Identifying systems' new initial conditions as influence points for the future

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Abstract

Purpose – *The purpose of this research paper is to review and contrast traditional foresight methods through the lens of one of the key insights about complex adaptive systems – namely, a system's sensitive dependence on initial conditions.*

Design/methodology/approach – *Foresight methods have often been criticized about their linear way of looking at the future. Insights from complex adaptive systems research, however, provide a new theory-driven approach for developing real foresight methods as opposed to traditional forecasting methods based primarily on linear extrapolation. This serves as a starting point for the re-analysis and re-classification of the foresight methods, presented profoundly in the American Council for the United Nation's University Millennium Project's* Futures Research Methodology – V2.0.

Findings – *The findings of the analysis show which foresight methods actually present the future as a continuation of the present, and which instead are able to identify a system's new and emerging initial conditions; and what kind of possible understanding of the system the methods offer to the user.*

Research limitations/implications – *This research paper provides a new perspective to reopen the discussion about the necessary qualities of foresight methods. This paper argues that instead of trying to forecast the future the foresight methods should help us to see and influence the future as it is emerging.*

Practical implications – *Discussion and guidelines for methodological work and an introduction of complex systems concept-tools map, a new set of methods and the way how it could be used together with* Futures Research Methodology – V2.0 *represent vast implications for organizations' foresight practices.*

Originality/value – *The origins of novelty are two: the complex adaptive systems perspective to discuss foresight methods, and the presentation of the new set of methods to support and complement* Futures Research Methodology – V2.0.

Keywords *Research methods, Complexity theory, Adaptive system theory*

Paper type *Research paper*

The logic of change rediscussed

The questions about the emergence of future are the fundamental starting point for methodological work and analysis[1]. Is future intended, selected and planned? And the emergent process predictable and known? Or is future continuously emerging and amplifying? And the emergent process unpredictable and unknown? (Streatfield, 2001; Aaltonen and Barth, 2005).

Juarrero (1999) states that the theory of complex adaptive systems (CAS) can serve as a theory-constitutive metaphor (c.f. Boyd, 1979) that permits a reconceptualization of cause, and rethinking action, i.e. rethinking the underlying logic of change.

A vital argument to our discussion is the CAS's sensitiveness to its initial conditions. This means that different initial conditions will place the system in different groups of attraction, changing into different evolutions, different histories. For instance, if a new activity is launched at a certain time, it will become a success, if it is launched in another time it may not succeed (Nicolis and Prigogine, 1989). In these types of systems events never materialize the same way twice, because the variables are continuously interacting and changing in response to each other (Sanders, 1998).

If one of the characteristics of CAS really is sensitivity to new initial conditions, and if this sensitivity to new and initial conditions provides opportunities for influencing the future of the system, then foresight methods should have the ability to identify these points of influence.

''Perking'' information is used in this paper as a term for those new and initial conditions to which the system may be sensitive. Perking information refers to emerging conditions, changes and developments that are already taking shape just below the surface, but are not yet visible (Sanders, 1998). These kinds of changes occur when the ontological linearity of a situation is interrupted, when there are changes in causal or temporal order between events or among the actors or the relationships between them (Aaltonen, 2006). Actually, every time when order interacts with disorder, new opportunities emerge. Every time when a new vision is launched, a new organization structure is presented and a new project manager is appointed, there is an opportunity to interrupt the existing ontological linearity. Emergence of new technologies, deregulations and new legislations as well as redefinitions of conceptual boundaries can be sources of disruption outside company walls.

Following this, two questions are essential in our study:

1. Do the methods present the future as an extension of the past or do they recognize new and initial conditions that could dramatically influence the future?
2. What is the nature of understanding of the system the methods can provide?

The assumptions, on which the major part of the old methodology has been built, differ significantly from the new set of assumptions, on which the new set of methods has been built. Due to this difference, it is argued that, the new set of methods and models should also be different. According to the new assumptions the whole is always more than the sum of its parts, and the future's development cannot be predicted from the nature of its constituent parts. In fact, because of the systems' nonlinear dynamics and feedback loops the future of the system cannot be predicted at all. It is, however, possible to develop foresight and influence the future development of the system by identifying and using the new and emerging initial conditions as points of influence (Letiche, 2000).

The classic sand pile simulation (Bak and Chen, 1991) serves as an illustration of how the concept of CAS creates a different basis of understanding on which the new set of methods might be built.

> An observer who studies a specific area of a pile can easily identify the mechanisms that cause sand to fall, and he or she can even predict whether avalanches will occur in the near future. To a local observer, large avalanches would remain unpredictable, however, because they are a consequence of the total history of the entire pile. The criticality is a global property of the sand pile.

This quotation brings to our awareness the temporal and relational boundaries relevant for effective foresight. And furthermore, it makes us aware that change introduces plurality, and when emergence occurs the results are new, and nonlinear. Therefore linear presentations of the future, extrapolations and business-as-usual scenarios, can be helpful, but in limited, stable circumstances or in combination with more dynamic methods.

A lot of things evolve because of carefully laid out plans and visions; the change is designed; it is managed; it is reengineered. This article claims that there is another way to understand change based on a different understanding about how things emerge, and this understanding calls for the use of different methods. ''Planned change'' is a popular approach to change management. But even planned change projects take place within a larger context characterized by unpredictability and uncertainty. Emergence as a consequence of local interaction between the agents involved without any master plan is more the reality in complex adaptive systems. In these local settings, the agents act logically but according to their principles, rules and their own logic, not one ''big'' logic imposed by a CEO or a president or a director (Sanders, 1998; Aaltonen, 2005; Aaltonen and Barth, 2005).

Besides that, a CAS consists of many agents that act in parallel, it also typically has many niches, which can be exploited by an agent able to anticipate a possibility and adapt to fill it. And filling the niches creates new niches – new opportunities are always being created in CAS as long as the system does not reach equilibrium (Waldrop, 1992; Kauffman, 2000; Mitleton-Kelly, 2003). These are also reasons why traditional, ontologically linear, foresight methods are doomed to fail.

This results also in increased complexity, and the more complex a system, the more states and properties it can manifest, and furthermore, novel features create inter-level causal relationships and higher level organization that did not previously exist (Juarrero, 1999). And if this is true, then the methods used to identify perking information, should be used to deal with these kinds of systems.

The Qualities of *Futures Research Methodology – V2.0* – old view

The *Futures Research Methodology – V2.0* covers the history of futures research methods since the 1940s. Over half of the methods are written by the inventor of the method or by a significant contributor to its evolution (Glenn and Gordon, 2003).

In the *Futures Research Methodology – V2.0* there are two relatively new methods, the SOFI index and the causal layered analysis. SOFI was used for the first time in 2001, causal layered analysis in 1999.

When we look at the rest of the methods, we find out that over four-fifths of them were invented in the 1970s or before, namely: environmental scanning, Delphi, futures wheel, trend impact analysis, cross-impact analysis, systems perspectives, decision modeling, statistical modeling, relevance trees, scenarios, participatory methods, simulation and games, genius forecasting, field anomaly relaxation, text mining, and agent modeling.

The methods are classified into four categories: quantitative, qualitative, normative and exploratory. The terms quantitative and qualitative need no explanation, but normative means work based on norms or values, while exploratory work explores what is possible regardless of what is desirable and norms and values do not have the same significance as they do in normative methods.

Evidently, Table I provides clear information about the methods and their properties. It shows that all the methods have at least two of the four properties used as the basis of the taxonomy, and two methods, scenarios and the SOFI index, all possess qualitative, quantitative, normative, and exploratory features (Aaltonen, 2005). But it does not provide the kind of information we need in order to be able to answer our two basic questions:

1. Which methods recognize new and initial conditions that could dramatically influence the future?
2. What kind of knowledge of the system is offered by the method?

The qualities of *Futures Research Methodology – V2.0* – new view

Applying language and models in different and novel ways can be a source for innovation. The differences between the old view about the qualities of futures research methods and the new view, presented in Figure 1, open up a possibility to imply, to support and to criticize one another (e.g. Letiche, 2000).

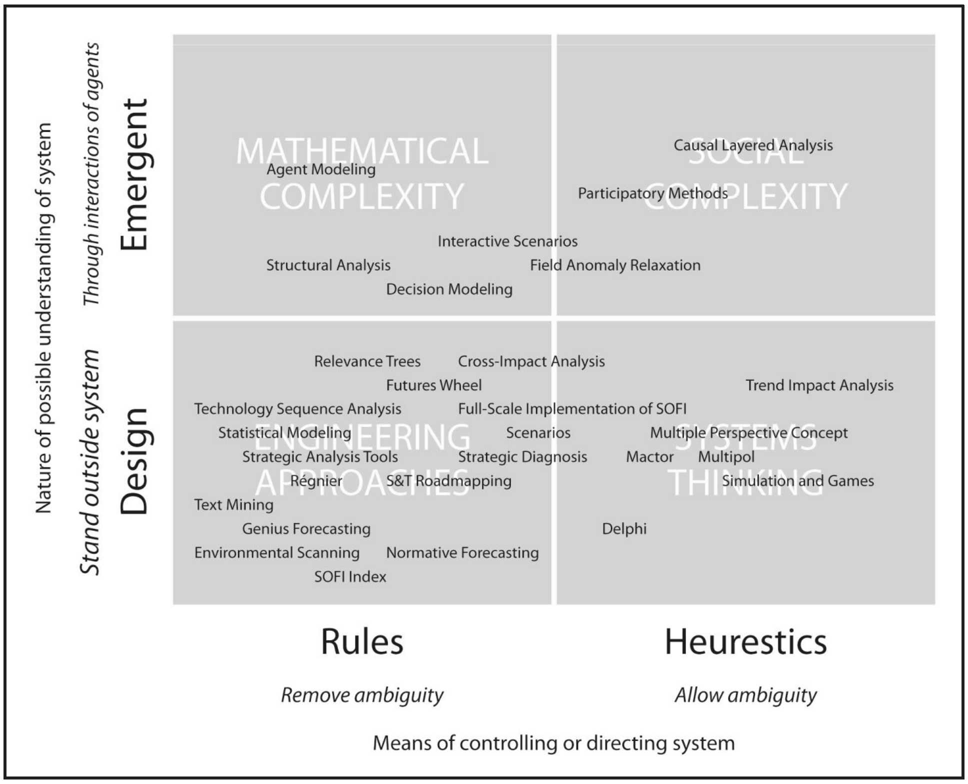
The matrix in Figure 1 seeks to describe the landscape where futures research methods are used, and the variety and distribution of methods relating to described qualities. Figure 1 identifies four distinct types of landscapes, two of which – engineering approaches and systems thinking – have a long history, are widely used and currently dominate thinking and practice in strategic management. The other two – mathematical complexity and social complexity – are not yet widely used and they represent both a contrasting and a complementary view of how the future emerges, and they are vital in our search for new initial

Table I AC/UNU Millennium project taxonomy of *Futures Research Methodology – V2.0*

Method	*Quantitative*	*Qualitative*	*Normative*	*Exploratory*
Environmental scanning		X		X
Delphi		X	X	X
Futures wheel		X	X	X
Trend impact analysis	X			X
Cross-impact analysis	X			X
Structural analysis	X	X		X
Systems perspectives	X			X
Decision modeling	X			X
Statistical modeling	X			X
Technology sequence analysis		X	X	
Relevance trees and morphological analysis		X	X	
Scenarios	X	X	X	X
Interactive scenarios		X	X	X
Participatory methods		X	X	
Simulation and games		X		X
Genius forecasting, vision, intuition		X	X	X
S&T road-mapping		X	X	X
Field anomaly relaxation		X		X
Text mining		X	X	X
Agent modeling		X		X
SOFI index	X	X	X	X
Multiple perspective concept		X	X	X
Causal layered analysis		X		X

Source: Glenn and Gordon (2003)

Figure 1 The re-analysis of *Futures Research Methodology – V2.0*



conditions (Senge, 1990; Hammer and Champy, 1993; Axelrod and Cohen, 1999; Stacey *et al.*, 2000; Watts, 2003).

The differences in the basic assumptions between these four approaches can be clarified in the following way: the vertical dimension looks at the nature of our possible understanding of the system, and the horizontal at our means of controlling or directing that system. The vertical dimension design is contrasted with emergence, engineering approaches and systems thinking represent design, and mathematical complexity and social complexity represent more emergent processes. The matrix works in the vertical with ontology, the nature of things defined in terms of causality, and in the horizontal in terms of epistemology, i.e. what kind of knowledge can be achieved by the methods (Snowden and Stanbridge, 2004)[2].

The foresight methods presented in Table I are placed in the new sense-making model (Weick, 1995; Bogner and Barr, 2000; Weick, 2001; Hopkinson, 2001; Woodside, 2001). The model works as an effective communication tool that aims at delivering a large amount of information about the whole methodology of the *Futures Research Methodology – V2.0*, the properties of the methods in the *Futures Research Methodology – V2.0*, and the relationships between the methods.

The analysis reveals that most of the methods presented in *Futures Research Methodology – V2.0* are designed to remove ambiguity and they concentrate on knowing, or to be more precise, on delivering more knowledge into the decision-making process. Most of the methods are also used outside the system in order to bring new information inside the system. They are found in the low left and right hand corners of the matrix.

The difference between the sides is that the right side allows more ambiguity than the left one. The embedded conception of causality for both low sides, of how things happen, is that there is an actor, that is capable of finding the causalities and this actor is able to design interventions that lead to a desirable future.

There are methods that are reliant, even if implicitly, on different causal assumption, i.e. different ontology, about how things happen. They are placed in the upper half of the model and share the belief that things happen through the (local) interaction of agents. The movement towards a future is seen as depending on the other actors as the adaptive moves of a single actor can influence other actors' strategies by creating new possibilities and constraints. These methods are more sensitive to the new and initial conditions of systems and more capable of benefiting from the niches and space that continuously emerge from such conditions (Waldrop, 1992; Holland, 1995; Mitleton-Kelly, 2003).

Based on the relatively few number of methods that habituate the upper part of the model, it would be accurate to say that this approach is not as popular among futurists as the ones in the lower part of the Figure 1. However, some methods are designed to remove ambiguity and simulate emergent possibilities. They stand in the mathematical complexity corner. The smallest number of methods lies in the social complexity corner. The methods that try to identify a future direction with a degree of ambiguity and aim to do so in a not always orderly environment are few, but they are the ones in which the initial phases are different from the final phases. In other words, they begin an exercise that will finish in a place different from its point of origin (Cilliers, 1998; Juarrero, 1999; Stacey *et al.*, 2000; Shaw, 2002; Barabási, 2002).

A necessary companion to *Futures Research Methodology – V2.0* in identifying new initial conditions – complex systems concept-tools map

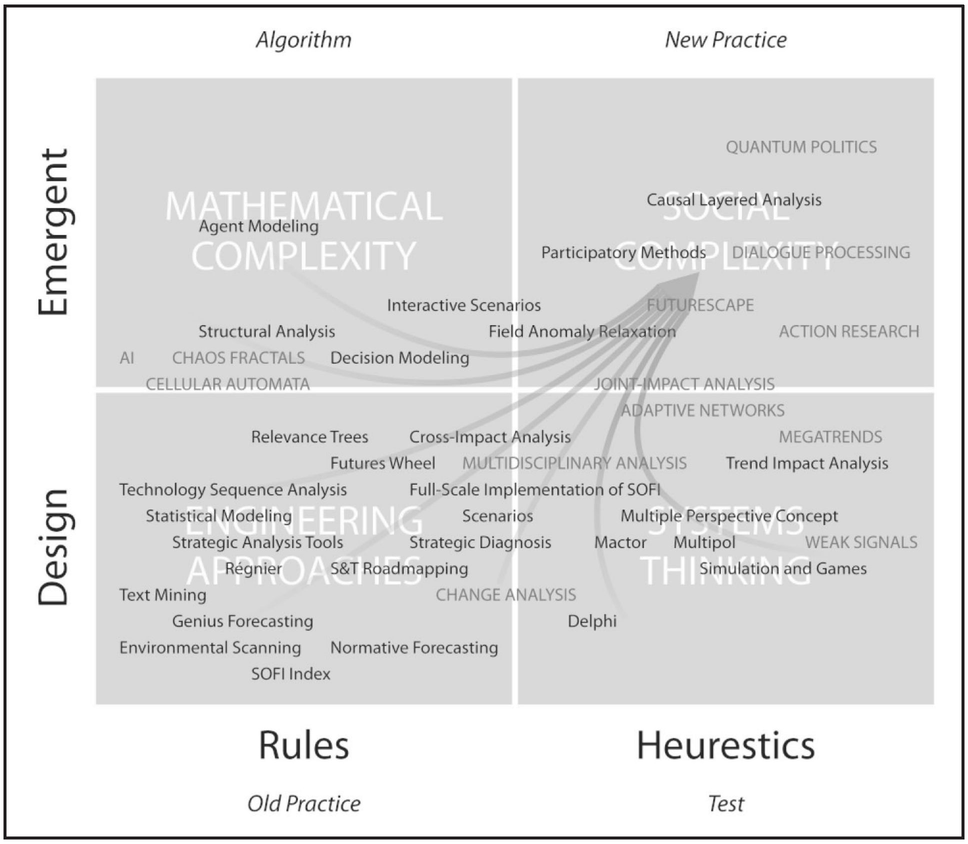
In this paper the analysis and classification of the AC/UNU Millennium project's *Futures Research Methodology – V2.0* report was challenged and further elaborated upon. Qualitative, quantitative, normative and exploratory perspectives were replaced with engineering, systems thinking, mathematical complexity, and social complexity perspectives. The traditional logic of designed change was complemented by CAS's point-of-view.

According to the arguments laid out in this paper, it is natural to explain the location of the major parts of *Futures Research Methodology – V2.0* as being built on the assumptions of their time. However, it must be noted that there are also foresight methods that allow ambiguity, and those that are sensitive to new and initial conditions, i.e. not all foresight methods are classified as engineering approaches. Even those methods, classified in the low left hand corner, aimed at removing ambiguity and directing the system from outside, are not totally inappropriate or not to be used at all. They are useful if used under stable conditions to provide more information on an existing situation, and when used in combination with other methods.

In Figure 2 the *Futures Research Methodology – V2.0* is complemented by a new set of methods – the complex systems concept-tools map which is based on CAS's view of the world; it provides an alternative and complementing causal view of how things emerge. This new set of methods aims at understanding the complexities – interdependencies, connections, and patterns of interaction – in the larger environment in which the decisions are made. From these relationships, between order and disorder, self-organizing change occurs as a result of the interaction that takes place.

Every method has its own embedded qualities, and they need to be understood properly as has been done in Figures 1 and 2. Glenn and Gordon (2003) state a few words of warning: simply taking and extending futures research methods into the future assumes that the only forces shaping the history are those that exist in history. Because, tremendous changes can occur when a new building block (e.g. LAN-based networks, increasingly powerful microchips, the internet, JAVA programming language) is discovered (Holland, 1995; Bogner and Barr, 2000).

Figure 2 *Futures Research Methodology – V2.0* with complex systems concept – tools map



Despite these difficulties, or maybe because of them, the need for foresight, and the development of foresight skills is a must. In this work nonlinear thinking is critical because a small event in one place can cause turbulence in another due to the system's sensitivity to new initial conditions. In addition systems thinking is vital due to the necessity of looking at whole systems and scanning across industries and disciplines in order to discover emerging conditions and finding opportunities for innovation (Sanders, 1998).

Conclusions – from forecast to foresight

The main conclusions of this study are condensed in the following five points:

1. A deep and broad understanding of methods; and their qualities is the starting point for successful foresight.
2. No single method should be trusted; an insightful combination of various, even contradictory methods can create foresight; *Futures Research Methodology – V2.0* can be successfully used with complex systems concept-tools map.
3. Methods in low left quadrant present the future as a continuation of the present, ontologically linear. Mathematical complexity, e.g. agent-based models, is based on CAS's view of the world, but the methods that stand there often confuse simulation with foresight. Methods in low right corner allow more ambiguity and therefore can be used as a basis for testing.
4. In our opinion and experience, the three domains – engineering approaches, systems thinking and mathematical complexity – are the starting points, not the finishing points of a foresight exercise. In fact, every foresight exercise should create and use necessary information from all the necessary sources, and then finish the exercise with methods that stand in the social complexity domain (like the arrow in Figure 2 depicts), where nonlinear developments, and therefore emergence of new practices are possible.
5. More important than the qualities of presenting the future as an extrapolation of the present, are the qualities that allow us to see and influence the future by responding to and influencing what is emerging.

Notes

1. In this article we will not distinguish foresight methodology from futures research methodology.
2. The EU report ''Business knowledge management: a study on market prospects, business needs and technological trends'' (2005) uses the same model to assess organizational knowledge management in Europe, and to present a new initiative, Knowledge Management Made in Europe (KMME), where the emerging opportunities for EU are seen to take place in the upper right quadrant – field of social complexity.

References

Aaltonen, M. (2005), ''Futures research methods as boundary objects'', *Futura*, Vol. 2/3, pp. 29-38.

Aaltonen, M. (2006), ''Circular cause, time and narrativity'', *International Journal of Management Concepts and Philosophy*, Vol. 2 No. 3, forthcoming.

Aaltonen, M. and Barth, T. (2005), ''How do we make sense of the future: an analysis of *Futures Research Methodology V2.0*'', *Journal of Futures Studies*, Vol. 9 No. 4, pp. 45-60.

Axelrod, R. and Cohen, M. (1999), *Harnessing Complexity: Organizational Implications of a Scientific Frontier*, The Free Press, New York, NY.

Bak, P. and Chen, K. (1991), ''Self-organized criticality'', *Scientific American*, Vol. 246, pp. 46-53.

Barabási, A.-L. (2002), *Linked: The New Science of Networks*, Perseus, Cambridge, MA.

Bogner, W.C. and Barr, P.S. (2000), ''Making sense in hypercompetitive environments: a cognitive explanation for persistence of high velocity competition'', *Organization Science*, Vol. 11 No. 2, pp. 337-70.

Boyd, R. (1979), ''Metaphor and theory of change: what is 'metaphor' a metaphor for?'', in Ortony, A. (Ed.), *Metaphor and Thought*, Cambridge University Press, Cambridge.

Cilliers, P. (1998), *Complexity and Postmodernism: Understanding Complex Systems*, Routledge, London.

Glenn, J.C. and Gordon, T.J. (2003), *Futures Research Methodology – V2.0*, AC/UNU Millennium Project, Washington, DC.

Hammer, M. and Champy, J. (1993), *Reengineering the Corporation*, Nicholas Brealey Publishing, London.

Holland, J.H. (1995), *Hidden Order: How Adaptation Builds Complexity*, Perseus Books, Cambridge, MA.

Hopkinson, G.C. (2001), ''Influence in marketing channels: a sense-making investigation'', *Psychology and Marketing*, Vol. 18 No. 5, pp. 423-44.

Juarrero, A. (1999), *Dynamics in Action: Intentional Behavior as a Complex System*, MIT Press, Cambridge, MA.

Kauffman, S. (2000), *Investigations*, Oxford University Press, Oxford.

Letiche, H. (2000), ''Phenomenal complexity theory as informed by Bergson'', *Journal of Organizational Change Management*, Vol. 12 No. 6, pp. 545-57.

Mitleton-Kelly, E. (2003), *Complex Systems and Evolutionary Perspectives on Organisations: The Application of Complexity Theory to Organisations*, Pergamon, Amsterdam.

Nicolis, G. and Prigogine, I. (1989), *Exploring Complexity*, Freeman and Co., New York, NY.

Sanders, T.I. (1998), *Strategic Thinking and the New Science: Planning in the Midst of Chaos, Complexity, and Change*, The Free Press, New York, NY.

Senge, P. (1990), *The Fifth Discipline: The Art and Practice of the Learning Organization*, Doubleday Currency, New York, NY.

Shaw, P. (2002), *Changing Conversations in Organizations: A Complexity Approach to Change*, Routledge, London.

Snowden, D. and Stanbridge, P. (2004), ''The landscape of management: creating the context for understanding social complexity'', *E:CO*, Vol. 6 Nos 1/2, pp. 140-8.

Stacey, R.D., Griffin, D. and Shaw, P. (2000), *Complexity Management: Fad or Radical Challenge to Systems Thinking?*, Routledge, London.

Streatfield, P.J. (2001), *The Paradox of Control in Organizations*, Routledge, London.

Waldrop, M.M. (1992), *Complexity: The Emerging Science at the Edge of Order and Chaos*, Touchstone, New York, NY.

Watts, D.J. (2003), *Six Degrees: The Science of a Connected Age*, W.W. Norton & Company, New York, NY.

Weick, K.E. (1995), *Sensemaking in Organizations*, Sage, Thousand Oaks, CA.

Weick, K.E. (2001), *Making Sense of the Organization*, Sage, Thousand Oaks, CA.

Woodside, A.G. (2001), ''Editorial: sense making in marketing organizations and consumer psychology: theory and practice'', *Psychology and Marketing*, Vol. 18 No. 5, pp. 415-21.

Further reading

Arbnor, I. and Bjerke, B. (1997), *Methodology for Creating Business Knowledge*, Sage, London.

Christensen, C. and Raynor, M. (2003), ''Why hard-nosed executives should care abut management theory'', *Harvard Business Review*, Vol. 81 No. 9, pp. 67-74.

Lorenz, E.N. (1993), *The Essence of Chaos*, University of Washington Press, Seattle, WA.

Stacey, R. (2001), *Complex Responsive Processes in Organizations*, Routledge, London.

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