Resilience by Shock Testing

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Abstract: The environment dominated by emerging uncertainties set a challenge to decision making. Our paper describes a method developed to plan for uncertainty. As the basis for theoretical elaboration we examine ontological uncertainty, the situation where we do not know what we do not know. We describe a method called “Seven Shocks” planning method and its theoretical framework. The two fundamentals of the method are instrumental usage of extreme events and definition of the portfolio of resilience developing actions.

Key Words: Resilience, X-event, Robust portfolio, Seven shocks

1. Introduction

Increasing complexity and the greater rate of change in the global economic system is creating a challenging planning environment dominated by uncertainty. The systemic nature of the global environment is so complex that it is unrealistic to assume we will have sufficient information to reduce uncertainty. Traditional planning methods are not powerful enough for this environment.

While organizational planners are wise to focus on the “most probable future, one that produces maximum return for their investment, the risk posed to these organizations of extreme events can be of such a magnitude that it is equally important to plan for ‘less probable’ extreme events.

Figure 1: Events that shape our environment are the tails of the probability distribution. The number of these “Dragons” is increasing.

In this paper we are focusing on the requirements of the environment where uncertainty is dominating the development. Surprises? both negative and positive? are part of every decision making environment in all of the levels, global, national, organization and individual layer (Goodier et al. 2010)[1]. In order to clarify the challenge and for method development purposes we are using extreme events as a key to this world of surprises.

When we are speaking about extreme events we are referring to the events that are low by their probability but high of their impact. The literature speaks about rare events (Goodwin and Wright 2010) [2] and wild cards (Kaivo-oja et al. 2010) [3]. The typical feature is that these events have low predictability and their surprise value is high. Surprise emerging because the events are breaking some of our basic assumptions of how the world should operate (Casti 2012, Goodwin and Wright 2009, Sircar et al 2013, Weick 2001) [4]–[7].

In this situation decision makers have two alternative strategies available (Daft and Weick 1984)[8], either to improve predictions capability or invest in resilience.

Anticipation capabilities are improved by investing in collecting more information by scanning for weak signals (Ansoff 1984, Weick 2001, Daft 1984, 2001)[7]–[9], trends (Godet 1984)[10] or analyzing financial statistics in order to predict potential tipping points (see Prechter (1994)[11] about Elliot waves). The horizon scanning literature is prominent and we have plenty of theoretical elaborations about weak signals collection and analysis, but all of these do not explain how to deal with the Dragons tails of the probability distribution. From this context our research question is

How to plan for uncertainty?

In this paper we study the alternative strategy. How to analyze uncertainty and improve resilience by designing strategies and structures that are designed for uncertainty (Hamel and Valikangas 2003, Ulanowitz et al. 2009)[12],[13].

In this paper we do not try to improve predictability of the environment; vice versa, we are using non-likely events as instru-
ments for reaching the goal; better decision making methods and better decisions for uncertainty. We claim that by focusing attention on extreme environments shaped by the relevant uncertainties, we are able to define the requirements for systemic resilience (Casti 2013)[14].

2. What do we mean by resilience?

We consider that resilience building is potentially an adequate strategy for operating under uncertainty, thus it is essential to use some space for explaining what does we mean by “resilience”.

Resilience is derived from the Latin word resilio, meaning “to jump back”. Many experts agree that resilience can be defined as the ability of system to absorb disturbance and still retain its basic function and structure. Complex systems theory sees resilience of a complex system as its capacity to absorb shocks while maintaining function (McDaniels et al 2008).

Today, the definitions of resilience are quite diverse. In engineering and physics, resilience is defined as “how fast a variable has been displaced from equilibrium returns to it.” (Pimm 1991, Holling 1973; Carpenter et al 2001; Resilience Alliance 2005, McDaniels et al 2008)[50][48][46][52][49]. This approach has been applied even recently in the UN-Habitat paper of urban resilience (UN Habitat 2012)[15].

Yet, ecological and social resilience focus on persistence and robustness to buffer capacity, withstand shock and maintain functions. Social/ecological resilience, on the other hand, emphasizes the adaptive capacity, transformability, learning and innovation. Up to 1970’s the concept of resilience focused on the ability to bounce back after the shock or disruption, to recover the state of stability and equilibrium (Allenby and Fink 2005)[41]. Since 2000, a lot of works of resilience describe the concept as the process (Reimmoeller and Baardwijk 2003 and Cho et al 2007)[47],[51].

Management literature follows the process path. In strategic management, resilience has been defined as a process capability; in order to reinvent themselves, companies need to overcome barriers to change and develop multiple sources of competitive advantage. Strategic resilience is about continuously anticipating and adjusting to deep, secular trends that can permanently impair the earning power of a core business. It is about having the capacity to change before the case for change becomes desperately obvious (Hamel and Valikangas 2003)[12].

Resilience may be defined as the extent to which a system can modify its circumstances to move to a less vulnerable condition (Luers et al 2003)[16].

The elements of resilience definition we are using in this paper goes beyond “bouncing back” or “process of absorption of shocks in order to maintain the equilibrium or the function the organization had prior to shock”. We extend both of the dimensions; immediate reaction and the long term process. The elements of resilience in this study are: productive response to change, reconstruction, renewal, learning, sustainability.

The source of uncertainty is increasing complexity of the systems surrounding us (Casti 2012, OECD)[4],[17]. Complex Adaptive Systems theory (CAS) tells us that a system is the most flexible, when it is in the state of self-organizing (Anderson 1999, Ulanowitz 2009, Brown and Eisenhardt 1998) [13],[18],[19]. This is the phase where shocks come into a picture. In order to get or maintain this narrow state of self-organizing, the system has to import energy (Anderson 1999) [18]. A shock is either new information or new physical energy that is disrupting system, so that it is shaken to self-organizing state. Typical for this state on the edge of chaos (Brown and Eisenhardt 1998)[19] is that it will give up some old conventions and reformulate rules for internal collaboration and external co-evolution.

Dalziel and McManus[20] were able to describe this essential feature as one picture

To conclude, we define resilience as

“the capacity to continuously restructure oneself by using the shock energy in order to maintain sustainable state of self-organizing.”

3. Theory driven planning method

The choice of planning method is always dependent on the context and the environment. The method we describe is designed for long-term planning in systemic environments. Uncertainty becomes a relevant planning parameter in the situation in which we have a lot of interaction with the environment and the time frame is long. If the interaction with the environment is limited and the consequences are known, planning should be focused on the analysis of historical data and efficient implementation of plans (Ansoff 1984, Raynor 2008, Stahle et al. 2003)[22],[23]. The ultimate goal of long-term planning is to support decision making in the short-term. The optimization challenge is to find the best solution that meets both the requirements of the current environment and prepares us to meet surprises and extreme events in a way that we do not only survive but benefit of uncertainty.

The next four paragraphs we will describe the four phases and the theoretical framework of the planning method developed. In their 2010 published paper Goodwin and Wright (2009, 2010)[2],[5] are presenting some solutions for dealing with uncertainty by comparing different foresight methods and identification of calibration methods in order to improve predictability. Even if our strategy is almost opposite of the Goodwin and Wright’s, we will use the six causes of low predictability as a framework (Goodwin and Wright 2010)[2] as theoretical framework for elaboration of our approach that uses low predictability as a vehicle of development. According to Goodwin and Wright the elements of low predictability are

1. Sparsity of reference class
2. Reference class is outdated or does not contain extreme events
3. Inappropriate statistical models that use wrong probability distribution
4. Danger of misplaced causality, due the lack of data or unwilling experts (Blackett report 2010)[24]
5. Cognitive biases that use heuristics that are reducing uncertainty
6. Frame blindness, frames that are inadequate for the problem, or wrong problems defined by decision makers
In principle the organization that prepares for recovery is trying to reach the pre-shock equilibrium state, when an organization that is developing resilience is able to use shock as a spring board for improved performance (Dalziell and McManus 2004).

3.1 Extreme events

The first task of the process is to choose the extreme events that are used for the stress test of a system to be studied.

Goodwin and Wright claim that predictability requires data. In our layout the scarcity of the data of the previous extreme events is a prerequisite for low probability events. If we have enough data, the event is not an extreme event in the meaning we adopt. So, all the events that have a high impact on the global system are not extreme events. Economic cycles are natural part of the global dynamics, hurricanes are frequent phenomena, bad traffic accidents are extreme events for those that participate in them, but not surprising for those that are developing traffic safety. One of the requirements of the extreme event in this study is that it does not have a track record in the near future or it has not happened yet at all.

As Goodwin and Wright stated one of the key constraints for studying the unknown is our existing cognitive structures. Our perception of the operating environment defines how we are interacting with it (Berger and Luckmann 1966, Luhmann 1995)[25],[26] , and causalities are based on past experience. (Weick 2001, Hodgkinson 1999,2003)[7],[27],[28] In order to deal with true uncertainty, we have to apply techniques that force us to elaborate environments that do not behave according to pre-existing rationales. The technique uses existing mental models of uncertainties as a starting point. First we identify the basic assumptions (shared mental models) of the planners of the entity in the consideration, and then challenge them by presenting an extreme event that will have a strong disruptive impact on the set of basic assumptions (Goodwin and Wright 2010)[2].

We are analyzing uncertainties, so in this method it is not only important to approach the uncertainty from one extreme event perspective. The process will activate the participants of the process to consider both low probability and high impact extreme ends of one uncertainty. The stretched theoretical extreme situations are then used as a context for the next phase of the process.

3.2 Extreme scenarios

Foresight is reaching to the uncertainty by using scenario techniques. One of the corner stones of scenarios is the plausibility requirement (see Meitzner D and Reger G, 2005)[29] , and in this respect our approach makes a major deviation from the scenario concept presented in the foresight literature (Sircar et al. 2013)[6]. Instead of business as usual scenarios we are focusing on low probability and high impact scenarios, that even if they are consistent within the description, are not plausible in the traditional meaning (narrowing the causality requirements as Goodwin and Wright says 2010)[2]. The analysis of wild cards (Mendonca et al. 2009)[30] becomes closest to our approach.

Our extreme scenarios are following von Reibnitz, Schwab, Cerruti approach (2003)[31]

“A scenario approach involves developing future environment situations (scenarios) and describing the path from any given present to these future situations, These scenarios cover the edges of the scenario funnel.”

We define “the edges of the scenario funnel” by using shocks, low probability and high impact extreme events as drivers of the scenarios. There is another deviating aspect in our approach as well. In the definition above, the “path” refers to the chain of
events that lead to the scenario. In our approach we make significant modification, by path we refer to actions that build up resilience to succeed in this situation. (Brown and Eisenhardt 1998, Liesio and Salo 2012)

Due the nature of the extreme scenarios one of the problems of the scenario planning - the bias caused by wishful thinking (Janis 1972, Wright and Goodwin 2009) is overcome - we claim - by using this technique, because it covers both extreme ends of the uncertainty continuum and thus avoids the situation where only the preferred scenario will be taken into consideration in decision making. If the development of the European Union is the key uncertainty, then we will study both “the collapse of EU” and “Federation of European States” extreme scenarios. It is essential that we do not say that any of the extreme scenarios will happen; both of these alternatives are theoretical and they have only an instrumental value (Sircar et al 2013). The reality will be something in between these extreme alternatives.

3.3 System mapping

As described above, the theoretical extreme scenarios we describe are driven by low probability, high impact events. Many of these events have not happened at all (collapse of European Monetary Union). And those that we have experienced in the previous context (power outages in 1960’s) will have a totally different impact now (in the era of the global internet). How to write a scenario and describe the situation that may be even beyond imagination?

In our method we are using systems mapping called in some contexts as a causal mapping (Goodier et al. 2010) or soft systems mapping (Checkland 1985). In futures context the method is called causal mapping as well (Goodier et al. 2010, Eden and Ackerman 1998). The principle idea is to start by describing a system at its current state (Business as Usual); define its current agents/actors, their relationships and drivers of the system’s behavior. Typical features of systems descriptions are interaction between agents/nodes of the system, feedback loops that either damp down or accelerate developments and complexity (Checkland 2000).

Systems maps are able to reveal something about the behavior of the extreme scenario. Network topology (Barabasi 2002, Jeong et al 2000) tell us what kinds of structures are vulnerable for certain kinds of disruptions and and dynamic systems theory is able to inform us about principle behavior rules of feedback loops (Casti 1994). All of this helps us to imagine, how systems with different structures behave when they are disrupted and thus we are able to add the potential impact descriptions to our scenarios.

3.4 Action generation and assessment

Uncertainty is not a novel feature for policy and business planners, but it is more dominant than before. The phenomenon seems to stay (Morton 2012, World Economic Forum Global Risks Report 2013) and shape the environment (World Economic Forum 2013, here after WEF 2013). One of the players/agents will be the best in this new kind of environment, even in the situation generated by the extreme circumstances defined in the previous step.

Scenario planning has been accused of being too theoretical and too far from organization’s reality (Courtney 2003). The recent attempts to look at uncertainty and resilience in concrete means have failed in multiple ways, either the theoretical background is missing (WEF 2013) or the methods recommended are looking at only the risks and threats, not success factors (Blackett report 2012). In this method we take a leap from hypothetical scenarios to concrete actions. The exploratory research projects (Casti et all. 2011) proved to be successful so we made a decision to develop the method further.

Here we analyse the specific features of this environment and define what agent(s) will succeed in this type of environment. What sorts of capabilities are needed and what is typical for the operations of the most successful player/agent in this environment. Now we focus on the organization itself. The process is participatory. In this participatory phase (we invite 50-300 experts with diverse background) to participate to the web-based enquiry) the question posed to the panel of experts is: What are the development actions that should be initiated now or in the near future in order to succeed
in this extreme environment in question? All of the different extreme scenarios that are included will be covered with the same question.

In this phase we have (if we have 200 experts and 7-14 scenarios) collected 1000-3000 action ideas that are scenario specific. The research team will analyze the presented ideas by using text-mining tools that will cluster the presented actions automatically into 8-10 clusters (either predefined or machine produced clusters). The most representative (typical for the cluster, or those with most novelty value, assessed subjectively by the research team) 2-3 examples of the cluster will go to the next phase.

The second phase of the web-processing is to ask participants to assess the value of the set of actions (20-30 actions) in all the extreme scenario environments. If wanted the current situation can be one of the scenarios used as assessment contexts. In addition to the feasibility to the scenarios, we can add some additional criteria, for instance, current feasibility of an action idea, fit to the existing capabilities, the investment required or value for existing operations. The analysis matrix is large about $20 \times 10$ and it contains huge number of combinations of actions. In order to distinguish the combination of actions that will be most efficient in improving resilience against all the extreme scenarios we need computation.

### 3.5 RPM methodology

Robust Portfolio Modeling (RPM) is a decision support methodology for analyzing multiple criteria portfolio problems (Morton et al 2012)[17]. It uses standard decision analysis models (e.g. multi attribute utility/value theory) to capture the benefits of different option and option portfolios (i.e. option combinations), but admits incomplete information about the parameters (e.g., criteria importance weights, probabilities, diverse views of multiple stakeholders). Since there is incomplete information on the model parameters (futures’ likelihoods, actions benefits, or importance of the assessment criteria) there are usually multiple efficient portfolios. Based on combinatorial optimization techniques the RPM identifies those feasible option portfolios (i.e., that satisfy relevant portfolio constraints regarding limited resources) and are efficient, in the sense no other feasible portfolio offer more benefit in light of the incomplete information. The chosen approach avoids the need to carry out exhaustive pairwise comparisons among all possible portfolios by using multi-objective zero-one linear programming (please find a detailed description in Liesio and Salo 2012)[43]).

Based on the identification of efficient portfolios, the options can be classified into i) core options included in all efficient portfolios, ii) contingent options that are included in some but not all efficient portfolios and exterior options included in none of the efficient portfolios (Liesio et al 2008)[44].

As Godwin and Wright states (2001)[45] predictability problem is a problem of insufficient statistical data. In our approach we have a well-founded decision recommendations (Liesio and Salo 2012, Morton et al 2012)[17],[43]. The approach that has been used in several case studies in the projects to the International Institute for Applied Systems Analysis (IIASA) is not based on existing statistical methods, instead it improves validity and reliability of the research by applying systematic
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Fig. 5 Expert panel used tool that is designed to avoid the impact of existing cognitive filters. Tool produced by Fountain Park (www.fountainpark.com)

Fig. 6 All the activities are assessed in the multidimensional space. This illustration is showing an example of a set of 5 actions that have been assessed by to decision parameters. The method is calculating all the combinations and identifies actions that belong to the most of the efficient portfolios. Please read more about the mathematical basis of the method from Liesio and Salo 2012).

(Dalziell and McManus 2004)[20] analysis as a basis for conclusions.

Our development work is defined by leading design challenges; the tools to be developed should be pragmatic, generic and easy to apply in everyday planning work by either public or private sector organizations.

AN EXAMPLE:

A steel company was assessing investment alternatives in the Russian market. Uncertainties are prominent.

1st They defined key uncertainties (the decision making structure as one of them).

2nd The extreme environments are described for the decision making are; very centralized decision making (internal conflicts are increasing, state controlled by a strong police and well equipped army or laissez-faire society (where market forces will attract 70

3rd Successful steel companies that operate in the extreme environments defined by highly centralized decision making are partnering with the police and the army and developing mobile, easy to transport and fast to erect barracks, logistic centers, hospitals. In the world of fast urbanization, the fastest growing steel companies are producing small steel houses, that non-skilled family can put together by themselves in a couple of days.

4th The above actions and others listed were assessed by their feasibility in different environments and in this case especially the fit to the current product development strategy.

5th One of the core development actions listed was an additional investment of the small fast to erect workshop concept that was already included to the development plans.
Casti and Ilmola (2012)[40]

4. Conclusion

Our research question was; How to plan for uncertainty and help decision makers to meet the challenge of increasing uncertainty. In this paper we have presented a method and its theoretical framework. We have analyzed uncertainty and generated a portfolio of concrete actions that should improve resilience.

In the method developed we are using seven shocks for stress testing of the nation/organisation. Resilience is always a context dependent feature, resilience is built in order to meet the certain uncertainties (Allenby and Fink 2005) [41] within a particular organization. In the method developed we use extreme events as this context.

It is self-evident that to run the test with only seven shocks does not cover true uncertainties, the 777 shocks that will happen in reality.

Our preliminary solution to this challenge has been diversity of shocks. Each of the shocks should represent different type of uncertainties, such as technology, economy, society and nature driven shocks. If the analysis of the organization specific uncertainties is done carefully and the implementation of the diversity principle is comprehensive, the organization is able to define roughly speaking the space of uncertainty, the area that should cover the most of the shocks.

We have tested the method (Casti and Ilmola 2010)[40] in six different case studies, but still there is an urgent need for additional research. In order to claim that the method has generic value, we ought leave the existing level of analysis (national economy) and look at the global value chain and the applicability of the method in truly complex environment. We ought to also reach out to the organizational decision making and examine the usability of the method in the corporate level.

There are several dangerous areas of bias and false conclusions. Some of them are typical foresight studies, some emerge from lack of comprehensive theoretical framework.

Our quest is look at low probability - or even non-probability extreme events. Our existing cognitive framework is constraining this attempt as Goodwin and Wright (2010)[2] stated in their excellent paper. We have addressed this challenge by developing a systematic, repeatable analysis, which is not totally driven by the events we are able to imagine (Blackett report 2012)[24]. But still we do not know how much the context of the chosen extreme events defines the final solution. So we are eager to join to the group of futures scientists that are developing more advanced methods for futures science and foresight.

The second problem arises from the fact that the methods described here have different theoretical backgrounds, they consist of tools developed in several disciplines. This “fusion method” may provide us at the end of the day with a true innovation - or a total failure due lack of consistency of the theoretical compilation. There is urgent need for developing a comprehensive and strong theoretical framework for uncertainty management.

All presented above is only the first step to design business models, structures and operations that are specifically designed for uncertainty.

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