KNOWLEDGE. By accumulating and integrating knowledge in one context we develop our ability to understand others - the basis of WISDOM.

To engage in the process of meaning making, is to move up this hierarchy .

Suppose we go back to the development investment decision that we mentioned above.

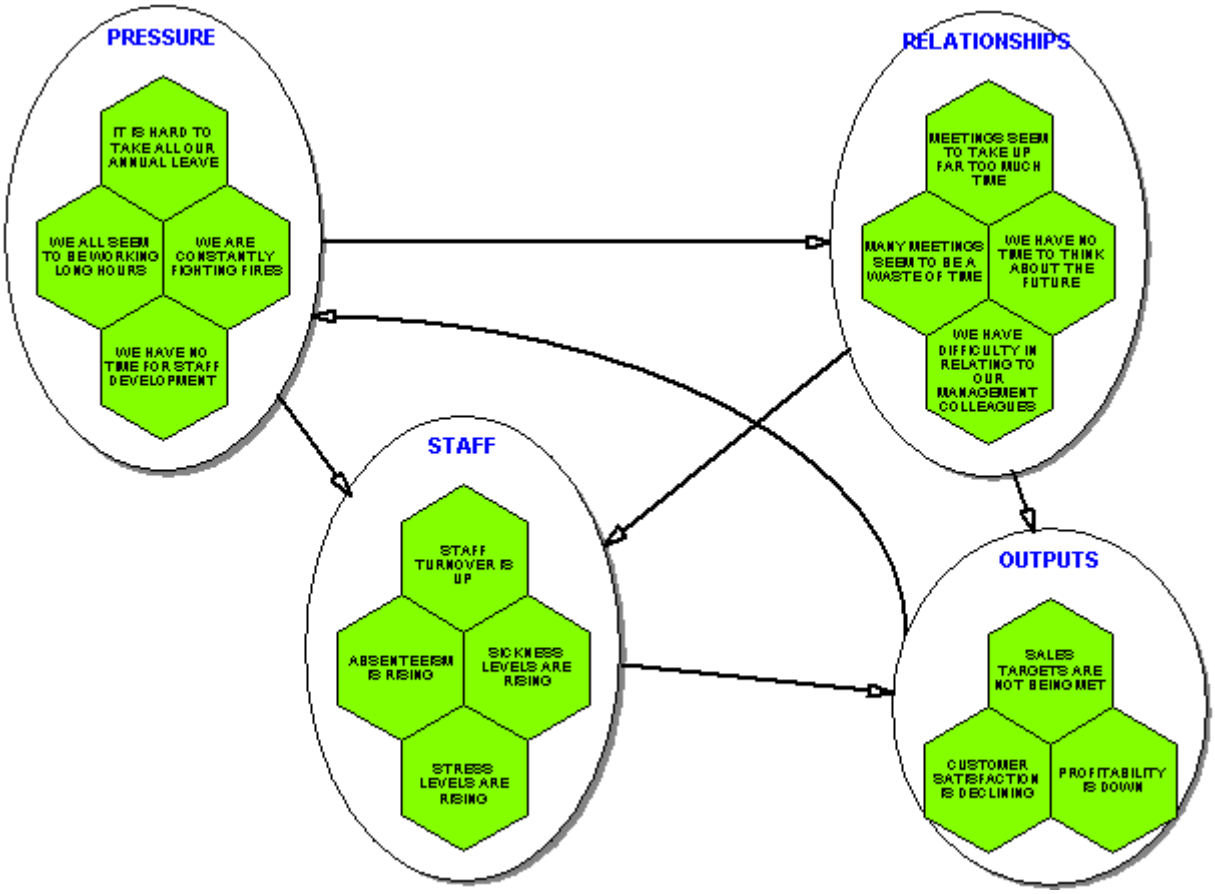
There may be some hard facts:

- Absenteeism is rising
- Customer satisfaction is declining
- Profitability is down
- Staff turnover is up
- Sickness levels are rising
- Sales targets are not being met

and there may be some soft aspects:

- We feel we are lagging in staff development
- We experience difficulties in relating to our management colleagues
- We all seem to be working long hours
- It is hard to take all our annual leave
- Meetings seem to take up far too much time
- A lot of meetings seem to be a waste of time

When we put these together we may have a map that looks like this:



A map like this helps to explore what changes we need to make and how we need to proceed to get the results we are looking for.

Without the means of expressing this to our colleagues (or even to ourselves) we may make a decision based on little more than guessing. As we express such patterns and share them with somebody else, we can begin a process of exploration and design. This will then develop towards a shared strategy for change. In doing so we spread the capacity to make good decisions in such fuzzy areas and also improve the quality of those decisions by including more minds in the process. So we are developing a way of moving up the hierarchy, changing information into knowledge – actually creating meaning through our interactions.

6. The Principles and Phenomena in Problem Solving

To advance our understanding of problem solving and to explain some oddities of human behaviour it will be helpful to have available a list of several very useful ideas developed over the years. Being acquainted with these concepts will help us to develop better and more readily accepted solutions. These concepts will also help us to understand what is going on when our solutions do not appear to be working as logically as you thought.

The Hawthorne Effect. The attention paid to people when a problem solver offers them a solution or benefit can have a greater positive effect than the solution itself. The psychological happiness produced by the fact that the solver "cares about" the person with a problem can produce increased motivation, production, health, and so on. Therefore, the solution itself may not be the cause (or the entire cause) of the positive results. (Compare the Placebo Effect.)

The Placebo Effect. A placebo is a harmless pill (usually made from sugar or starch). During the testing of new medicines, one group of people is given the medicine which is currently undergoing a test run, while the other group is given a placebo. So that no one knows who is getting the real medicine and who is getting essentially nothing. The first amazing fact in the placebo effect is that sixty percent of those taking the placebos report

feeling better. The second amazing fact is that this holds true even when the people are told they are taking a dummy pill.

Occam's Razor. Entities ought not to be multiplied except from necessity. The explanation which requires the fewest assumptions or presents the lowest level of complexity, is most likely to be the correct one. In other words, when two or more explanations satisfy all the requirements for a satisfactory explanation of the same set of phenomena, the simpler explanation is the right one. This "law" was proposed by William of Occam (also spelled Ockham), a fourteenth-century English philosopher. It is not always correct, but nevertheless presents a useful idea.

The Peter Principle. In all hierarchies, whether in government or in business, every single employee tends to rise to his level of incompetence; in any position you may find an employee too noncompetent to execute his duties. The idea is that when people perform a job well, they will be promoted to a more complex and difficult position. Eventually, they either rise to a highly complex position or will no longer be promoted in case they are not able to perform on a high and competent level. They stay on the level where they are no longer competent. This "law" was partly intended to be tongue-in-cheek, but there is a distressing amount of truth to it. (A corollary is that work is accomplished by those who have not yet reached their level of incompetence.)

Parkinson's Law. Work expands as to fill the time available for its completion. If a project is given six months for completion, it will require six months to finish. If the same project is given two years for completion, it will require two years to finish. Two factors are responsible for this phenomenon. First, when a deadline appears to be far off, people work more slowly and put tasks for that project farther down their priority lists. Second, when a large amount of time is available, people will do more unessential things on a project than when less time is available. Most projects are defined in a way that many non-required tasks can be performed or cannot performed, depending on the available time.

In any project activities increase exponentially as the deadline nears, because humans have a tendency for procrastinating and will do most of the work close to the deadline. The solution to this problem is to set multiple deadlines for segments or parts of a given project, to assure that the project advances in a healthy and timely way. Deadlines are extremely valuable for producing results. Any project assigned without a deadline is likely never to become completed.

Parkinson's Second Law is that expenditure rises to meet income, and Parkinson's New Law is that the printed word expands to fill the space available for it. WE can say the same about television news, management levels, and a whole host of other entities. Named after professor C. Northcote Parkinson of the University of Malaya, 1955.

Murphy's Law. If anything can go wrong, it will. There are hundreds of corollaries to this law, all pointing out that too often we do not "expect the unexpected." Murphy's law is a sobering reminder for us to control our assumptions on how every part of our plan, solution, or idea will work out. Named (possible, but not for certain) after Ed Murphy, 1949. Corollaries of note include nothing is ever as simple as it seems, and everything takes longer than you expect.

The Pareto Principle. This is also known as the 20/80 rule or the rule of the vital few and the trivial many. The principle states that the vital few are responsible for the majority of effect or importance: 20% of a company's salesmen are responsible for 80% of sales; 20% of a company's customers provide 80% of the product volume; only 20% of the problems on a long problem list are responsible for 80% of the difficulties; and so on. The percentage figures are not intended to be real - in a given case, 13% of the employees may make 87% of the phone calls, etc. The idea is to realize that a small core - of people, problems, ideas, products, events - is responsible for the majority of effect or importance. If you know, for example, that 20% of a grocery store's product items provide 80% of the store's sales or profits, you might want to set up a mini-market that carries just that 20% inventory.

Remember that the Pareto Principle works in reverse, too. If 20% of what you do accounts for 80% of the impact your work will have on civilization, then 80% of what you do accounts for only 20% of the impact. This principle was named after its enunciator, Italian economist Vilfredo Pareto (1848-1923).

The Rule of Redundant Systems. All critical systems should have a redundant backup system. When failure of a system will cause serious harm, there should be some substitute means of performing available, which then will perform the functions of this system. With airliners, for example, there are sometimes triple redundancy

control systems: three separate systems operate the control surfaces of the aircraft. A new high-speed train will have three braking systems: one electric, one hydraulic, and one compressed air. In business, a redundant accounting system might be employed, such as computer and paper, disk mirroring (where data is written to two different storage devices) and so on. In a family situation, redundant communication channels may exist: regular family talks, refrigerator notes, special retreat time, after dinner problem solving. Also in the business world redundant communication channels are desireable. If the company newsletter fails, a staff meeting may be scheduled. If a memo is forgotten, make a phone call. The Rule of Redundant Systems is not intended to work as an excuse for sloppy or defective systems, always refering to the backup as a common excuse. The redundant system is only there in case the primary excellent system should fail.

The Zeigarnik Effect. This is the desire to complete one task before beginning another. There is a pronounced psychological need in most of us for completion: we do not like to drop one project in midstream and start with another. This effect explains why some people especially resist interruption, why some people work after hours to finish a task before going home, and why some people have difficulties to simultaneously handle multiple, protracted projects. This completion need can be handled by structuring tasks around natural interruptions like breaks, lunch, quitting time, and so forth, and by training yourself to view interruptions or task-switching as acceptable and normal.

The Contrast Principle. In the perception of two items or events, if one follows right after the other, and if the second item or event is quite different from the first, we will then see the true difference between the two. If we talk to a nice person after talking to a nasty person, the nice person will seem even nicer. Similarly, researchers discovered that after looking at photographs of beautiful people, test subjects rated their spouses less attractive than before looking at the photos. After reviewing a failure or bad suggestion, a success or good suggestion will appear to be much better than it really is.

The Contrast Principle can have a profound effect in problem solving and decision making, because the idea or decision that arrives right after a bad idea or bad decision may be overrated.

Cognitive Dissonance. This is an uncomfortable psychological state or feeling occurring when someone experiences two incompatible beliefs or thoughts. In that case, there is a powerful tendency to resolve the conflict by rationalizing or altering one's view of one or both of the beliefs. A striking example would be the shock you would feel upon learning that someone you dearly love, has just murdered someone. The dissonance set up by such a situation would have a tendency to be resolved: The murdered person must have deserved it; or I'm sure it was an accident; or I never really loved my beloved anyway. Note that the tendency is to change things so that the beliefs are compatible.

Hearing about crime often causes people dissonance--between their belief in justice and morality and the events that occur. When a woman is raped, dissonance is set up because such things should not happen. Therefore, the woman must have done something to "deserve" it: she should not have dressed that way; what was she doing in this part of town at that time of night?; why did she have her window open, anyway? and so on.

Note this kind of thinking: my idea was rejected; but it was a good idea; good ideas are not rejected by honest people; therefore the boss is crooked, paid off, playing favorites, etc.

The Principle of Perceptual Consistency. We tend to pigeon-hole people, things, and circumstances into simple, generalized entities. Once we have done that, we tend to perceive new information about those things as to support our generalizations. We also tend to generalize from our impressions about one trait or circumstance of a person or situation. For example, good looking people are usually judged by others to be more intelligent and capable than they really are while less attractive people are judged to be less intelligent and less capable than they really are, simply because of this generalized transference. And once a person has been tagged as intelligent or unintelligent, subsequent events surrounding that person will tend to be perceived as reinforcing this generalization. If, for example, Person A has been judged to be an excellent problem solver, idea X will be judged excellent if he enunciates it. But if Person B, who has been judged a poor problem solver, enunciates idea X, the idea will be judged as poor.

If several people are watching a game on television and one person says, "Look what a klutz Williams is," everyone will begin to interpret many of Williams' actions as klutzy. If, on the other hand, the person had said, "Look how efficiently Williams moves," everyone watching would have begun to interpret a lot of Williams' moves in a positive way.

The net effect of this principle is that a lot of time and evidence will be required for us to change our view of a person or situation. Before the Japanese attacked Pearl Harbor, a great amount of evidence had been discovered that a surprise attack was imminent. But top military leaders refused to consider this evidence, because they already "knew" that no such attack was about to come.

This perceptual consistency principle explains why people wearing ties appear to be more important and intelligent than those without them. Similarly, women wearing glasses are viewed as being more intelligent than those wearing (invisible) contact lenses.

The Turnpike Effect. The availability and unforeseen utility of a resource leads to greater use than was predicted. In the past, builders of highways projected the use of the new roads based on historical flow over existing roads. But very soon every newly built highway was frequented much more than anticipated. When people discovered the existence of the highway and the ease of travel which was then possible, they used the highway even more than the old roads in the same place. Similarly, any new resource will most likely be used more than actually predicted. This can be computer terminals in the library, free meals on skid row, a new airport, piles of scratch paper near a phone, a company ombudsman or other resource person, a telephone answering machine. Afterwards these resources are used by researchers to do surveys about the need or desirability for such a resource.

Thus, the statement, "We don't get many calls for such an item [or service]," doesn't necessarily mean that the item or service wouldn't be used if it were available. We see something and we want it or use it. You may want to take the turnpike effect into account when you plan for the usage of some service or resource you are developing. One rule of thumb is to add at least 15% to your predicted demand.

The Turnpike effect explains why there is such an aggressive struggle to get consumer goods on store shelves. Manufacturers are willing to pay individual stores thousands of dollars for shelf space only to get their products right in front of the consumers' faces. Similarly, the books that are in the stores get read more than the ones that have to be specially ordered. Perhaps a brief way to express the turnpike effect is to say that availability shapes demand.

6.1 The Typical Idea Cycle

Every idea goes through a life cycle from its very beginning to its very end. The cycles may differ, but one cycle which appears frequently is as follows. The cycle consists of seven, And I would like to present these seven phases now, together with a sampling of the kinds of words and responses the idea receives during that phase:

Resistance. The idea is new and strange, representing a threat to the status quo or a change in operations, both of which create anxiety. Therefore, many people resist the idea, put up obstacles and objections, and refer to the idea as ridiculous, impossible, strange, weird, crazy, unworkable, boat rocking, foolish, stupid.

Notice. The idea begins to catch on and gain support. Some people begin to plan for its adoption. During this stage it is often described as new, fresh, interesting, possible, coming, the future, tomorrow, exciting, hot.

Snowball. Critical mass is reached and the idea is implemented or accepted by a rapidly increasing number of people. A real bandwagon effect occurs as people jump aboard. Now the idea is frequently referred to as cutting edge, latest, great, powerful, popular, today, now.

Institution. The idea is now part of the accepted collection of ideas, standard operating procedure, no longer questioned or viewed as in any way unusual. It is usually described as standard, current, established, proven, sound, routine, customary, regular, ordinary, common, accepted, usual.

Decline. The idea has begun to lose favor and is on the way out. Many people are now referring to it as being older, dated, yesterday, old-fashioned, boring, antiquated.

Dormancy. The idea is once again completely out of favor, now being viewed upon as no longer worth the thought. Descriptive terms for this stage are dead, historical, past, long gone, quaint, over.

Rebirth. The idea returns, often in a somewhat new way, and again finds acceptance. Adherents describe it as renewed, classic, traditional, revamped, reinvigorated, reapplied, reborn, revitalized.

6.2 The Components of Good Directions

To prevent confusion, be sure your directions are clear and accurate. Here are three components for good directions (adapted from Richard Saul Wurman in Information Anxiety):

Time. How long will each step take? Examples: "This part of disk preparation requires about ten minutes." "The leg from Minsk to Omsk requires three hours."

Anticipation. What should be happening? What should be expected as the process or journey proceeds? Describe the things for the user to look forward to. Examples: "When connection is made, you will hear a beep." "When the pulley is adjusted properly, the current draw will be between 7 and 9 amps." "When you mix the two ingredients together, you will notice a change in colour from white to pink." "Just before you reach the turn off, you will see a large, brown factory with green window awnings."

Failure. What occurrence will warn of failure? What remedy should be applied in such a case? Examples: "If the wiper motor does not run after installation, this is probably due to a bad surface. Try tightening all three mounting bolts or attach a jumper from the motor to the frame." "If the page preview reveals too large a space between the columns, check your right margin setting in the document, to make sure it is the width of just one column." "If you see a lighthouse on the left, you've taken the wrong road and should return to the intersection where you saw the factory.

7. The Logic of Failure

As managers, scientists, and people from the streets, we think about and make decisions every day. We face all sorts of complex problems: ferreting out the fault behind a failure, selecting a debugging tool or defect tracking system, choosing the best candidate to fill an open position, analyzing potential problems that will put a project at risk. Some of these problems call on specific technical skills and knowledge. All of these tasks depend on our cognitive abilities, our ability to think.

In The Logic of Failure*,* the author Dietrich Dörner reports on the cognitive and psychological tendencies of people solving complex problems. Dörner, a professor of psychology at the University of Bamberg, focuses on "system" problems, in which the problem solver faces many inter-dependent variables and incomplete information. His book will give you insights on common cognitive mistakes-traps that you can recognize and avoid.

The author is focusing on the following goal: to help us to become better problem solvers. He stresses the importance of recognizing the actual situation we are in, choosing an appropriate problem-solving strategy, and having the right thinking tools.

Being merely human we have some cognitive and psychological limitations. As humans, most of us just don't do well solving highly complex problems under pressure. Where do we go wrong?

The Logic of Failure offers some answers. The author describes a series of experiments where normal, intelligent people (for the sake of the argument, let's say that's you and me) solve complex problems in computer simulations.

As you might guess from the title, the experimental subjects' results were less than stellar. They showed characteristic tendencies that always lead to poor results:

- Failure to recognize networks of interdependent variables, where a change in one variable will affect many other variables
- To consistently underestimate exponential growth (People are often surprised, for example, that taking 1, doubling it, doubling it again, and so forth, leads to more than 4 billion in only thirty-two steps)
- Failure to formulate clear goals

- Failure to consider ripple effects and long-term consequences
- Retreat into familiar, solvable problems, even when they are not the problems which need to be solved
- Failure to reflect on the outcome of decisions and actions

The Logic of Failure paints a pretty dismal picture of our human abilities to solve problems in complex systems. Software systems, software projects, and software organizations are pretty complex systems; should we just pack up and go home? Or resign ourselves to muddling through?

Well, suppose we had some subjects who did do well- and they showed common patterns in how they approach problems. They tended to ask more questions. They were less likely to reverse their decisions in favour of an opposite course of action, but also less likely to hold onto decisions when circumstances dictated a change. They reflected on the results of their decisions and their actions. They showed an ability to recognize which problems were important, and choose appropriate strategies to deal with them.

We are not talking about being a genius, says Dörner, but of learning through experience and learning through reflection. "I think, we should not concern ourselves with the development of exotic mental capabilities," the author suggests. The one thing that does matter, he argues, is the development of our common sense. According to Dörner, "Thinking about our own thinking...can make us better problem solvers."

7.1 Developing a Thinking Discipline

The Thinking Manager's Toolbox by William J. Altier is a how-to guide for effective problem solving and decision making. This 1999 book is explicit about analytical thinking processes. While it doesn't cover every human cognitive shortcoming, it provides clear guidance for setting goals and making tradeoffs, choosing among alternatives, identifying potential future problems ("risks"), and tracking down the causes of problems you already have.

Altier devotes the first part of the book to "fundamental" analytical processes, with detailed descriptions, examples and tips for:

- Situation Analysis, for understanding what kind of thinking is needed
- Decision Analysis, for making various types of choices
- Potential Problem/Opportunity Analysis, for identifying potential detrimental and beneficial conditions
- Problem Analysis, for finding the root cause of a problem, and
- Implementation Planning, which is a special application of decision analysis

The second half of the book, "The Advanced Toolbox," talks about how to adapt the fundamental processes for your own situations. It also covers the use of Scenario Planning, which addresses one of the weaknesses Dörner identified in his book the tendency to only deal with immediate problems and ignore possible future problems. This includes those which are caused by the "solution" to yesterday's problem. The appendix provides worksheets and templates to use in all the processes described.

Why do we need to follow a defined, step-by-step process to think? Because an explicit process, says Altier, "enables people to take mental steps together." This is one of the author's key ideas: in the fields of management and testing, we can't just 'get by' on our own mental juice. We need to bring our teams, our customers, and our peers into agreement on goals, decisions, and problem causes. And we need to engage others in planning, identifying and mitigating risk.

7.2 The Expanding of the Toolbox

If we stick with Altier's concept of a toolbox, we look at analytical techniques like those in his book as just one tool in our collection. A skilled problem solver will also develop the skills that Dörner's successful subjects exhibited: the ability to understand the internal dynamics of a system and its tendencies over time, as well as build habits of reflection. A skilled problem solver will assess the situation and choose an appropriate approach.

It requires effort to reflect on our own thinking, to disrupt our habitual patterns of thought, follow all the steps of a logical process, and wrap our brains around networks of causation and vectors of exponential growth. And it's not always comfortable to look back and see where our thinking was inadequate and subsequent actions were way, way off.

Dörner and Altier suggest we apply more rigor in the way we use our brains - that we think about how we think.

8. The Thinking and Deciding

Cognitive behaviour has to do with the way we think and the way we use our brains to learn and solve problems.

We think we know how we think. But without watching people actually using their brains, we are likely to have a lot of inaccurate notions.

Our habits as problem solvers often make us poor planners. Probably our main shortcoming is that we like to over-simplify problems.

We do so by:

- not gathering enough information before looking for a solution
- jumping into action before deciding what to do
- having vague or undefined goals
- ignoring contingencies
- focusing only on parts of a problem that we feel competent to solve
- focusing on trivia and ignoring the big picture
- getting lost in abstractions and fantasies
- ignoring the side effects and long-term repercussions of our actions
- assuming that present trends will continue
- using a solution that's worked before though it may not apply to the problem at hand
- acting on decisions and ignoring the resulting feedback
- blaming the ill will or incompetence of someone else when actions don't get results

In a nutshell, we prefer not to see that any problem is part of a whole system of interacting factors. Any problem is much more complex than we like to believe.
And that's a drag on our resources of both time and energy.

But no one sets out to fail. But consider some of the things we've all seen happing:

Not gathering enough information before looking for a solution. You take a brief that's too brief. You're in the middle of design and discover you've been making huge assumptions because you don't have enough reliable information. A good way for you and the client to end up on the wrong page.

Jumping into action before deciding what to do. Clients are often in a huge hurry to get a new site up and running. You reluctantly agree to an unrealistically short time frame. There's no time to think; you dive in; you end up lost somewhere with no plan to fall back on.

Having vague or undefined goals. Precise goals make it possible to do reverse planning as well as to plan ahead. Without them, it's much easier to drift off track and waste time on low priority objectives. With them, you know when you've done exactly what you set out to do.

Ignoring contingencies. You don't plan for things that could go wrong. And you find yourself living in a worst case scenario with no idea how you got there. Or how to get out.

Focusing only on parts of a problem that we feel competent to solve. The client needs their online catalog to interface with their inventory database. You see the job as a chance to show off your talents as a Flash programmer.

Focusing on trivia and ignoring the big picture. The whole project is only a fuzzy picture in your mind, so you spend all day getting the mouse-overs on the home page looking groovy.

Getting lost in abstractions and fantasies. While developing an online store for pet products, you begin thinking up schemes for turning the client's site into an online community for pet owners, with an obedience school directory, downloadable library of animal literature, chat rooms for pets, a searchable encyclopedia of pet trivia, a gallery of pet snapshots, online pet auction, and a virtual aquarium.

Ignoring the side effects and long-term repercussions of our actions. Your client has a growing number of competitors, and research shows that potential customers shop around before buying. You design a home page that requires first-time visitors to download a plug-in and complete a 20-item registration form before they can enter the site.

Assuming that present trends will continue. This is gonna keep on growing. There's no end in sight.

Using a solution that's worked before though it may not apply to the problem at hand. Think cookie cutters and retreads. Off the shelf. Deja vu du jour.

Acting on decisions and ignoring the resulting feedback. Traffic logs? Search engine results? Say what?

Blaming the ill will or incompetence of someone else when actions don't get results. It's not my fault. Somebody screwed up.

And failure doesn't have to come from incompetence. The operators of the Chernobyl reactor, as Dörner points out, were "experts." And as experts, they ignored safety standards because they "knew what they were doing."

Dörner identifies four habits of mind and characteristics of thought that account for the frequency of our failures:

- The slowness of our thinking—We streamline the process of problem solving to save time and energy.
- Our wish to feel confident and competent in our problem solving abilities—We try to repeat past successes.
- Our inability to absorb quickly and retain large amounts of information—We prefer unmoving mental models, which cannot capture a dynamic, ever-changing process.
- Our tendency to focus on immediately pressing problems—We ignore the problems our solutions will create.

According to Dörner there's no evidence that intelligence, specialized experience, or motivation produces better problem solvers.

Also, he doesn't believe there's much to be gained in liberating the "right side" of the brain or exercising the estimated 90% of brain power we supposedly don't use. Successful problem solving is so complex that there are no hard-and-fast rules that work all the time.

But a few techniques are learnable and can make a big difference for anyone:

- Before creating a plan, make your goals explicit and specific.
- Picture the problem and its solutions as something in motion, existing in time.
- Think in terms of systems; your actions will affect many things, not just what you intend.
- Give a lot more attention to feedback; observe the results of your actions.
- Stop and reflect; don't act just to be doing something.
- Learn a wide range of strategies and be able to shift from one to the other as circumstances change.

For Dörner this last technique separates the "wise" from the rest of us. Problem-solving is a matter of choosing the right strategy at the right time. The more you have to choose from, the better your chance of applying what works when needed.

There's probably never enough time to thoroughly study a problem before acting. And endless studies can become a way of not acting at all, as Dörner points out, too.

Sometimes, given the constraints of time and circumstances, our best strategy is "ready-fire-aim." The mistake is not to check the results, so we can adjust our aim with the next shot.

Real problem-solving is ongoing. Any action of our own creates a new complex situation, which requires observation, reflection, decision, and action. And on and on.

9. Conclusion

The management of complexity is a necessary human concern. It allows us to structure the world which surrounds us, as well as the events we experience, and other people's actions that we are confronted with. Thus, we may even be able to categorize all these factors in one comprehensive system.

With complex, badly-structured problems the need for affiliation is increasing. This effect then leads to social comparative processes.

The underlying attribution process, in the sense of amateur causal perceptions, has its source in our desire to be able to predict and control the ongoings of our world.

Complexity and Strategy, in the sense of 'lifelong-learning', are obviously linked together: If we strategically reduce complex problem definitions, problems will occur, which again will be transferred to the account of complexity.

Complexity provokes actions which in return will provoke complexity again.

As we try to deal withever more complex and dynamic situations it is helpful to leave our ideas behind and move on towards a medium ("mind-mapping"), where we can explore the contents and the relationships of these situations.

Example: try to connect these 9 points from the chart below by using four lines only, no break allowed.

Instructions solution

o o o

o o o ?

o o o

You will find the solution, only when leaving the apparent solution space, perceiving the possibility of crossing the borders, and therefore enter a new ordering state, with which we find the solution we are looking for.

Often though, "Principles and Phenomena" interfere with the problem-solving process. Dörner refers to this as the "Logic of Failure".

Hopefully this little brain-teaser and the solution for it will present a strategic module for your toolbox. And I do hope that my presentation and its content have given the answer to my initial question "How to manage Complexity?".

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