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Mechanisms of Change[**]

To understand organizational, strategic and technological change it would be helpful to resort to mechanisms that are responsible for triggering and directing deep-seated social change processes. Propositions about mechanisms have an interesting epistemological status, they take an intermediate stance between law-like and descriptive statements. On the one hand they designate concrete events and on the other they draw on the causality responsible for the emergence of these events. In this article we describe some fundamental characteristics of mechanisms, describe some important change mechanisms and articulate some desiderata for mechanisms-research.

Key words: **change processes, mechanisms, logic of explanation, management of change**

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1.   Introduction

In 1898, Scott, an officer in the British Navy, introduced two improvements into naval gunnery that led to continuous-aim firing and changed gunfire at sea from an art to a science (Morison 1966). By chance, he observed a crew member being 'appreciably more accurate than the rest'. With improving gunnery on his mind for years (motivation), he was eager to turn that crew member's tacit knowledge into explicit knowledge (sagacity). As the captain of the ship he was also in a position to put his idea into practice (micro-environment). An US American navy officer, Sims, who loathed 'indirection and shiftiness', learned from Scott about continuous-aim firing and was determined to fulfil 'the task of educating the navy'. His strategy was contradictory to the established hierarchy and he rebelled 'against tedium, against inefficiency from on high, and against the artificial limitations placed on his actions by the social structure, in his case, junior rank'. Initially inhibited by senior rank, Sims succeeded eventually by calling on Roosevelt and gaining support for his suggested changes.

Morison's case study of 'Gunfire at Sea' shows (at least) three mechanisms of change at work: while Scott's discovery favoured the prepared mind and happened to take place in a conducive environment (serendipity), it was Sims' goal orientation (teleology) combined with his determination being in contradiction to the established structure (dialectics) leading to a major change in the field of naval gunnery. The case shows that structures reinforce conservative forces and are slow to change. Vested interests oppose even promising innovations especially if these are associated with far-reaching consequences for the overall structure. In parts the case study suggests that the implementation of continuous aim-firing was a cumbersome if in the end successful campaign of one individual against the establishment. But as a matter of fact, the campaign only was successful because the structures contained conservative forces as well as progressive forces aiming at overcoming outdated solutions. Such forces were the technological impetus of industrialization arriving in the US navy, the strong position of officers allowing them to pursue their projects and finally the possibility to gain support beyond the established chain of command.

Events and sequiturs are causally related via mechanisms: Mechanisms are the 'nuts and bolts' or 'cogs and wheels' of explanation (Elster 1989: 3), they provide understanding of why something happens. Thus, to understand how systems change, it is useful to study the respective mechanisms. In order to actually manage processes one needs to identify mechanisms, to open the black box and understand links between input and output. Of course, with realities being complex, there are severe limitations to predicting developments. Technological change goes hand in hand with social, cultural and organizational change, inter-acting and inter-restricting. However, insight into how things work makes it easier to act and react.

This article has the aim of furthering the appreciation of mechanisms as core elements of change.

2.   Nature of mechanisms

Propositions about mechanisms take an intermediate stance between law-like and descriptive statements. On the one hand they designate concrete events and on the other they draw on the causality responsible for the emergence of these events. Therefore

mechanisms always have to do with change processes. A given situation is trans-formed by the given causal forces and if you want to explain how systems change you reasonably have to look at the mechanisms which come to force.

Looking at mechanisms is asking for the logic of explanation. Mechanisms do not fit with the subsumption model of scientific explanation (Hempel 1970) but have its own more direct logic (Schmid 2006). But that is only a technical point which we do not want to discuss here. The main point is that the request to understand the causal mechanisms that "produce" empirical phenomena requires deeper insights (cf. figure 1).

Figure 1: Mechanisms: Opening the Black-Box
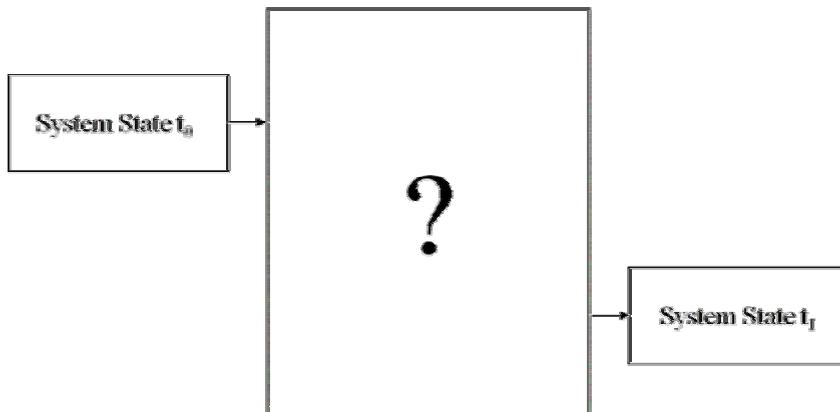
Searching for mechanisms means opening black boxes. Thereby it is desirable to de-rive propositions about causal mechanisms from approved theories but regrettably, this is a rarely accomplished ideal. The reasons for this are many. The most important reason lies in the very nature of the propositions used in common explanations, which normally do not employ true theories but refer to theoretical perspectives or concep-tual frameworks. More often than not one finds some loosely connected remarks on possible determinants or some indefinite references to abstract principles. The con-ceptual vagueness produces the interesting phenomenon that authors with quite dif-ferent theoretical orientations often refer to one and the same mechanism. However, not only theories but the concept of mechanism too, is not consistently employed. One can find very broad definitions which embrace any more or less ordered se-quence of activities or events (Martin 2003), and statements such as mechanisms are "sometimes true theories" or "bits of sometimes-true theories" (Davis/Marquis 2005, 340) do not give justice to the nature of mechanisms. Such imprecise conceptions do not further progress in knowledge and they do not meet the standard conception of mechanisms in science (Bunge 1967, 2004; Hedström/Swedberg 1996). Next to these misleading conceptions of mechanisms there are superficial notions, for example when a "causal" explanation is reduced to the regression coefficient (common in econometrics and causal modelling). The underlying methodology is a kind of "black-boxism" that is satisfied with looking for empirical relations and remains vague about the interplay of generative forces that are producing the statistical association in the

first place (Boudon 1991). Finally, there are very special conceptions of mechanisms, for example the view that (social) mechanisms are the means and procedures that mediate individual acts (for example trust, coercion, exchange) to enable and regulate social interactions (Schmid 2006).

In our view, it is desirable to find an ensemble of fundamental mechanisms that are rooted in corroborated theories with a wide range of applications. So mechanisms as a valuable scientific concept should not be confounded with its rhetorical use, e.g. in storytelling and ambiguous narratives. Furthermore, mechanisms should not be confounded with sequencing i.e. a succession of events, were the generative aspect is lacking or nebulous. And finally, mechanisms should not be confounded with mere descriptions, i.e. with reports about empirical associations, devoid of any attempt to explain the causal forces which are responsible for bringing the empirical phenomenon into being. To summarize: valuable conceptions of mechanisms should look for generative, fundamental, and deep mechanisms, which are rooted in general theories. The last point is of great importance, because only a program that looks for connecting mechanisms with general and true laws of behaviour (i.e. a program embedded in a naturalistic methodology) will achieve deeper insights in social processes. The relativistic methodological suggestions of Elster (1989: 2007) are not convincing (and are not necessary for a fertile 'mechanism program'), a point which cannot be discussed here at length (for a critical discussion see Norkus 2006).

3.   Mechanisms to explain change

Mechanisms may work on an individual, group or system level and usually several mechanisms are at work and interact, resulting in change. Which mechanisms are relevant for our topic? This question is not easily answered. Processes of change are investigated in different disciplines and in different fields of research. Table 1 provides a sample of fundamental mechanisms which are capable to give direction to processes of change. To be sure many of the mentioned mechanisms denote not single mechanisms but families of mechanisms which must be more precisely specified for concrete applications. In addition most of the labels are not very precise. Even such a fundamental term as "reward mechanism" is not fully accurate. The core mechanism, which is meant by learning theories is not rewarding but reinforcement. The famous law of effect of Thorndike (1898) is as follows: „When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection's strength is increased: When made and accompanied or followed by an annoying state of affairs, its strength is decreased." (Thorndike 1932: 176). It is not the reward which is responsible for learning and the stabilization of behavior but the reinforcement of behavioral responses. This idea was worked out in full clearness by Herrnstein (1970) and documented in his simple formula about the relation between the frequency of reinforcement and the frequency of behavioral responses.[1] But this is not the end of the discussion, as the results of learning studies show intermittent reinforcement is more effective than continuous reinforcement. If

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[1] $B = k\ R_f\ /\ (R_{f0} + R_f)$: B=Frequency of Responses, R_f=Frequency of Reinforcement, R_{f0} and k are constants.

you want to explain this fact you have to look for more special mechanisms (c.f. Bower/Hilgard 1981).

Table 1: Mechanisms in different research fields (examples)

Field	Mechanisms
Learning	Trial and error, reward, punishment, insight, association, observation, imitation, imprinting
Motivation	Deprivation of needs, internalization, moral development, motivational orientation, goal specification, self-efficiency
Economics	Alterations in preferences, competition, relative prices, budget changes, scarcity, utility maximizing, disequilibrium, market mechanisms, exchange, acceleration principle
Decision theory	Total systems approach, muddling through, mixed scanning, modification, development, emergence, choice, teleology
Social psychology	Identification, ideologization, emotional disturbances, social contagion, social dysfunctions, reduction of cognitive dissonances, attribution tendencies, traps and behavioral circles
Sociology	Dialectics, shifts in system needs, power imbalances, social construction of reality, disintegration, serendipity, belief formation mechanism, reference group mechanism
Sociology of organizations	Coercion, alienation, norm conflicts, overregulation, over-complexity, structural ambivalence, legitimization, institutionalization, trust, co-orientation, negative feedback process
Ecology/Evolution theory	Variation, selection, retention, adaptation, mutation, self organizing, critical diversity, autocatalysis, crystallization
Organizational development	Unfreezing, moving, freezing, unfolding, maturation, decay, sensemaking, rituals, psycho-games

A further point is that we are interested in mechanisms that lead to profound changes and not just small fluctuations around a rather stable condition. Not all mechanisms lead to such a system change, on the contrary: many mechanisms stabilize a system and recreate equilibrium.

In an often cited article about change processes in organizations, Poole and Van de Ven (1995) describe four classes of mechanisms (figure 2). One of these mechanisms can be found in *life cycle theories and models* in diverse theoretical traditions. The understanding is that certain processes will pass through complete cycles. Examples are given by theories which deal with the cognitive and morale development of persons, theories which stress the process nature of decision-making, stage models about team-building, and concepts which characterize the life cycle of products and organizations. A common assumption in these approaches is, that change processes take place in firmly connected ways analogous to genetic programs with every step being the result of the successful accomplishment of the preceding step. Such cyclic processes can be found in many micro- and macro-phenomena of organizational change, for example in approval procedures, technical operations or planning practices. Perhaps the most famous stage model of change stems from Greiner (1972) about the growth of organizations.

Figure 2: Mechanisms of organizational change (Van de Ven/Poole 1995: 520)
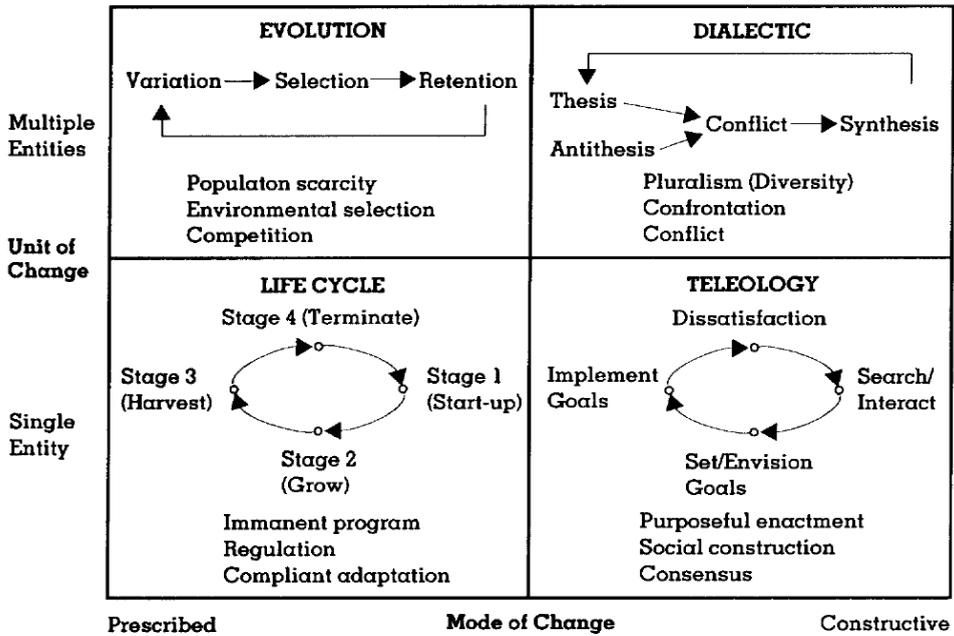
A second type of development mechanism can be found *in teleological theories.* These often conceive decision processes as cycles too. The first step is goal setting, followed by planning, implementation and modification of behavior and goals. The process is determined by conscious behavioral steps on the basis of collective agreements about desirable states. Unlike life cycle concepts teleological approaches do not assume fixed behavioral sequences, the formative element is the commitment to a new state of affairs and efforts to move the system in that direction. A third type of change theories emphasizes the *dialectic nature of change* processes. They refer primarily on the conflicting nature of the social life. A dialectical process theory explains the alteration between stability and change by the existence of antithetical forces. Change will occur if one of the forces gains enough power to challenge the status quo. The confrontation between thesis and anti-thesis will (at best) lead to a synthesis with a new equilibrium. Some theories understand change as *evolution.* In this view there exists a high selection pressure and only those structures will survive which are able to produce the resources which are necessary to persist in the competition between alternative systems. The evolution passes through the cycles of variation, selection and retention. According to the biological model variation simply results by chance (by mutation or by recombination of genes), selection is dependent on the fitness landscapes and retention will fail, if a species will be eliminated very early because it is not capable of reaching a sufficient number of individuals to withstand the selection pressure. The organizational theoretic evolutionary model is not as strict as the biological model. Variation in the social sphere is not merely a matter of chance but can deliberately be designed. Selec-

tion too is not liable to the blind forces of the environment but is also subject to conscious decisions. And retention can be supported by building a stabilizing infrastructure and by the establishment of procedures which strengthen the resilience of the system. A further important difference lies in the (reasonable) assumption, that the acquired capabilities can be transmitted to the next generation and therefore social innovations are not tied to the basic "genetic" constitution of its owners. The evolution theoretic description of change actually does not provide mechanisms in a strict sense, because its propositions stay too indeterminate. The same holds for the other three mentioned theoretical perspectives. Van de Ven and Poole speak of "generic" mechanisms, but it seems more appropriate to describe them as classes of mechanisms, and it is a promising perspective to look at some of the mechanisms of change in a more precise manner (see the articles in this volume by Bekmeier-Feuerhahn (2009: teleological mechanism), Martin (2009: dialectic mechanism) and Weisenfeld (2009) serendipity as a mechanism of change).

4.   The interaction of mechanisms

Can a single mechanism explain a complex reality? In an article titled 'Darwinian Fundamentalism', Gould (1997) refers to a "movement of strict constructionism, a self-styled form of Darwinian fundamentalism" and laments that "the ultra-Darwinists share a conviction that natural selection regulates everything of any importance in evolution". While with regard to social phenomena, a mono-causal explanation (of a part of reality) such as technological determinism is widely criticized (Chandler 1995), one *theoretical framework or perspective* might do: At the 2003 Critical Management Conference in Cambridge, in a private talk, a colleague said to the presenter of a paper: 'You see, we are all SCOT people, so your approach does not really fit'. SCOT, or social construction of technology, is about analyzing social forces in technological developments. Key mechanisms are variation, selection and closure (Pinch/Bijker 1984), each of which again may result from different (sub-) mechanisms. For example, how is selection brought about? Is it existing relevant social groups that are targeted, or are new forms of usage developed or do institutions such as regulations put restrictions on what can be selected?

The description of a mechanism can be more or less informative, depending on the level of explanation, and one causal relationship may enter several theories: "Normal science proceeds in part by aggregating what were thought to be disparate phenomena and causal mechanisms under one master mechanism" (Schwartz 2004). For example, the 'evolutionary' mechanisms of variation and selection are present in SCOT (Pinch/Bijker 1984: 411) if, albeit, not independent from each other (Van den Belt/Rip 1988, Kemp et al. 1998), in evolutionary organization theory (e.g. Aldrich 1999), and in the evolutionary framework of the strategy-making process (Burgelman 2002).

Not only is one mechanism used in a variety of theories, to explain change it is often necessary to refer not to one mechanism or one theory but to several mechanisms (from one or many theories) For example when adopting a new instrument in management, teleological and diffusion processes may be tightly entangled and may produce some surprising results. Connected with this problem is the question how

different mechanisms will interact. Sometimes they may work together, sometimes they will counteract one another, and these interrelationships may depend on some further mechanisms.

While in a concrete case it should usually be possible to identify diverse mechanisms and to describe their interplay, on a general level there is a lot to be done to describe fundamental mechanisms of change and their logical and causal relationships.

5.   Summary and Outlook

The introductory example 'Gunfire at sea' showed the teleological, serendipitous and dialectic mechanisms at work. Each of these mechanisms is particularly relevant in the management of strategy, innovation & technology and organization respectively, but they are complemented by each other and by other mechanisms and they interact. *Teleology* is inherent in strategy making, however the element of chance may play a crucial role not only regarding implementation of a strategy but also regarding its initiation, and tensions may reinforce or prevent the implementation of goals. Both the British and the US-American officer wanted to introduce the innovation of continuous aim-firing and were driven by their goal to implement it. *Serendipity* is associated with 'accidental sagacity' (Merton/Barber 2004: 9) which is well expressed in the quote from Pasteur: Chance favors the prepared mind[2], but "it particularly favors those at work in microenvironments that make for unanticipated socio-cognitive interactions between those prepared minds" (Merton/Barber 2004: 259). Scott observed by chance the outstanding performance of a crew member and, given his interest in improving the accuracy of firing at sea, was highly motivated to make use of the chance event. Finally, the tensions and contradictions in a social system are particularly important in *dialectical* change but are complemented by chance events and driven by goals. The conservative forces in the US army were confronted with progressive forces aiming at overcoming the outdated practice.

In the articles to follow we shall explore these mechanisms more broadly. But there are, as we have shown, many mechanisms discussed in the branches of the social sciences. To avoid the dangers of an atomization of mechanisms-research and to really get deeper insights in change processes, one has to look for mechanisms which are rooted in fundamental and valuable theories. Therewith it will be possible to identify the circumstances that trigger, push and stabilize the respective mechanisms. A further important objective is to gain a better understanding of the interdependence of mechanisms and of their causation. Progress in these tasks will improve the explanation of concrete cases of change and will be of great help in assessing the chances and dangers of planned change projects.

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2   Dans les champs de l'observation le hasard ne favorise que les esprits prepares (Louis Pasteur, Inaugural lecture, University of Lille, December 7, 1854)

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