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Serendipity as a Mechanism of Change and its Potential for Explaining Change Processes**

Serendipity plays an important role in science and technology development. This article investigates serendipity as a potential mechanism of change in management areas such as technology management, strategy and organization. The mechanism will be described and conditions that support or hinder the mechanism will be discussed.

Key words: **mechanisms of change, serendipity, organizational change, strategic change, technological change**

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1. Introduction

What causes entities to change is an important question since its answer gives some indication as to whether change can be controlled and to what extent it can be managed.

The common distinction between consciously conceived and not purposefully conceived change either as two ends of a continuum or as occurring simultaneously (Poole 2004: 4) suggests that any occurrence of change can be categorized as either planned or unplanned.

However, an episode of change usually covers both planned and unplanned elements. Thus, while the impulse might be planned or unplanned, the unfolding process of change will be an interplay between various elements. For example, teleology as a planned generative mechanism (Van de Ven and Poole 1995) incorporates unplanned elements when interacting with a changing environment and adapting goals to a new (unplanned) situation. Serendipity, often characterized incompletely as an unplanned happy chance event, needs a conducive micro-environment with actors being willing and competent to take the event forward, thereby conceiving of and planning further steps. Especially in the history of science and technology, serendipity has been attributed a key role in discovery and has been referred to as the element of chance. On the other side, acknowledging serendipity's role in a certain discovery or invention may compromise a scientist's merit (Campanario 1996). Therefore, to harness serendipity's positive effects it is not only necessary to underline its importance in change processes but also to further its recognition as a vital ingredient in these processes the skillful use of which is valuable. In what follows, serendipity will be investigated as a potential mechanism of change in management areas such as technology management, strategy and organization.

This article has the aims of introducing serendipity as a mechanism of change and discussing conducive factors of and barriers to unfolding its effects.

Section 2 provides a description of serendipity as a mechanism. Sections 3 to 5 describe serendipity in the area of technology, strategy and organization. Section 6 discusses types of serendipity and conditions of serendipity leading to profound change. Section 7 draws conclusions.

2. Description of the mechanism

At the bottom of change are mechanisms that link sequences of events (Martin et al 2009: this volume). One mechanism that may lead to profound changes is serendipity. Serendipity is a particular type of discovery in which observation, sagacity and chance are brought together within a certain context (socio-cognitive micro-environment, Merton 2004: 261).

The term serendipity was coined by Walpole in 1754:

> "This discovery, indeed, is almost of that kind which I call Serendipity, a very expressive word, which, as I have nothing better to tell you, I shall endeavor to explain to you: you will understand it better by the derivation than by the definition. I once read a silly fairy tale, called the three Princes of Serendip: as their Highnesses traveled, they were always making discoveries, by accidents and sagacity, of things which they were not in quest of: for instance, one of them discovered that a mule blind to the right eye had traveled the

> same road lately, because the grass was eaten only on the left side, where it was worse than on the right – now do you understand Serendipity?" (Horace Walpole in a letter from 1754, quoted in Merton and Barber 2004: 1-2).

Not looking for it ('not in quest of'), he (one of them) saw and discovered it ('a mule blind to the right eye') through combining information (grass along both sides of the road, shorter on the left side), and applying judgment.

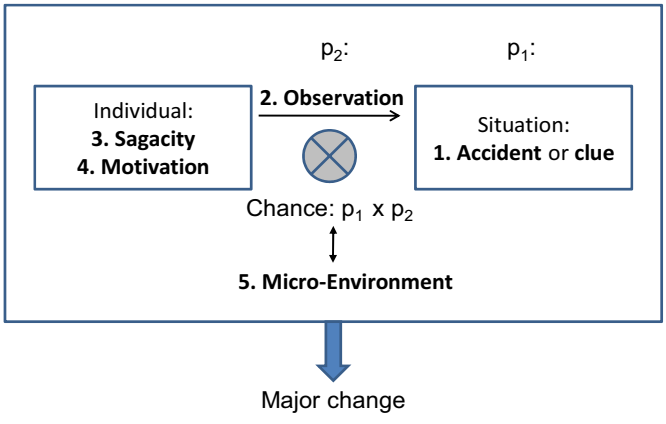
Given conducive circumstances and an observer of a lucky accident, who has the ability and the motivation to make use of it, this chance event may unfold and achieve something lasting such as a new technology, a new strategy or a new organizational feature.

Crucial elements are: Accident or clue (characteristic of the situation), observation (seeing), sagacity (knowing), motivation (bringing together), and an environment conducive to the take-up of the discovery. The chance event consists of the accident being observed by an individual. While perception and the decision to act on it are individual acts, these acts take place within a certain context or causal background (de Rond and Thietart 2007) and may induce a dynamic of its own. Environments provide plenty of information of which only a small subset is of interest to an individual. A particular environment may or may not provide a certain piece of information and an individual may look for a piece of information or it may 'stumble upon it'. The element of chance is twofold and is based on the probability that a situation provides a clue (p_1) and the probability (p_2) that an individual becomes aware of the clue (matching of situation and individual). For observation to occur a sensory stimulus ('it') needs to be received. Being bombarded with many stimuli, people can pay attention to only a subset and thus select what intrudes the consciousness. The respective information is being sent to the brain where it is processed (perceived). The process includes applying clues such as memories to interpret information. Sagacity lies in the combination of the interpreted information with (often tacit) knowledge. For the sagacity to have an impact, the observer needs to be motivated. Referring to scientific knowledge generation Polanyi notes: "We must conclude that the paradigmatic case of scientific knowledge, in which all faculties that are necessary for finding and holding scientific knowledge are fully developed, is the knowledge of approaching discovery. To hold such knowledge is an act deeply committed to the conviction that there is something there to be discovered. It is personal, in the sense of involving the personality of him who holds it, and also in the sense of being, as a rule, solitary; but there is no trace in it of self-indulgence. The discoverer is filled with a compelling sense of responsibility for the pursuit of a hidden truth, which demands his services for revealing it. His act of knowing exercises a personal judgement in relating evidence to an external reality, an aspect of which he is seeking to apprehend" (Polanyi 1966: 24-5). Knowledge renders an individual more capable of perceiving the significance of an observation. Figure 1 visualizes the relation between the five elements: accident, observation, sagacity, motivation and micro-environment.

All five elements are necessary for serendipity to lead to a profound change. Obviously, an accident needs to be noticed to make use of it. Had the contamination of Fleming's petri dish gone unnoticed (e.g., had the dish been disposed of beforehand),

the property of the mold to kill off certain bacteria wouldn't have been observed by him either. The observer, Fleming, was able to draw conclusions, however, he did not pursue it. Not being able to isolate it, he "loses interest in penicillin and publishes nothing on it after 1931" (Crease 1989: 883) – a lack of intrinsic or extrinsic motivation. Only later was its value as an antibiotic discovered (by others) and pharmaceutical companies took great interest in it, especially with a heightened sense of urgency in the Second World War. Thus, the environment then was particularly conducive.

Figure 1: Five elements of serendipity



p_1 an accident happens: the environment provides a clue,
p_2 an individual observes
⟷ interaction between observed chance event and micro environment

Pfizer's discovery of sildenafil citrate's side effect led to Viagra's primary use for treating impotence. The observation of the side effect was coupled with relevant knowledge and the extrinsic motivation to salvage "sunk costs by rescuing an ill-fated research program" (de Rond and Thietart 2007: 538). A society, in which health care and policy extends to wellbeing in a broader sense provides a conducive environment for the development and commercialization of such a medication.

Both cases show the importance of the environment in which the discovery takes place: Fleming (Crease 1989) as well as Pfizer's employees (de Rond and Thietart 2007) were not the first or only agents to make their respective discovery but both are associated with it.

The micro-environment (Merton and Barber 2004) varies with the relevance of contextual variables (de Rond and Thietart 2007) such as organizational structures, type of market and technological development.

In science there are many examples where serendipity played a role, e.g. Fleming's discovery of penicillin and Röntgen's discovery of x-rays, or Hericourt's and Richet's discovery of tuberculosis treatment (as mentioned in Merton and Barber 2004: 164).

This is not surprising since science is a journey of discovery with many unknown parameters, but serendipity also induces changes in the areas of technology management, strategy and organization, that is, areas where change is often planned to a great extent.

3. Serendipity in technology management

The term 'technology' comes from the Greek and refers to the systematic treatment of an art or a craft, it "encompasses reasoned application" (Herschbach 1995: 32). Nelson (1987: 75) differentiates between 'generic knowledge' and 'techniques': "On the one hand a technology consists of a body of knowledge, which I shall call generic, in the form of a number of generalizations about how things work, key variables influencing performance, the nature of the currently binding constraints and approaches to pushing these back, widely applicable problem solving heuristics, etcetera … On the other hand, a technology also comprises the collection of specific ways of doing things, or artifacts, that are known to be effective in achieving their ends if performed with reasonable skill in the appropriate context. These comprise the currently operative 'techniques' of a technology". Technologies incorporate knowledge into something that benefits users. Thus, for a technology to be put to use it needs two units: one that develops and/or offers the technology and one that adopts and/or adapts the technology. Technology management refers to the management of knowledge for beneficial use. The benefits of resulting artifacts are not clear at the outset and establishing 'something that benefits users' incorporates social construction (Pinch and Bijker 1984).

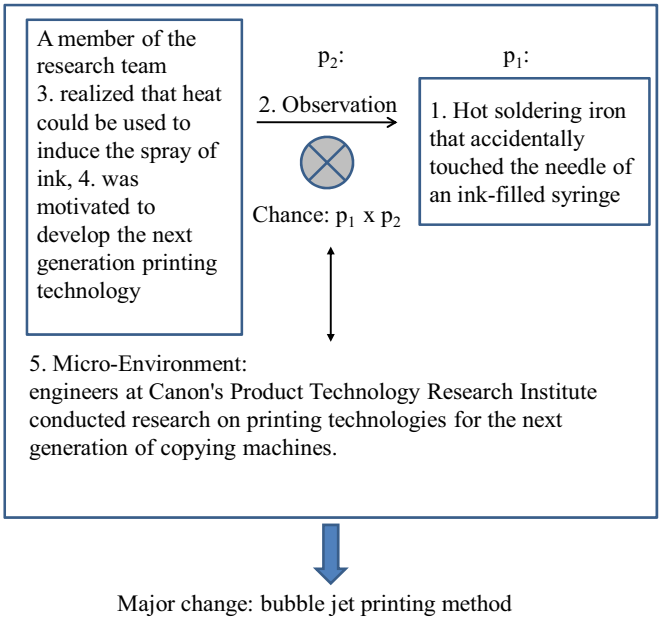
Serendipity in technology management involves the chance observation of an accidental (i.e., not planned) event, drawing conclusions from the observation with regard to the development of respective knowledge and being able to put that knowledge to use. The accidental discovery of the principle behind inkjet printers shall serve as an example.

> "In the later half of the 1970s, engineers at Canon's Product Technology Research Institute conducted research on printing technologies for the next generation of copying machines. This work included research on ink-jet printing technologies, which the company was already conducting. Based on their research reports, Canon concluded that this field had significant potential, and set up the Ink-Jet R&D Group within the Institute. The objective of this effort was to give Canon a fundamental printing technology capability, and the Group started research in a small laboratory containing a minimal number of measuring instruments and only two desks. Initial work was devoted to producing piezoelemental data necessary for ink jets, but this pursuit led to the discovery of a new technology.
>
> During testing, a hot soldering iron accidentally touched the needle of an ink-filled syringe, causing ink to spray from the needle's tip. Witnessing this, a member of the research team realized that heat, instead of pressure, could perhaps be used to induce the spray of ink.
>
> In 1997, technical concepts borne of this discovery were combined with thermal-head technologies under development at the time. This enabled the number of ink nozzles to be multiplied, a notion that was previously inconceivable, opening the way to a new high-speed printing technology. Numerous tests and refinements were made until Canon succeeded in developing the world's first Bubble Jet printing method in 1981. The new tech-

> nique was displayed at the Canon Grand Fair the same year, drawing high praise from Japanese and overseas observers, as well as the attention of the mass media. Canon continued to make refinements, finally unveiling the BJ-80 Bubble Jet printer four years later, in 1985. This huge technological development was the product of eight years – the period from the discovery of the initial principle to commercialization – and the input of numerous people." (http://www.bubblejet.canon.com.my/print_story/print_stry.htm)

The chance observation of a 'hot soldering iron (that) accidentally touched the needle of an ink-filled syringe, causing ink to spray from the needle's tip' led to one 'member of the research team … (realizing) that heat, instead of pressure, could perhaps be used to induce the spray of ink'. The accident happened while a person was present who observed (observation) and draw the conclusion (sagacity) that heat might be used in a new technology. Since the person was a member of a research group aiming at developing the next generation printing technology (motivation) and Canon had concluded 'that this field had significant potential', and had already set up the Ink-Jet R&D Group within the Institute, the accidental discovery took place in a highly conducive micro-environment and therefore led to the world's first Bubble Jet printing method in 1981.

Figure 2: Serendipity in technology management: The case of Canon's ink jet printer



It is the *combination* of these elements that leads to serendipitous events, and in this case led to that particular printing technology becoming a success. Accidents are commonplace but more often than not are seen as detrimental to developments. The interpretation of an accident as a nuisance, a minor instance or an opportunity, is foremost an individual instance and therefore the perception of an accident as an opportunity requires the presence of an individual that is receptive to the chance event

and that is equipped with some knowledge to draw a useful conclusion. Furthermore, the individual needs to have an intrinsic and/or extrinsic incentive to make use of the conclusion. The purposeful enactment of making use of the conclusion takes place in a certain environment. That micro-environment may or may not provide the necessary conditions for nurturing the outcome and for tapping the full potential of the happy accident. The unfolding change process incorporates unplanned (especially: the chance event) and planned (especially: the decision to make use of the discovery and subsequent steps) elements that interact within the micro-environment.

4. Serendipity in strategy

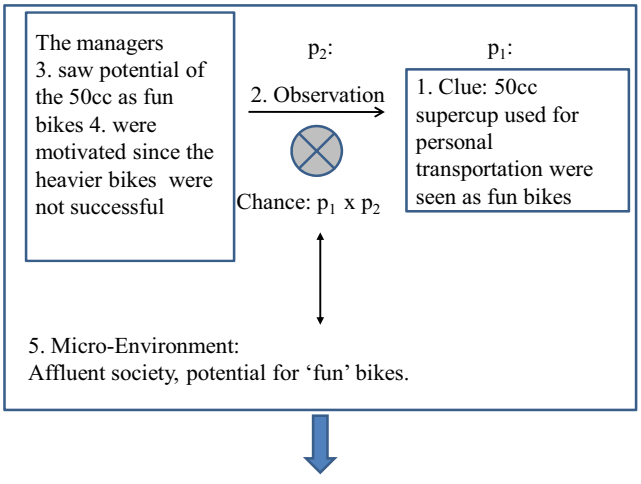
Serendipity may alter or initiate a firm's strategy. Serendipity in strategic management involves the chance observation of an accidental event, drawing conclusions from the observation with regard to the (re-) orientation of strategies and being able to implement the resulting strategy. An individual may observe by chance an opportunity, imagine the potential significance and develop the idea, receiving support from other members of the organization or being in a position to determine the strategy and being motivated to turn it into a business opportunity.

In the 1960s, Honda entered the USA motorcycle market and was particularly successful with the smaller 50cc supercup. The accounts of its strategy and reasons for success vary (Rumelt 1996): While a BCG report praised the company's philosophy of producing high volumes per model, achieving high productivity and tailoring the marketing strategies to achieving a big market share (BCG 1975), Pascale (1984: 51) tells a story that "highlights miscalculation, serendipity, and organizational learning-counterpoints to the streamlined 'strategy' version related earlier." According to Pascale, Honda did not enter the U.S. market with a detailed and well-informed strategy, rather, Honda had hardly any knowledge about the U.S. market and initially wanted to sell midsized bikes.

> "We used the Honda 50s ourselves to ride around Los Angeles on errands. They attracted a lot of attention. One day we had a call from a Sears buyer. While persisting in our refusal to sell through an intermediary, we took note of Sears' interest. But we still hesitated to push the 50cc bikes out of fear they might harm our image in a heavily macho market. But when the larger bikes started breaking, we had no choice. We let the 50cc bikes move. And surprisingly, the retailers who wanted to sell them were not motorcycle dealers, they were sporting goods stores."
> (http://www1.ximb.ac.in/users/fac/dpdash/dpdash.nsf/pages/BP_Honda)

There was no plan to sell the Honda 50cc via other than motorbike retailers, and initially the focus was on the heavier bikes. By chance, the Honda managers were observed riding their small bikes for personal transportation. Subsequently, demand unfolded for that light bike, new segments of buyers opened up and the Honda managers reinvested to boost demand even further. A growing middle class and an affluent society provided a micro-environment in which the small light bikes were used for sports and leisure.

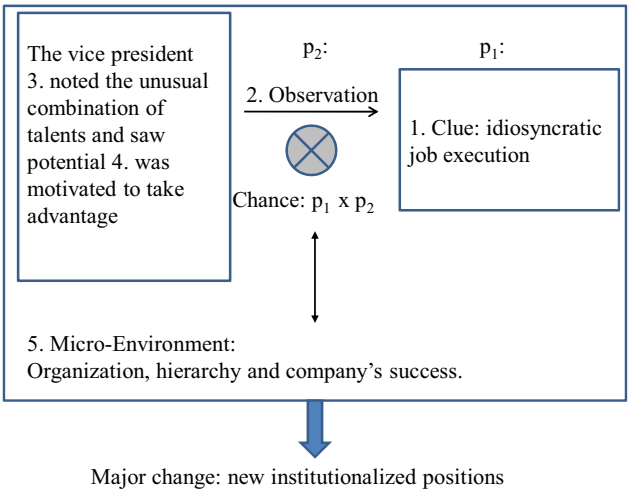
Figure 3: Serendipity in strategic management: The case of Honda's 50cc supercup



5. Serendipity in organizational change

Serendipity may alter the organization. Serendipity in organization again involves the chance observation of an accidental event, drawing conclusions from the observation with regard to the (re-) organization and being able to keep the resulting organization. An individual may observe unplanned organizational change, appreciate the potential in that change and try to institutionalize the change, receiving support from other members of the organization or being in a position to determine the institutionalization and being motivated to turn it into a lasting feature of the organization.

Figure 4: Serendipity in organization: The case of job creation



Miner (1990) describes organizational change through the selective retention of jobs. The chance event consists of the occurrence of "unplanned, idiosyncratic processes of job creation" (197). For example, a vice president, "upon observing the unusual combination of talents offered by [a] … particular line manager … created a new job for the line manager to take advantage of the manager's unusual mix of knowledge and abilities" (198).

There was no plan to set up that particular job. The vice president took note of the manager's talents, perceived the 'unusual mix' as beneficial for the organization and, given the hierarchical power and his interest in the company's success, created a position, thereby institutionalizing the change in the organization.

6. Types of serendipity and conditions for change

The unplanned element of the serendipity mechanism of change consists of an accident or a clue provided by the situation at hand, observed by an individual agent. Campanario (1996: 10) uses two categories to classify incidents of serendipity: (1) discovering something in the course of an investigation that has not been aimed at in the original project and (2) reaching a project goal accidently. Thus, becoming aware of the clue may be an accidental part of a journey of discovery (looking for something and finding something else, the example of Pfizer's Viagra) or an agent may find a solution to the project at hand by accident (Canon's inkjet printer). In both cases the agent needs to have a prepared mind, be curious, and have the resources and the inclination to push through. Being already on a journey of discovery implies a search process and motivation directed at finding something, a common situation in science & technology. However, as shown above, becoming aware of a chance event and being motivated to make use of it is not confined to the area of science & technology. Unplanned 'side-effects' of strategies may lead to re-orientation of investment with a changed focus on a new market or a new customer group, unplanned phenomena occurring in an organization may lead to re-structuring.

When does serendipity lead to profound change, i.e.: what makes a serendipitous event being adopted in a social system and thus, bring about major change?

Rogers (1962), studying innovations in areas such as hybrid corn, television, and manufacturing, proposed that new ideas follow a pattern in entering and spreading in a society. Describing the adoption process as consisting of the five stages: knowledge, persuasion, decision, implementation and confirmation, Rogers indicates how complex the process of adoption of the result of the innovation process is. It is Van de Ven et al (1999: 10) who describe the non-linearity of the innovation journey, with "complex bundles of innovation ideas and divergent activities by different organizational units". Thus, the entire process from the idea to the introduction is marked by different sub-processes, interactions of agents and institutions, and the resulting barriers to adoption will vary with the micro-environment. The nature and ways to overcome these barriers need further research and table 1 only gives some examples.

Table 1: Barriers to serendipitous events: examples

Area	Technology	Strategy	Organization
Observation of accident/clue	Lack of access	Dynamic strategic field	Complexity of work processes
Motivation	Lack of research target	Perceived risk	Lack of a promoter
Sagacity	Lack of technological knowledge	Lack of vision	Lack of professionalism in HRM
Micro-Environment	Lack of adopters	Lack of strategic fit	Cultural problems

Table 1 shows that barriers to serendipity vary with the field of interest. For example, in the field of technology development, observation of a clue requires access to technologies at work, in the field of strategy or organization one needs to single out the serendipitous event from the many forces at work. Not making use of the observation may be caused by a lack of a research target (as the case of Fleming shows), by the perception of high risks (e.g. the Honda managers could have refrained from pushing the supercup on account of high perceived risk) or by a lack of a promoter in the organization.

7. Conclusion

"Whether by the retrospective streamlining of accounts of discovery or because of the 'human interest' inherent in the intrusion of accident into the realm of scientific rationality, the factor of accident has not been given its due" (Merton and Barber 2004: 159). Accidents are not planned but they may induce significant change, so a key question is how to deal with them. If you cannot plan them, at least you might be able to take advantage of them. Making use of an accident requires to note its potential significance (sagacity) and to 'do something' about it (motivation). The adoption of the thus proposed change requires a conducive micro-environment. Therefore, furthering the 'taking advantage of accidents or clues' involves training, setting incentives and creating a climate for taking up ideas. Concrete measures very much depend on the respective environment.

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