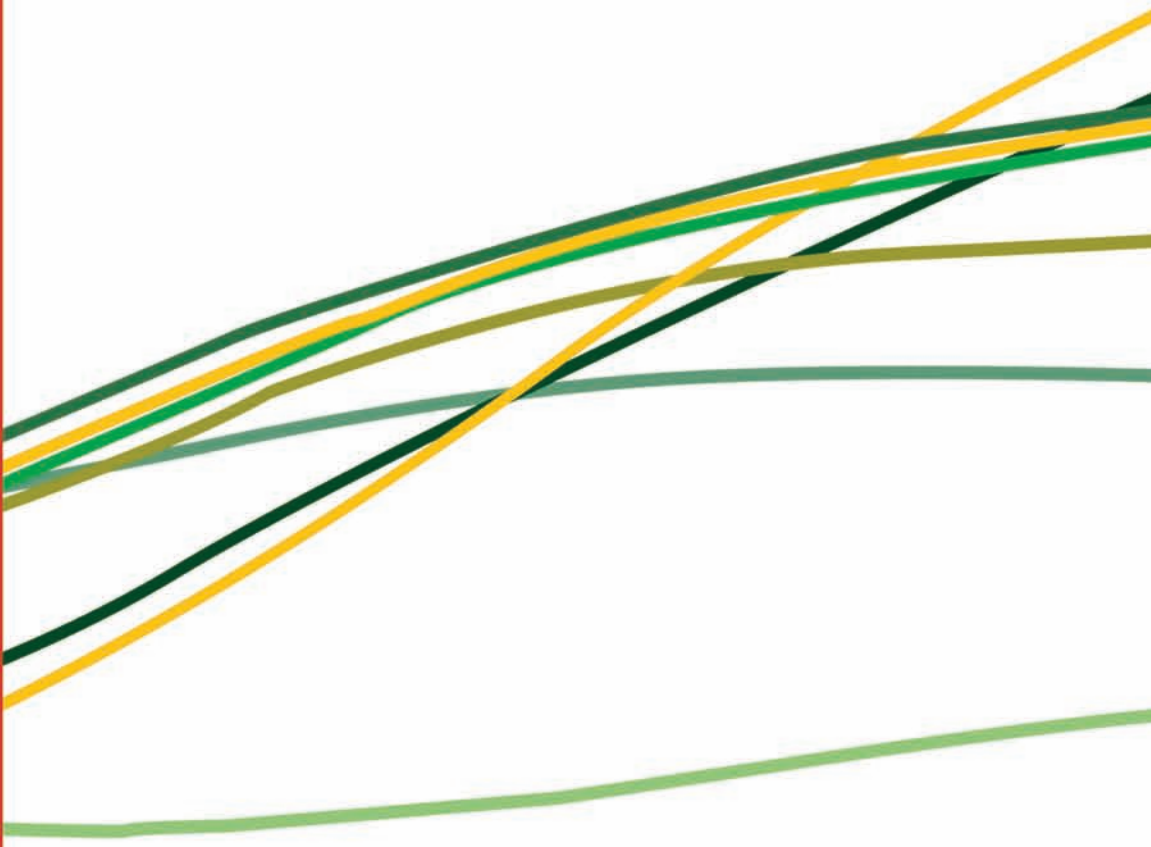
Thinking about the Future

Strategic Anticipation and RAHS



RAHS
risk assessment & horizon scanning
SINGAPORE

Thinking about the Future—Strategic Anticipation and RAHS

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Preface

The world finds itself in an era of unparalleled and unprecedented change, and in a geo-strategic environment that is increasingly more complex, uncertain and interconnected. Strategic surprises continue to afflict many countries. Singapore has been surprised by a series of strategic shocks, from the Asian financial crisis in 1997 to the events of 9/11 to the SARS crisis in 2003.

We cannot predict the future but we can put in place systems and processes that can help us anticipate possible futures and that can help us be better prepared if something should happen. It is important that governments prepare themselves for this new environment. We must develop more intelligent and robust ways to think about the future.

We have been using scenario planning for some 15 years now in the government of Singapore and it has been a useful way of thinking about the future. Scenario planning surfaces and questions the assumptions that underpin the ways in which we perceive the world around us. It is an attempt to describe what might plausibly happen, so that decision makers can then anticipate how they will react to each scenario. It can also be used as a tool to proactively address upcoming challenges and further explore global trends that are visible but not yet well understood.

But in our experience, scenario planning does not provide a complete answer. It could not help us anticipate strategic shocks like 9/11 and SARS. Also, an over reliance on scenario planning may lead to an expectation that events would unfold just as they had been predicted. This could affect our readiness to deal with new and unexpected threats. Hence we began to look for complementary methods for strategic anticipation and this led to the initiation of the Risk Assessment and Horizon Scanning (RAHS) programme.

RAHS started out as a process of discovery and still remains so. Some of the concepts and technologies may work, some may not. But it is important to note that it is based on good science and that it is evolutionary. It has also introduced major benefits not anticipated when we first embarked on the project. For instance, we have begun to understand which combinations of concepts and technologies have more potential than others.

More importantly, RAHS has provided an opportunity to adopt a whole-of-government approach to strategic anticipation. Most governments today are still organised primarily along vertical lines of accountability with limited incentives for inter-agency cooperation. There is duplication of effort, competition for resources and misalignment of strategies. In Singapore, the whole-of-government approach seeks to foster the vision, coordination and coherence required to serve national interests and outcomes. We recognise the need for a small but active centre which builds the organisational software required to get people from different agencies to work towards a common goal.[1]

[1] Yeoh, C.Y. (2005). Aligning Public Agencies for National Outcomes, *Ethos*. Retrieved from http://www.cscollege.gov.sg/cgl/EthosPast/05Jul/06Aligning.pdf

RAHS is a natural part of this process, hinging on a collaborative approach linking ministries and agencies across the government for strategic anticipation. If RAHS can connect silos and challenge mindsets, develop an instinct to share and encourage a collective analysis of possible futures, it is worth making the effort to introduce it.

We started the RAHS project on national security three years ago and we have since developed a RAHS version 1.0 and expanded the RAHS project into a wider programme. RAHS has been used at different levels, by different agencies, in different ways. We are discovering new applications of RAHS in domains as diverse as education, where the Ministry of Education is using RAHS tools to investigate the effectiveness of teaching and learning, and tourism, where the Singapore Tourism Board is using RAHS to explore tourism scenarios for 2025.

We also have an active outreach programme in place. RAHS has been used by the three local universities; the students provide useful feedback on the software developed, and have used it to build models to explain different political, social and economic problems. Beyond the universities, we also intend to reach out to private sector, industry and to a wider international audience.

In conjunction with the 2nd International Risk Assessment and Horizon Scanning Symposium, we hope this volume will help explain the RAHS story, and encourage discussion on various approaches and applications to strategic anticipation.

Thinking about the Future—Strategic Anticipation and RAHS is a compilation of 12 articles on the RAHS programme, and of other approaches and applications to strategic anticipation. The articles

have been kindly contributed by partners who have collaborated with us in the RAHS programme. We thank them for their generous contributions. We hope *Thinking about the Future—Strategic Anticipation and RAHS* will add some value to the existing literature on strategic anticipation, and that it will prove to be an interesting and thought-provoking read.

Foreword

It is important for the story of RAHS to be told. The following essay, "The RAHS Story", is an edited version of the speech given by Peter Ho, Permanent Secretary for National Security and Intelligence Coordination, at the Welcome Dinner of the inaugural International Risk Assessment and Horizon Scanning Symposium on 19 March 2007. It serves as a useful historical account of the genesis of the RAHS project from as far back as 2002, when Ho was the Permanent Secretary for Defence. This account introduces the people who served as early influences on the RAHS project, and traces how Ho helped to bring different strands together and fostered a climate of continuous experimentation and discovery within the Civil Service. He was one of the first few in Singapore to understand the need for different approaches and ways of thinking to deal with an environment of complexity and the importance of the anticipation of emerging strategic issues.

The RAHS Story

Peter Ho

THE STORY OF THE RAHS PROJECT

RAHS did not start out as a project. There was neither a master-plan to begin with nor any flash of inspiration. Instead, the story of RAHS, like a river fed by many tributaries, traces its origins to encounters with several individuals over many years. If my recollection of these encounters differs from theirs, I ask for their forgiveness in advance. I put it down to old age, a faulty memory and a predilection for telling tall tales.

DAVID SNOWDEN

I first met Dave Snowden in February 2002. He was then in IBM, heading its Institute for Knowledge Management. At that time, I was the Permanent Secretary in the Ministry of Defence (MINDEF). In those days, knowledge management was all the rage. Dave was working with the Navy on knowledge management. Richard Lim, then the Deputy Secretary for Technology in MINDEF, suggested that I meet him. He thought I would find Dave interesting.

So we met for dinner. We spoke of many things, including knowledge management. But Dave spoke most passionately about sense-making and complexity. In his distinctive Welsh accent, he tried to explain the Cynefin model to me. Frankly, I found him quite incomprehensible.

Nevertheless, I dimly glimpsed through the cloud of academic jargon and the Welsh accent something that I sensed was important. Dave piqued my interest enough so that I would meet him now and then in the years ahead. In the course of many more meetings, I got used to his accent and gained a better understanding of sense-making and complexity, and the domains and dynamics associated with the Cynefin model.

As I came to understand Dave's ideas, I realised that they resonated with my view that we had entered a period of rapid change and great complexity. Bear in mind that this was after 9/11, and that in this part of the world, we were still experiencing the political and economic aftershocks of the 1997 Asian financial crisis. Dave's Cynefin model provided me with a most useful insight: that we were no longer operating just in the simple or complicated spaces, where events were more predictable, and cause and effect were clearer. Instead, we were operating in complex and chaotic domains, where the first to discern patterns out of chaos would have the competitive advantage.

PETER SCHWARTZ

At this point, I should mention scenario planning. For many years, the Singapore government had used scenario planning as a tool to plan for the future. In fact, in the 1980s I had written a paper suggesting that scenario planning could be a useful tool for government. Eventually, scenario planning was adopted by the Singapore government and continues to this day as a vital tool for forward planning. Because of our interest in scenario planning, I got to know Peter Schwartz, who would later play a pivotal role in the RAHS project. Peter first made his name in scenario planning circles when his team in Shell anticipated the oil shock of the 1970s, saving his company billions while others went down.

For some years, I had an uneasy feeling that scenario planning was not enough. The events of 9/11 convinced me that we needed something to complement scenario planning. The Cynefin model helped me to understand the limits of scenario planning. Scenario planning is a linear tool. It operates best in the known and knowable spaces of the Cynefin diagram, because the futures that it postulates are linear extrapolations from the known present. But in the complex and chaotic quadrants of the Cynefin diagram, where I believe we are operating today, this is not enough. In the face of more unknown unknowns that exist in the complex and chaotic quadrants, we must have other complementary yet diverse approaches and tools to understand our operating environment.

The Cynefin framework lent itself to some very useful insights. Dave conducted a Cynefin workshop for my people in MINDEF, followed by another workshop for several other ministries. This must have been sometime in 2003. But we came up short on tangible results. Perhaps the time was not right. Perhaps we had not yet found a context for the Cynefin model. So these early initiatives did not take off.

JOHN PETERSEN

I first met John Petersen because of MINDEF's interest in the LISA (Large-scale Integrated Search and Analysis) project. LISA is now called DIANE (Digital Analysis Environment). DSO was interested in working with John on LISA because of the tool's potential use by the intelligence agencies.

As with Dave Snowden, I had my first meeting with John Petersen over dinner. At this point, you might well ask why I have had so many of my first encounters over dinner. Well, the reason is a simple and prosaic one. I had discovered, earlier on, that I often learnt more in an informal setting such as a meal, rather than in a more formal setting of a meeting.

I discovered that John was doing a lot of thinking about the future, and that got me interested. John had also written about wild cards, or strategic surprises. He had developed an Arlington Index to measure the rate of change and the impact of these wild cards. After that first meeting, I kept in touch with John. We would meet each other either in Washington DC or in Singapore.

Later, when he knew about our interest in thinking about the future, John proposed a Surprise Anticipation Centre, which we subsequently renamed the Horizon Scanning Centre, with a technology plan to map "rivers of the future". I asked the National Security Coordination Secretariat to have a word with him. The Secretariat later worked with John on two pilot projects before we got into serious discussions on the RAHS project.

JEFF JONAS

I first heard about Jeff Jonas in 2001 and his work on NORA (Non-Obvious Relationship Analysis). He had done some impressive work in the field of complexity theory. NORA is a system that connects databases and looks for anomalous behaviour. NORA was first deployed in Las Vegas and used by the authorities and the casino operators to identify potential card sharks and other charlatans in almost real time. Later, Jeff convinced me that had NORA been fielded by the security agencies before 9/11, it would have identified all but one of the hijackers.

Jeff is now with IBM, and besides NORA, he has another system, ANNA, which is a tool to anonymise data. That is an important capability if agencies and organisations are going to share sensitive data. NORA and ANNA are now collectively labelled Entity Analytics Solutions.

JOHN POINDEXTER

No retelling of the RAHS story will be complete without mention of John Poindexter. I first met John in Washington in July 2002, when he was heading DARPA's Total Information Awareness Office. He spent an hour briefing me on the Total Information Awareness programme. It was a tour de force presentation. He was a master of the subject. I was impressed with the sheer audacity of the concept: that by connecting a vast number of databases, we could find the proverbial needle in the haystack. Also impressive were many of the technologies that his team was then investigating; it demonstrated what technology could help us achieve.

It is unfortunate the US government shut down the TIA project. It had great potential. In some ways, RAHS is a very modest version of TIA. John continues to provide useful advice to our RAHS project especially in relation to continued experimentation and testing, and the need to work hard on the cultural shifts that are necessary to break down vertical silos to connect horizontally.

DIFFERENT STRANDS COMING TOGETHER

I had spent quite a lot of time thinking about how we could better prepare for the future, especially when the environment is complex or even chaotic. There were also important lessons that had emerged from the UK. They had bad experiences in the late 1990s with the mad cow disease, floods and the transport workers' strike. They set about putting in place a whole-of-government approach to horizon scanning to deal with future shocks and unanticipated consequences.

Our own experience in Singapore with SARS in 2003 convinced me that we should get a horizon scanning initiative started. LISA would

provide a basic capability that we could build on. But it was important that we got a dialogue going to generate new ideas and perspectives.

I had a sense that the ideas of Dave Snowden, John Petersen, Jeff Jonas, John Poindexter and others were connected. Instinct told me that we were nearing a point where we could make these connections. The question was how.

In early 2004, when I was still in MINDEF, I asked Peter Schwartz whether he could organise a sense-making workshop. I thought that if someone like Peter, who as a futurologist could hot-house some of the thinkers like John Petersen, Dave Snowden, John Poindexter, Jeff Jonas and Max Boisot together with some of our people, we might connect the different strands. Peter willingly agreed, and the workshop was organised in early 2005. Unfortunately, by then I was no longer in MINDEF, and I could not attend the sense-making workshop as I was overseas, as I often am these days.

At the sense-making workshop, participants shared our initial ideas for the RAHS project to get a sense of whether we were headed in the right direction. But more importantly, I was curious to see if the different strands in sense-making could come together, if there could be a synthesis. The results were mixed but we got a clearer sense of how we would proceed on the RAHS project, that is, in combining one aspect of ordered theory—systems thinking— with one aspect of unordered theory—the Cynefin framework—in a proof of concept. The RAHS project, in the formal sense of it, was then conceived.

SCEPTICISM WITH RAHS, BELIEVING IN RAHS

When we began to firm up the RAHS project in mid-2005, there was general scepticism all round. I think that when the project was

finally approved, I had the sense that the decision-makers were thinking: “upon your shoulders”.

But as we continue to cope with pandemics, unexpected weather phenomena, and economic and financial uncertainties, there has been growing acceptance of the potential of RAHS.

DISCOVERY AND EXPERIMENTATION

I wanted to recount the untold story of RAHS because it would help me illustrate a couple of points. RAHS is a journey of discovery. We never started off thinking about RAHS. But through a process of discovery, synchronicity, serendipity, good luck and a good network of friends, we have made some good progress since we started this project in mid-2005. But we realise too that RAHS may well be a journey without end. It will evolve over time, with new concepts, models and technologies.

I have described RAHS like a river. The RAHS river will flow into an ocean, where new lands, yet to be discovered, lie over the horizon. But instead of ships that will carry adventurers to distant and exotic lands, we will have a RAHS Experimentation Centre, or REC, to explore and discover concepts and applications of RAHS. The REC was launched in October 2007.

We have already lined up a number of experiments that the REC will be running over the next year or two. These include experiments with foreign government agencies, universities and industry partners like HP and IBM.

We will encourage our own agencies, particularly those outside the security arena, to use the REC. The RAHS system will be enriched if applications beyond security emerge.

Of course, we look forward to collaboration with like-minded organisations in operational, conceptual and technological areas related to risk assessment and horizon scanning. Singapore can be a useful test bed, where experiments are conducted before attempting to implement them elsewhere.

NON-LINEAR THINKING

I would like to make a final point about the RAHS system. It is a broader strategic point. Until now, policy-makers well-schooled in linear thinking have helped to achieve great success for Singapore. They have provided structure and process to guide the development of Singapore from Third World to First. Going forward, with globalisation and with everyone competing with linear logic, more and more, we will have to rely on non-linear approaches, not just to be creative and innovative but also to be resilient in the face of unexpected events both bad (such as natural disasters and terrorism) and good (such as breakthrough or disruptive innovation, new openings and opportunities for our economy). I hope that as the RAHS system gains traction and wider acceptance, it will also help to develop a capacity for non-linear thinking among our policy-makers, planners, and decision-makers. If it can do that, it will give Singapore an immense strategic advantage and the RAHS project would have more than paid for itself.

Looking back at the improbable beginnings of the RAHS journey, I think we have got this far only because we were believers. We had to believe that there are intelligent ways to think about and sense the future, and that we need to do so together as government and as a community. I believe that RAHS is the first step in a journey of a thousand miles. But it has provided us with a unique opportunity to better deal with a complex and uncertain future.

SECTION 1

Singapore's Risk Assessment and Horizon Scanning Programme

Explaining the RAHS Programme

National Security Coordination Centre, Singapore

Singapore undertook a comprehensive review of its national security structures, processes and measures in 2004. As a result of this, the National Security Coordination Secretariat[1] was established at the Prime Minister's Office in August that year. Risk Assessment and Horizon Scanning (RAHS) was identified as an important new capability to be developed for government. The need for such a programme can be traced to our experience with SARS and the other strategic surprises that preceded this, for example the Asian financial crisis, the fall of the Suharto government and Singapore's experience with the Jemaah Islamiyah.

There was a general recognition that the world had entered an era of unparalleled and unprecedented change, and a geo-strategic environment that is more complex, uncertain and inter-connected. The underlying philosophy to the RAHS programme is that while we cannot predict the future, we can put in place systems and processes that can help us anticipate possible futures and that can help us be better prepared if something should happen.

We started to look for concepts, methods and processes to strengthen the scenario planning framework we had in place.

[1] The Secretariat comprises the National Security Coordination Centre and the Joint Counter Terrorism Centre.

Scenario planning is essentially predicated on recent history or past observations that help analysts discern emerging patterns of potential and novel threats. But in an era where governments are increasingly faced with strategic surprises, it is critical to investigate other approaches to strategic anticipation. The RAHS programme was started to explore useful methods that could complement scenario planning.

DEVELOPING THE RAHS SYSTEM

The project to develop a baseline capability for RAHS was completed in October 2007. As the RAHS programme explores leading-edge methods and technologies, it will be a process of discovery and continuous R&D. It has introduced major benefits not anticipated when we first embarked on the project. For instance, RAHS has provided an opportunity to adopt a whole-of-government approach to strategic anticipation. RAHS hinges on a collaborative approach linking ministries and agencies across government. It has the potential to connect silos and challenge mindsets, develop an instinct to share, and encourage a collective analysis of possible futures.

The system was developed in collaboration with John Petersen of the Arlington Institute (USA) and Dave Snowden of Cognitive Edge (UK). Singapore agencies such as the Defence Science and Technology Agency and the DSO National Laboratories have also played a major role. The National Security Coordination Centre (NSCC) is the lead agency responsible for the development of the system. Peter Ho, Head Civil Service and Permanent Secretary for National Security and Intelligence Coordination, provided guidance and support to the project.

The RAHS system concept revolves around several key processes: building models; collecting data and organising information; detecting emerging trends and discovering anomalous patterns;

and collaborating with other analysts across government in a classified network. The system has incorporated different approaches to horizon scanning. The resultant diversity will reduce the possibility of getting blindsided by reliance on one particular approach or by one way of thinking about the future.

The RAHS network will comprise agencies covering strategic and operational counter-terrorism intelligence, environmental scanning and scenario planning, biomedical surveillance, cyber surveillance, maritime security, chemical-biological-radiological-explosives surveillance, energy security and education. NSCC has been working with these agencies on domain-specific case studies.

WHAT THE SYSTEM IS NOT DESIGNED TO DO

The RAHS system seeks to give early warning of possible emerging strategic-level surprises, typically on the 2–5 year time horizon, so that policy choices can be made, and pre-emptive and preventive steps taken where necessary. The system is not a tool to monitor or direct ongoing crises.

It is not a tool for prediction. It cannot foretell discrete events. It is designed more as a tool for anticipatory analysis, to pick up weak signals or outliers pointing to worrying trends, crises and major turning points. The tool cannot replace the analyst. It is meant to augment the analyst by helping to automate some of the more tedious aspects of research work, so that the analyst can focus on the more important analytical tasks. It cannot replace instinct and it cannot ask the right questions.

The RAHS system does not perform data mining. Data mining attempts to extract patterns automatically from databases, which can then be used to identify threats automatically against incoming data. Past efforts around the world have shown that fully automated

early warning systems can result in high false alarm rates. The RAHS system is not an automated early warning system. The philosophy behind RAHS is that we need to enhance the analyst's ability to see and discover patterns from data. Towards this end, the development of the RAHS system will continue to tap not only advances in information technology but, more importantly, advances in theories of human decision-making from diverse fields including cognitive psychology and the social sciences.

THE WIDER RAHS PROGRAMME

Recognizing that RAHS requires a long-term commitment and that there is significant research and development work ahead, a comprehensive RAHS infrastructure has been put in place:

- *NSCC* provides policy direction and drives the resource end of this enterprise. It ensures the different parts of the system are coordinated and move in tandem. The Centre will also lead the effort to explore new concepts, methods and techniques.
- The *Horizon Scanning Centre* is the operational nerve centre of the RAHS network.
- The *RAHS Experimentation Centre* drives technology R&D efforts. It allows new tools to be tested before they are integrated as new features in the operational system.

We are actively encouraging non-governmental agencies to try out RAHS to enrich the system through a greater diversity of views and applications. Under the RAHS Outreach Programme, RAHS has been used by the three local universities. Students from the Singapore Management University have used it in their agri-commodity trading programme and students from the National University of Singapore have used it to study the Asian Financial Crisis. Students at the Futures Studies Masters Programme at the

Nanyang Technological University are also using RAHS to examine possible futures relating to China, food, the public service and ethnic conflict.

In the next phase, we will explore how RAHS could be extended to domain experts in the think tanks, universities, the private sector and industry, by building up trusted networks and communities of practice. We hope to consult these experts for their views on weak signals or outliers, and we hope to collaborate, for example, to horizon scan for breakthrough technologies. In the longer term, we could also extend our horizon scanning efforts to include international collaboration partners.

There has been considerable international interest in the RAHS programme. The International Risk Assessment and Horizon Scanning Symposium has been very well-received; RAHS has been recognised as an innovative and ground-breaking programme, and the symposium has helped raise the international profile of Singapore as a hub for horizon scanning concepts and technologies. We continue to host visiting delegations from around the world, and have jointly conducted pilot projects and experiments with international partners. We have also shared the RAHS programme at international conferences such as the Global Futures Forum, the International Command and Control Research and Technology Symposium, and the European Futurists Conference.

OTHER STRATEGIC ADVANTAGES

Adding to the programme's value as an effective way to deal with strategic surprise, there are perhaps three other strategic advantages RAHS has to offer. First, by linking ministries and agencies in a network and encouraging the collective analysis of possible futures, RAHS contributes towards the development of a whole-of-government approach to strategic anticipation.

Second, RAHS has the potential to help policy-makers develop the capacity for non-linear thinking. Policy-makers well-schooled in linear thinking have helped achieve great success for many countries. They have provided structure and process to guide development. Going forward, we will have to rely on non-linear approaches. This will not only enable creativity and innovation but also resilience to unexpected events.

Third, RAHS provides a unique opportunity for the reinforcement of a risk-management approach to decision-making. By sensitising policy-makers to how risks are analysed and how they can be mitigated, RAHS, together with other risk management frameworks, can help create a stronger momentum for risk-based decision-making.

As the RAHS system gains traction and wider acceptance, we would be able to put in place a coordinated and networked approach to horizon scanning, allowing us to better deal with a complex and uncertain future. We would hopefully be able to realise the other strategic advantages the programme has to offer, and add to Singapore's other efforts in the quest for "governance at the leading edge".

For more information on the RAHS programme, please refer to http://www.rahs.org.sg

The RAHS System: Current and Future Capabilities

Humera Khan

INTRODUCTION

SARS and the 9/11 attacks are striking examples of the failure of traditional analytic and forecasting techniques for identifying, anticipating and addressing strategic threats in uncertain and complex environments. Singapore's response has been to create the Risk Assessment and Horizon Scanning (RAHS) programme, formally launched in 2007 as an innovative research initiative to assist analysts and decision-makers in increasing situational understanding and threat anticipation in order to reduce Singapore's risk profile.

The RAHS programme was developed on the premise that human analysis cannot be replaced by a machine; thus it is essential that analysts spend more time evaluating data and less time organising it. To this end, the RAHS software environment incorporates multiple complementary methods for understanding and evaluating information (using models), integrated alongside various automated techniques for sorting and organising data feeds. The focus of this paper is on evaluating the role and utility of some of the modelling methods in the RAHS software program, and recommendations for the inclusion of other methodologies for the transition towards computer simulation.

RISK ASSESSMENT AND HORIZON SCANNING IN SINGAPORE

The RAHS system can be described as having five main components:

- *Data Collection and Information Organisation*: Unstructured data is the glue that binds the RAHS system together, with all the components using mainly open source information brought into the system.
- *Context and Scenario Development*: Different types of models are constructed to understand and represent situations with an emphasis on context and structure.
- *Monitoring and Detection*: Monitoring is a key element of the system that allows the matching of incoming data to previously identified patterns or contents of interest.
- *Pattern Discovery and Evaluation*: These tools allow for the automated processing of data through natural language processing engines, as well as the visualisation of information in order to aid the serendipitous discovery of new patterns.
- *Collaboration*: Collaborative work, in terms of data, models, monitors and methods, are an important element of the RAHS program.

SITUATION ASSESSMENT AND RAHS MODELLING ENVIRONMENT

There are a variety of modelling techniques within RAHS, with a focus on situation assessment. There are two main categories, which can be divided into:

- *Context Development Models*: These models work on the premise of tagging incoming data feeds and visualising the

patterns that emerge from the tags. The tags are based on both content and context. The evaluation of the patterns is done based on the observation of a known pattern (desired or undesirable), or the observation of one that is unique and/or interesting within the context of the issue.

The creation of models depicting a pattern of interest, and the observation of actual patterns emerging over time allows the analysts to assess what is happening today; however, it does not allow the analyst to do projections or *what-if* evaluations of the future.

- *Scenario Development Models*: These models allow the analyst to conduct static situation assessment.

  i. *System maps* describe aspects of the system and its relationships and interdependencies. Constructed on the basis of direct impact and influence, they are mental models of current assumptions about the system and its components. Insights are gleaned through examining the relative leverage any factor has on the system and the feedback loops that will determine system behaviour. While including the feedback and strength of relationships, these models do not represent node "states" (options) and time delays; they too assume that everything will occur simultaneously and that feedback does not actually change any starting conditions.

  ii. *Scenario option spaces* filter and describe potential scenario paths and are constructed on the basis of the morphological checking of consistency. They can be used for simple *what-if* analysis assuming that consistent node options will occur simultaneously, with no time delay and without any feedback.

Neither category of the RAHS modelling techniques includes full-scale computer simulation. They both include the ability to create computer-based graphical representations but are unable to

actually simulate behaviour and future states. This gap can be bridged using a variety of techniques that are described in the following section.

MODELLING COMPLEX SYSTEMS

There are several aspects of complex systems that need to be included in the creation of simulation models. Various techniques are able to perform these at varying levels of sophistication. The factors that will be used to evaluate the utility of the various techniques are listed below:[1]

- Complex systems have unclear boundaries. It is difficult to determine the boundaries of the system due to the interconnectedness of the system to the external environment. The boundaries are set by the user based on the context of evaluation.
- Complex systems are open. Unlike production plants and inventory controls, complex systems are not closed.
- Complex systems show "hysteresis" (path dependence). Due to the dynamic nature of change, the states of these systems are not independent of the past and the time dimension cannot be ignored.
- Complex systems exhibit hierarchical nesting as their components might also be systems in and of themselves.
- Complex systems have dynamic interconnected networks (multiplicity).
- Complex systems show emergence despite having deterministic elements. This is sometimes referred to as "the whole being greater than the sum of the parts" and results in analysis being

[1] Complex System. (2008). Retrieved from http://en.wikipedia.org/wiki/Complex_system

needed at different levels. In organisations this can sometimes be seen when the optimisation of the whole does not occur from the optimisation of the performance of each individual department.

- Complex systems have non-linear relationships.
- Complex system relationships include feedback loops. Feedback can be either reinforcing (positive) or balancing (negative/ damping).

THE NEEDS OF THE RAHS PROGRAMME

Interdisciplinary approaches towards studying complex systems are an important aspect of research and analysis in today's world. Systems theory and complexity theory are two such approaches. Systems theory focuses on evaluating the manner in which a system is interconnected and the feedback mechanisms that exist within it. Complexity theory (the theory of complex adaptive systems) utilises both systems theory and evolutionary approaches.

Table 1 highlights some characteristics of simulations to evaluate the functionality of the current RAHS modelling techniques for complex systems.

Table 1: Characteristics of simulation techniques compared against current RAHS models

	RAHS Context Development Models	RAHS Scenario Development Models
Steady state / static	n/a	Yes
Dynamic	No	No
Stochastic	No	No
Deterministic	n/a	Yes
Discrete	Yes	Yes
Continuous	No	No

We can see that none of the current RAHS simulation techniques are dynamic, stochastic or continuous. Table 2 evaluates three additional broad areas in modelling that should be considered for inclusion in the RAHS program.

This table highlights the strengths of each technique:

- System dynamics allows for continuous, dynamic simulations.
- Dynamic Bayesian allows for discrete, dynamic simulations.
- Agent-based modelling allows for discrete, stochastic simulations.

The following sections address these three types of simulation techniques in further detail.

SYSTEM DYNAMICS

> *System dynamics is a set of techniques for thinking and computer modelling that helps its practitioners begin to understand complex systems—systems such as the human body or the national economy or the earth's climate. Systems tools help us keep track of multiple interconnections; they help us see things whole. Because much of conventional wisdom comes from seeing things in parts and focusing on one small part at a time, system dynamicists* [sic] *tend to have surprising points of view. They generate a lot of controversy.*[2]

System dynamics is a computer-based simulation technique that focuses on representing the interacting, interrelated and interdependent components that form a complex and unified whole, with an emphasis on feedback loops, time delays and accumulating changes in state. This continuous, dynamic simulation method is

[2] Meadows, D.H. (1991). System Dynamics Meets the Press. *The Global Citizen*. Retrieved from http://sysdyn.clexchange.org/sdep/papers/D-4143.pdf

Table 2: Additional modelling techniques

	System Dynamics	Agent-based Modelling	Dynamic Bayesian Networks
Steady state/static	No	No	No
Dynamic	Yes	Yes	Yes
Stochastic	No (The technique itself does not address randomness; however most commercial software packages include stochastic algorithms)	Yes (Monte Carlo techniques)	Stochastic techniques can be combined with standard Bayesian techniques
Deterministic	Yes	No	Yes
Discrete	No	Yes	Yes
Continuous	Yes	No	No

used to understand the basic structure of a system and thus the behaviour it can produce. Using inference or induction, it is used for representing physical systems and projecting both scenarios and strategies for complex systems. It is occasionally used for representing operational- and tactical-level detail; however, it is more appropriate for strategic-level decision-making where the emphasis is on the system as a whole rather than the details of individual components.

AGENT-BASED MODELLING

> *Agent-based models can explain the emergence of higher order patterns—network structures of terrorist organisations and the Internet, power law distributions in the sizes of traffic jams, wars and stock market crashes, and social segregation that persists despite populations of tolerant people. Agent-based models also can be used to identify lever points, defined as moments in time in which interventions have extreme consequences, and to distinguish among types of path dependency.*[3]

Agent-based modelling is a simulation technique used for examining the behaviour of multiple interacting agents within the context of a system. Each individual agent and its rules for interaction are described on the assumption that each act in their own self-interest. The agents are able to learn, adapt, and reproduce. Monte Carlo algorithms are used to introduce randomness. The actual system-behaviour is emergent at the macro level, even though each agent's behaviour might be deterministic at a micro level. An underlying principle in creating such models is induction or inference within the context of pre-defined space and time parameters.

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[3] Agent-based Model. (2008). Retrieved from http://en.wikipedia.org/wiki/Agent_based_model

Also, the results do not move towards steady-state equilibrium, but instead are dynamic.

BAYESIAN NETWORKS

Bayesian networks are directed graphs that represent probabilistic relationships between variables. Dynamic Bayesian methods are used to depict dynamically-changing probabilistic relationships over a time component. Also based on inference or induction, this technique is the most heavily causal of all of these techniques. It is often used for event-forecasting at the operational and tactical level, rather than at a strategic level as it does not include feedback or emergence.

A COMPARATIVE EVALUATION OF SIMULATION TECHNIQUES

The three simulation techniques can be comparatively evaluated based on the aforementioned factors, as shown in Table 3.

We can see that whereas system dynamics and agent-based modelling can both be used to represent complex adaptive systems to varying degrees, dynamic Bayesian networks cannot be used as they cannot represent emergence or feedback. Some recommendations regarding the usage of these varying techniques are given in Table 4.

CONCLUSION

Current RAHS modelling techniques include the ability to create graphical representations for situation assessment. However, they are unable to actually simulate behaviour and future states as none of them are dynamic, stochastic or continuous. Three broad areas in computer simulation should be considered for inclusion in the RAHS program to bridge this gap:

Table 3: A comparative evaluation of simulation techniques

	System Dynamics	Agent-based Modelling	Dynamic Bayesian Networks
Boundaries	User defines the boundaries and the scope of system for evaluation.	User defines the boundaries and the scope of system for evaluation.	User defines the boundaries and the scope of system for evaluation.
Open	Originally designed for closed systems, some commercial software is designed to represent open systems.	Open systems are often described using this method.	Open systems are often described using this method.
Hysteresis	This is an important aspect of the modelling technique.	This is an important aspect of the modelling technique.	This is an important aspect of the modelling technique.
Hierarchical Nesting	Software and modellers include this to varying degrees in their models.	Software and modellers include this to varying degrees in their models.	Software and modellers include this to varying degrees in their models.
Multiplicity	This is an important aspect of the modelling technique.	This is an important aspect of the modelling technique.	This is an important aspect of the modelling technique.
Emergence	This can be seen from a micro level to a macro level for carefully constructed models.	This is seen from a micro level to a macro level.	Not included
Non-linear Relationships	This is an important aspect of the modelling technique.	This is an important aspect of the modelling technique.	Software and modellers include this to varying degrees in their models.
Feedback	This is an important aspect of the modelling technique.	This is an important aspect of the modelling technique.	Not included

Table 4: Recommendations on modelling techniques

	System Dynamics	Agent-based Modelling	Dynamic Bayesian Networks
Physical Systems (actual behaviour and projections)	Yes	Not an optimal usage of technique	Can be used
Information Flows (actual behaviour and projections)	Yes	Not an optimal usage of technique	Can be used
Human Behaviour (actual behaviour and projections)	Not an optimal usage of technique	Yes	Should not be used
Events (actual and projected)	Should not be used	Can be used	Yes
Operations (effects-based)	Can be used	Can be used	Yes
Scenarios (strategic)	Yes	Yes	Should not be used
Scenarios (operational and tactical)	Not an optimal usage of technique	Yes	Yes
Strategies	Yes	Yes	Can be used
Risk	Not an optimal usage of technique	Can be used to a limited extent	Yes

- *System dynamics* to allow for continuous, dynamic simulations. Applications include: modelling physical systems, information systems, political turmoil, scenarios and strategies.
- *Agent-based modelling* to allow for discrete, stochastic simulations. Applications include: modelling human behaviour, information flows, operations, organisational networks and events.
- *Dynamic Bayesian networks* to allow for discrete, dynamic simulations. Applications include: modelling effects-based operations, events, operational and tactical decision-making, and risk.

Editor's note: System dynamics, agent-based modelling and Bayesian networks will be incorporated in future versions of RAHS.

SECTION 2

Approaches to Strategic Anticipation

Managing Complexities and Uncertainties[1]

Lam Chuan Leong

History is not without its disruptive surprises. At the end of the 19th century, it was thought that everything that could be known had been discovered. Yet only a few years later came the X-ray, subatomic particles, nuclear fission and other discoveries that completely changed the world.

Clearly, however, the pace and nature of disruptive change are evolving more rapidly than ever before. It is now commonplace to assert that the world is more complex and uncertain. Three major factors have helped accelerate the pace of change. First, the increasing sophistication of markets and distribution channels has allowed new products to be diffused very rapidly, not only within national borders but also globally. Second, transport and communications technologies have brought the world closer together. This has enabled global production and spread the economic gains and the knowledge of production globally in a far shorter period of time. Third, the revolution in information technology has greatly sped up the diffusion of information, in terms of both technology and also social behaviour. Societies that used to exist in isolation without outside influence can now see and learn through the media or the Internet about what is going on elsewhere almost instantaneously. Together with easier international travel, information

[1] This article was first published in *Ethos* 4, April 2008.

technology spreads and speeds up the learning process of societies in both good and bad ways.

The positive aspects of these developments are well-known. On the downside are "globalised" threats such as contagious diseases, financial crises, terrorism and conflicts. The increase in complexity and uncertainty brought about by these factors has inevitable implications on the way the public and private sectors manage their affairs.

RISKS OF COGNITIVE FRAGMENTATION

Studies on human cognition have shown that the human mind cannot handle too many items at once. It tries to cope with complexity by breaking it down into compartments or sub-components which are left to be handled by other people or at other times. This has given rise to the ever finer modes of specialisation that characterise modern societies. However, this also brings with it the risk of "fragmentation". On occasion, fragmentation can lead to a serious failure as shown in the following example by Gary Klein:[2]

> *During an operation, the surgeon decides to lower the patient's blood pressure. He directs the anaesthesiologist to give the patient a drug that will have this effect, but does not explain what he is trying to accomplish. The anaesthesiologist gives the drug, notes that the patient's blood pressure goes down and boosts the level of another drug that will increase the blood pressure. To the anaesthesiologist, this is standard operating procedure to keep the patient's vital signs stable. The surgeon notes that the blood*

[2] Klein, G. (1999). *Sources of Power: How People Make Decisions.* Cambridge, MA: MIT Press.

pressure is higher than he wants and directs the anaesthesiologist to increase the dosage of the first drug. The anaesthesiologist follows the request, watches for the blood pressure to reduce, and then boosts the drug that will return the blood pressure to its normal level. This cycle continues until the patient ends the game by dying.

This is a simple example that could be put right once the lesson has been learnt, but there are more complex situations where it is not as easy to avoid the negative consequences of fragmentation. For example, people put their money into banks or insurance companies and assumed that these institutions—and their regulators—knew what they were doing. That did not, however, prevent banks from lending to sub-prime borrowers. The banks thought they had diversified their risks and assumed that the financial products had been structured to minimise risks. They looked to credit rating agencies and even loan insurance agencies to take care of some of the work of risk assessment and management. So the whole chain of fragmentation continued.

Had nothing untoward happened, most of them would have been richly rewarded. As it turned out, there was a correlation of risks, and the whole chain fell apart with very serious consequences on a system-wide basis, harming even those who had little to do with it. The same could be said of the food production chain and its potential impact on human health.

We act like a hive of bees, with each bee tending to his individual cell and depending on the actions of thousands of his companions to succeed as a colony. Through this self-organising principle, the arrangement succeeds remarkably well. Indeed, it is a tribute to human organisation that failures are relatively rare, even though this fragmentation process is so widespread. However, as complexity increases, we must expect that the risks arising from

fragmentation will increase. We must therefore adopt an approach that caters to such risks rather than assume that they cannot occur. This calls for a different mental mode in the management of complexity.

Most of our current mental models assume that with given starting conditions, we can reasonably predict the outcome of management actions and therefore choose a set of actions or strategy that brings us to a desired outcome. Studies in complexity clearly indicate that such precision of prediction is impossible for any reasonable period into the future. We need to replace the current mental model that says, "If we do such and such, then an outcome of such and such will result"—with a new one that says instead, "If we do such and such, then *probably such a range of outcomes is likely to result*". In fact, we have to be prepared for outcomes that are totally unexpected and perhaps thought of as "crazy" before the fact. Such mental models do not come about easily because it is the job of many formal education systems to teach predictability and knowledge of a form that is deductive, i.e. that input A invariably leads to outcome A.

RISK MANAGEMENT AS POLICY

It has been said that the good execution of a mediocre strategy is better than a brilliant strategy poorly executed. Yet many managers tend to assume that execution is something that can safely be left in the hands of other, usually more junior, staff. This is also an outcome of a linear mode of thinking, i.e. that once the key input parameters have been set in the form of the strategy chosen, the outcome must inevitably follow as night follows day. But if the outcome is uncertain and the unexpected has a fair chance to happen, we need to pay more attention to execution.

In particular, management has to accept the need to be prepared for surprises at all times. It should:

- Cultivate a mindset that anticipates or at least prepares for "wild card" scenarios.
- Accept the need to build and manage an effective risk anticipation and management system.
- Accept a certain cost to "insure" against low-probability but high-impact outcomes, e.g. choosing a strategy that yields slightly less value than the "optimal" strategy if doing so takes into account a low-probability but high-impact (or loss) outcome. Adopting such a way of thinking is not without challenges. Practical leaders seldom want to waste time thinking about low-probability future events. They have their plates full with current problems. Incurring current costs to insure against future events may seem fruitless, particularly if fast and mobile managers would have moved on to new pastures by the time any adverse impact happens, if at all. But for those who have long-term and total responsibilities for the whole organisation, risk management and the associated costs cannot be avoided.

BEYOND SCENARIO PLANNING

Amongst the many tools of risk management, scenario planning has been advocated as a major tool to combat future uncertainty and to address the problem that the future is inherently unpredictable. Scenario planning is extremely useful in creating awareness of risks and the possibility of unexpected outcomes. However, to fully realise the benefits of scenario planning, this requires a better understanding of the underlying process between scenario envisioning and the formulation of strategies.

Both analysis and practice show that the gap between scenarios and strategies cannot be bridged directly. One can see this with a simple artificial example of a stock market. The scenarios are simple. For a certain time horizon, the market is either up, down or flat. Knowing these scenarios does not at all help the investor in coming to a strategy. It is impossible to create a strategy that will be robust under all scenarios, yet the strategy of staying out of the market or having a fully diversified portfolio will earn close to zero returns over time.

What scenarios can do is to start on the process of thinking about the possible range of outcomes and to develop leading indicators or "trip wires" which will add more knowledge to those outcomes that are more likely to result. Developing such indicators calls for great domain knowledge, extreme skill and judgment, and the ability to read "weak signals".

This is not a trivial task. Take the stock market for example: if the indicators point towards certain outcomes rather than others, then a strategy can be chosen. The sub-prime loan crisis is a good example of this process. Obviously the various scenarios of what can happen cannot be unknown to all the banks, but in their actual selection of strategy, each bank will act differently on the basis of its understanding of the market and its view of the indicators that it has developed. As it turned out, only Goldman Sachs read the appropriate signals and was duly rewarded.

THE NEED FOR CONTINGENT EXECUTION CAPABILITY

Another vital step in the scenarios-to-strategy process is the need to build contingent execution abilities. Singapore has been extremely successful in identifying needs and building the execution ability as well as institutions to carry them out. This is a key ingredient of Singapore's "brand name" overseas and what many

other countries have sought to learn from and emulate. These execution abilities will have to be maintained. Going forward, however, future uncertainties identified from scenarios have to be addressed through what may be called contingent execution abilities. These are abilities that can be called upon not for ongoing projects but for unexpected outcomes.

One good example of this approach is the military. It is clearly impossible to foretell the development or nature of any specific conflict and how it will unfold. No military is built to execute a specific strategy, however likely it is. Instead, armed forces must be trained and equipped to be capable of dealing with the full range of possible outcomes envisaged under the scenarios.

The fact is that outside of the military, contingent execution abilities are rare because of the cost of this extra "insurance". In stable times when conditions are unlikely to change much or change too slowly for new execution abilities to be acquired in time, there is no point in paying this "insurance" cost. But the outcome of armed conflict is so clearly damaging that countries do pay this insurance cost for such contingent execution potential. Civil defence measures to manage potential natural disasters and preparations for health threats like a flu epidemic are other examples of such contingent execution ability potential.

CONCLUSION: EXPECT THE UNEXPECTED

If uncertainties and their downside risks are increasing in pace and impact, it is necessary to pay more attention to risk identification and anticipation. More creativity and diversity are needed in this process; the scanning and interpretation of future outcomes are made more difficult by the human tendency to be trapped in past mental models. We must expect that linear extrapolation from past experience is not a sufficient guide.

Scenario planning, amongst other techniques, offers useful help in extending the ability to “foresee” unexpected outcomes. However, enormous domain knowledge, skills and indeed luck are needed to set up a system of indicators or trip wires that will help guide strategy formulation. In the execution of strategies, more monitoring of the impact of decisions and, in particular, a system of risk assessment and management has to be deliberately set in place and institutionalised. It is no longer possible to trust that a well reasoned and thought-out strategy will be executed flawlessly or not encounter unexpected outcomes. Finally, where the cost and benefits justify it, thought should be given to a development of contingent execution abilities beyond those needed for current operations.

The Future of Education—A Multi-Ontology Approach

Mika Aaltonen

THE ROLE OF EDUCATION

The empirical correlation between education and income is clearly positive. Microeconomic analyses regularly explain much of the difference in income between people with regard to differences in their levels of education.[1] What applies to individuals also applies to entire economies: there is a statistically significant relationship between the level of human capital and the level of GDP for both OECD countries and emerging markets. The size of the coefficient is consistent with estimates generated by the OECD: in the long run a 10 per cent increase in the number of years of education results in an 8 per cent increase in per capita GDP in the OECD countries and a 9 per cent increase in the emerging markets.[2]

The economic aspect of education is an important one. It works in a circular fashion: having a high-level and internationally competitive

[1] Each additional year of schooling appears to raise earnings by about 10 per cent in the United States. See: Krueger, A. and Lindahl, M. (2001). Education for growth: why and for whom? *Journal of Education Literature* 39, pp. 1101–1136.

[2] A slightly different estimation is given in the OECD Growth Project (2006), according to which the long-term economic effect on output of one additional year of education in the adult population falls between 3 and 6 per cent. See http://www.oecd.org/document/52/0.2340.en_2649_34515_37328564_1_1_1_1.00html

education system feeds economic success, and having economic success enables us to sustain our way of life, and to take care of our children, the aged and those who are less fortunate than we are in life.

But the social significance of schools goes far beyond its economic influence in Western societies. School systems can be considered outstanding examples of social innovation. They stand out as one of the few institutional structures, such as bureaucracy and multinational organisations, that have served as organisational models for decades or even centuries. Furthermore, they have safeguarded children while their parents were at work, ensured that students behaved appropriately and thus made sure that students would be able to function later in life within organisations and as citizens.

The objective of this article is to make sense of critical issues, themes and questions that must be considered when we think about and plan for the future, especially pertaining to education in the 21st century. It seeks to provide information needed to develop broad strategic goals or directions and to make appropriate decisions within a dynamic and changing environment.

SIX KINDS OF DECISIONS THAT BUILD OUR FUTURE

For the purpose of improving decision-making regarding our responsibility to future generations, we have created a decision-making landscape. It fully takes into consideration the three dimensions of time: the past, present and future. Moreover, the question of which future is being referred to must be more explicit in discourses about the future because different time horizons alter ontology, epistemology and methodology.

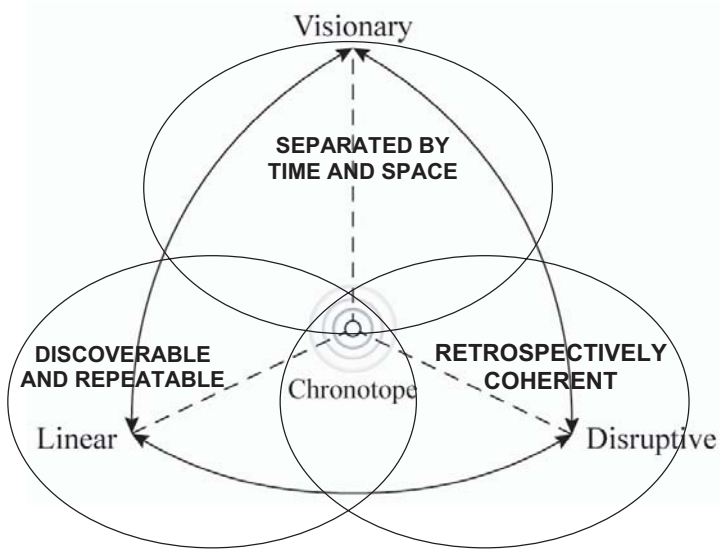

Figure 1: A decision-making landscape

Figure 1 illustrates the different types of systems where different causal assumptions apply in any decision-making landscape. In the bottom left corner is the linear system where cause and effect relationships are discoverable and repeatable. In the bottom right corner disruptive systems are found. There the cause and effect relationships can be found to be retrospectively coherent or not at all coherent. Above them is the visionary system, where the cause and effect relationships are separated by both time and space from the present moment. The present is an imaginary line drawn from the point where the arrows meet in the bottom left to an equivalent point on the right.

Many things concerning our sense-making efforts and decision-making activities will change when we are more precise about the quality of the decision-making landscape. The explicit recognition of different types of systems is the point of departure for

increasing our effectiveness with respect to sense-making and decision-making.

The shape of Figure 1 is based on specific motivations. The bottom left-hand corner where the arrows meet represents the present moment in its most linear state: there the cause and effect relationships are discoverable and repeatable. If we go further in time, even in a very linear situation, the curve starts to bend to the right, because as we move further away from the present moment the amount of uncertainty increases. In the bottom right-hand corner where the arrows meet, the present moment in a state of chaos can be found. The line on the right side bends to the left, because when the chaotic situation lies further away in the future, the likelihood of a future event or a condition coming into being can be changed by a policy consideration if work on it were begun in the present and if the policy consequences could be forecasted. The top corner presents the furthest relevant time horizon, which varies according to the challenges faced and type of organisation involved.

The reason why the line below, from left to right, is not straight like the imaginary line of the present moment should be is because the history of relevant events is under the imagined straight line. This shape thus allows us to reflect upon what has occurred when hindsight analysis is used.

THE EMPIRICAL ANALYSIS

We can use the decision-making landscape to reflect on forthcoming changes and our present-day decisions as we prepare to face them and also try to benefit from them.

In Figure 2, situations 1 and 3 deal with present situations: 1 on the linear side and 3 on the disruptive side. Situation 2, on the other hand, is about hindsight and our history.

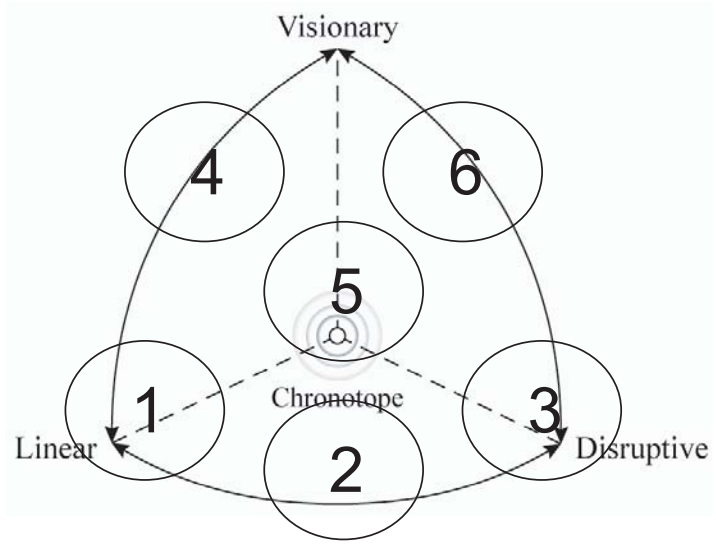

Figure 2: Six kinds of decisions

The Spanish National Reform Programme on convergence and employment is a case in point that demonstrates the type of answers produced by a linear approach (situation 1) to the future of education. The role of human capital is recognised as a vital resource for economic growth, and also as an element through which it is possible to achieve equality of opportunity. Besides taking a comprehensive approach to the operation and quality of the appropriate education system, the fundamental problems of compulsory secondary and tertiary education are tackled in detail.

The Spanish educational programme is implemented through a series of measures which are highlighted below:

- Measures to improve nursery education.
- Measures to improve primary education.
- Measures to improve compulsory secondary education.

- Measures to integrate immigrant students.
- Measures to enhance the efficient use of educational resources.
- Measures to provide scholarships and aid to students.
- Measures to improve secondary education.
- Measures to improve vocational and educational training.
- Measures to improve tertiary education.
- Measures for universal, permanent access.
- Measures for further education and training.
- Measures to incorporate the information society into education.

Each measure is accompanied by specific action plans, and if the measures are carefully considered and accurate, they should certainly improve the present situation, i.e. the future should look brighter after the action plans have been executed. However, these measures will not help the nation to adapt to or benefit from the changes that take place in the environment.

Situation 2 is about the past. Nevertheless, it is an important source of improvement. Looking deeper into our society helps us comprehend why certain systems, organisations and issues exist in the way they do, enabling a critical evaluation for their relevance today. For example, the present pension age of 65 years originates from Otto von Bismarck's Germany. At that time it was thought people who live longer should be given a pension as life expectancy after 65 years was not extremely long. If the same measurement were used today, a pension would start much later, perhaps at the age of 78 for men and 81 for women.

Situation 3 concerns a disruptive situation or a crisis. It tells us that we have not been able to lead our nation or organisation well or that something that could not have been anticipated has happened. If a decision-making situation has slipped to situation 3, then authoritative or crisis management is required.

In contrast to the above, the following three kinds of decisions are concerned with our responsibility to future generations: situations 4, 5 and 6.

Situation 4, although placed on the linear side further in the future, is a place not so unfamiliar to us. Perhaps it is not correct to talk about knowledge, but certainly we deal with situations that are knowable. And when the changes are knowable, we can prepare ourselves to face them. In situation 4 traditional foresight methods find their justifications. This kind of approach has been taken at the Royal Society of Arts. The idea is quite simple: due to the fact that jobs for life, state pension and paternalistic employers appear to be running its course by the end of the 20th century, the 21st century is going to require different skill sets that will enable people to change, adapt and innovate. As a result a list of five new, essential skills emerges.

In the middle of Figure 2, we find situation 5. It is set in the future and it is not linear or disruptive, but could be termed complex. A complex situation cannot be dealt with in a similar fashion to the others; instead it must be dealt with according to its quality. Thus, establishing appropriate enabling structures—whether social, educational or technological—can lead to positive emergent behaviour.

The Danes have taken a unique approach to education. Their case serves as an example for situation 6, which is a disruptive situation

in the future. When I discussed the PISA[3] index with a Danish expert and the fact that the Danes, perhaps surprisingly, had not been so successful, I received the answer: "We don't want to succeed according to PISA standards; we want our children to become innovative and creative." There are several institutional examples at different levels in Danish society that practise that principle: *Danfoss Universe*, the Danish company's theme park, illustrates how exciting nature really is and attracts people from all over Denmark and beyond; *Experimentariet* builds on experiences and knowledge and also provides opportunities for work with several corporate and government sponsorships; *Byproject Todenskiold* is all about story-living, i.e. combining play and learning at nurseries and schools; and last but definitely not least is *Kaospiloterna*, which has created an alternative, seriously taken and successful curricula for education. All the above Danish examples work beyond the traditional agendas and institutions of education by breaking the boundaries of how, what, when and with whom we should learn and educate ourselves.

DISCUSSION

One of the reasons why many real-world problems appear intractable and are difficult to resolve is that often only a single or a few causes are identified even though problems such as the

[3] The Programme for International Student Assessment (PISA) is an internationally standardised assessment that was jointly developed by participating countries and administered to 15-year-olds in schools. PISA assesses how far students near the end of compulsory education have acquired some of the knowledge and skills that are essential for full participation in society. In all cycles, the domains of reading, mathematical and scientific literacy are covered not merely in terms of mastery of the school curriculum, but in terms of important knowledge and skills needed in adult life. See http://www.oecd.org/department/0,3355,en_2649_35845621_1_1_1_1_1,00.html

challenge of the future of education arise from the interaction of multiple, underlying and interrelated causes.

Our work is targeted at expanding our thinking, concerns and planning so that we begin to create situational and temporally appropriate interventions, or if you wish a web of cause and effect relationships, that can influence the future of education for our benefit.

In conclusion, the following are six kinds of decisions that will build our future premised on the need for different leadership interventions to be considered specifically in different countries:

- The need for efficacy, i.e. cause and effect relationships, which are repeatable.
- A reassessment of the basic assumptions on which our systems are built.
- Improvements in our reaction time and our ability to make decisions efficiently.
- Foresight and appropriately timed decision-making.
- Building appropriate enabling systems.
- Making space for tests, pilots and experiments.

However, the interventions are not frozen realities without considerations of time or temporality. At the present moment these decisions are about the present “past”, the present “present” and the present “future”. As time passes, the present “present” turns into the future “past”, and the present “future” into the future “present”, and so on.

This means that in addition to comprehending change both as a top-down and a bottom-up reciprocal process as well as an outcome, the emergence of the future is also seen as being dependent on the occurrence and type of feedback received from the larger environment. Comprehending change in this way ensures that the desired change becomes a target formed from continuous reflection.

Using Morphological Analysis to Deal with Wicked Problems

Tom Ritchey

If your organisation works with long-term social, political or organisational planning, then you have got “wicked problems”. You may not call them by this name, but you know what they are. They are those complex, ever-changing societal and organisational planning problems that you have not been able to treat with much success, because you have not been able to define and structure them adequately. They are messy, devious and “reactive”, i.e. they fight back when you try to “resolve” them.

In 1973, Horst Rittel and Melvin Webber, both urban planners at the University of Berkley, California, wrote an article for *Policy Sciences* with the astounding title, “Dilemmas in a General Theory of Planning”. In this landmark article, the authors observed that there is a whole realm of social planning problems that cannot be successfully treated with traditional linear, analytical approaches. They called these *wicked problems*, in contrast to *tame problems*.

A year later, in his book "Re-designing the Future", Russell Ackoff[1] essentially put forward the same concept (although in less detail), which he called a "mess", and which later became a "social mess".[2]

Although we are (somewhat) wiser today and less susceptible to the belief that complex social planning problems can be "solved" by linear methods akin to engineering solutions, I think that we still have a lot to learn by looking at the original formulation of the distinction between "wicked" and "tame" problems.

First, let us look at what characterises a *tame problem*.[3] A tame problem:

- Has a relatively well-defined and stable problem statement, i.e. it is essentially the same problem today as it was yesterday.
- Has a definite stopping point, i.e. we know when a solution is reached.
- Has a solution which can be objectively evaluated as being right or wrong.
- Belongs to a class of similar problems which can be solved in a similar manner.
- Has solutions which can be tried and abandoned.

Wicked problems are completely different. Wicked problems are ill-defined, ambiguous and associated with strong moral, political and

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[1] Ackoff, R. (1974). *Re-defining the Future*. London: Wiley.

[2] Horn, H. (2001). *Knowledge Mapping for Complex Social Messes*. A presentation to the "Foundations in the Knowledge Economy" at the David and Lucile Packard Foundation. Retrieved at http://www.stanford.edu/~rhorn/a/recent/spchKnwldgPACKARD.pdf

[3] Conklin, J. (2001). Wicked Problems and Social Complexity. Retrieved at http://cognexus.org/wpf/wickedproblems.pdf

professional issues. Since they are strongly stakeholder-dependent, there is often little consensus about what the problem *is*, let alone how to resolve it. Importantly, wicked problems will not keep still: they are sets of complex, interacting issues evolving in a dynamic social context. Often, new forms of wicked problems emerge *as a result* of trying to understand and solve one of them.

The most evident and important wicked problems are complex, long-term social, political and organisational planning problems. Some examples are:

- How should we fight the "War on Terrorism"?
- What is a good national immigration policy?
- How do we get genuine democracies to emerge from authoritarian regimes?
- How should scientific and technological development be governed?
- How should we deal with crime and violence in our schools?
- How should our organisation develop in the face of an increasingly uncertain future?

As Rittel and Webber explain:[4]

> *... the classical systems approach ... is based on the assumption that a planning project can be organised into distinct phases: "understand the problems", "gather information", "synthesise information and wait for the creative leap", "work out solutions" and the like. For wicked problems however, this type of scheme*

[4] H. Rittel, H. and M. Webber, M. (1973). "Dilemmas in a General Theory of Planning.", *Policy Sciences* 4, pp. 155–169.

does not work. One cannot understand the problem without knowing about its context; one cannot meaningfully search for information without the orientation of a solution concept; one cannot first understand, and then solve.

TEN CRITERIA FOR WICKED PROBLEMS

Rittel and Webber characterise wicked problems by the following 10 criteria:[5]

1. *There is no definite formulation of a wicked problem.*

The information needed to understand the problem depends upon one's idea for solving it. This is to say: in order to describe a wicked problem in sufficient detail, one has to develop an exhaustive inventory for all the conceivable solutions ahead of time.

(This seemingly incredible criterion is in fact treatable, as I will demonstrate later.)

2. *Wicked problems have no stopping rules.*

In solving a tame problem, "the problem-solver knows when he has done his job. There are criteria that tell when *the* solution, or *a* solution, has been found". With wicked problems you never come to a "final", "complete" or "fully correct" solution since you have no objective criteria for such. The problem is continually evolving and mutating. You stop when you run out of resources, when a result is subjectively deemed "good enough" or when we feel "we've done what we can".

[5] Ibid. It has been pointed out that some of these criteria are closely related or have a high degree of overlap, and that they should therefore be condensed into four or five more general criteria. I think that this is a mistake, and that we should treat these criteria as arising from 10 more or less specifically encountered "frustrations" the authors experienced in dealing with complex social planning issues.

3. *Solutions to wicked problems are not true-or-false, but better or worse.*

The criteria for judging the validity of a "solution" to a wicked problem are strongly stakeholder-dependent. However, the judgements of different stakeholders "are likely to differ widely in accordance with their group or personal interests, their special value sets and their ideological predilections." Different stakeholders see different solutions as simply better or worse.

4. *There is no immediate and no ultimate test of a solution to a wicked problem.*

> *... any solution, after being implemented, will generate waves of consequences over an extended—virtually an unbounded—period of time. Moreover, the next day's consequences of the solution may yield utterly undesirable repercussions which outweigh the intended advantages or the advantages accomplished hitherto.*

5. *Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.*

> ... every *implemented solution is consequential. It leaves "traces" that cannot be undone ... And every attempt to reverse a decision or correct for the undesired consequences poses yet another set of wicked problems.*

6. *Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.*

> *There are no criteria which enable one to prove that all the solutions to a wicked problem have been identified and considered. It may happen that no solution is found, owing to logical inconsistencies in the "picture" of the problem.*

7. *Every wicked problem is essentially unique.*

> *There are no* classes *of wicked problems in the sense that the principles of solution can be developed to fit all members of that class.*
> *...[p]art of the art of dealing with wicked problems is the art of not knowing too early which type of solution to apply.*

(Note: this is a very important point)

8. *Every wicked problem can be considered to be a symptom of another [wicked] problem.*

Also, many internal aspects of a wicked problem can be considered to be symptoms of other internal aspects of the same problem. A good deal of mutual and circular causality is involved, and the problem has many causal levels to consider. Complex judgements are required in order to determine an appropriate *level of abstraction* needed to define the problem.

9. *The causes of a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.*

> *There is no rule or procedure to determine the "correct" explanation or combination of (explanations for a wicked problem). The reason is that in dealing with wicked problems there are several more ways of refuting a hypothesis than there are permissible in the [e.g. physical] sciences.*

10. *With wicked problems, the planner has no right to be wrong.*

In "hard" science, the researcher is allowed to make hypotheses that are later refuted. Indeed, it is such hypothesis generation and refutation that is a primary force behind scientific development.[6] One is not penalised for making hypotheses that turn out to be wrong.

However, "[i]n the world of ... wicked problems no such immunity is tolerated. Here the aim is not to find the truth, but to improve some characteristic of the world where people live. Planners are liable for the consequences of the actions they generate".

TACKLING WICKED PROBLEMS WITH GENERAL MORPHOLOGICAL ANALYSIS

How, then, does one tackle wicked problems? Some 20 years after Rittel & Webber wrote their article, Jonathan Rosenhead of the London School of Economics presented the following criteria for dealing with complex social planning problems—criteria that were clearly influenced by the ideas presented by Rittel, Webber and Ackoff.[7]

- Accommodate multiple alternative perspectives rather than prescribe single solutions.
- Function through group interaction and iteration rather than back-office calculations.

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[6] Ritchey, T. (1991, revised 1996). Analysis and Synthesis—On Scientific Method based on a Study by Bernhard Riemann. *Syst Res* 8(4), pp. 21–41. Retrieved at http://www.swemorph.com/pdf/anaeng-4.pdf

[7] Rosenhead, J. (1996). What's the problem? An Introduction to Problem Structuring Methods. *Interfaces* 26(6), pp. 117–131.

- Generate ownership of the problem formulation through transparency.
- Facilitate a graphical (visual) representation for the systematic, group exploration of a solution space.
- Focus on relationships between discrete alternatives rather than continuous variables.
- Concentrate on possibility rather than probability.

Group-facilitated, computer-aided General Morphological Analysis (GMA) is fully attuned to these criteria. Developed in the mid-1990s, GMA was designed as a non-quantified problem structuring method (PSM), which results in an inference model that strives to represent the total problem space and as many of the potential solutions to the given problem complex as possible.[8] This, in itself, goes a long way in satisfying Rittel and Webber's first seemingly incredible criterion concerning wicked problems: "in order to *describe* a wicked problem in sufficient detail, one has to develop an exhaustive inventory for all the conceivable solutions *ahead of time*." (emphasis mine)

As a process, GMA goes through a number of iterative steps or phases which represent cycles of analysis and synthesis—the basic method for developing (scientific) models.[9] The analysis phase begins by identifying and defining the most important

[8] Ritchey, T. (2002). Modelling Complex Socio-Technical Systems using Morphological Analysis. Adapted from an address to the Swedish Parliamentary IT Commission, Stockholm, December 2002. Retrieved at http://www.swemorph.com/pdf/it-webart.pdf. Also Ritchey, T. (2006). Problem Structuring using Computer-Aided Morphological Analysis. *Journal of the Operational Research Society* 57, pp. 792–801.

[9] Ritchey, T. (1998). Morphological Analysis—A General Method for Non-Quantified Modelling. Adapted from a paper presented at the 16th Euro Conference on Operational Analysis. Retrieved at http://www.swemorph.com/pdf/gma.pdf

dimensions of the problem complex to be investigated. Each of these dimensions is then given a range of relevant (discrete) values or conditions. Together, these make up the variables or parameters of the problem complex. A morphological field is constructed by setting the parameters against each other, in parallel columns, representing an *n*-dimensional configuration space. A particular constructed "field configuration" is designated by selecting a single value from each of the variables. This marks out a particular state or (formal) solution within the problem complex.

The morphological field represents the total "problem space", and can contain many thousands—or even hundreds of thousands—of possible (formal) solutions. A proper "solution space" is synthesised by a process of internal *cross-consistency assessment* (CCA). All of the parameter values in the morphological field are compared with one another, pair-wise, in the manner of a cross-impact matrix. As each pair of conditions is examined, a judgement is made as to whether—or to what extent—the pair can coexist, i.e. represent a consistent relationship. Note that there is no reference here to causality or probability, but only to possibility through mutual consistency. Using this technique, a typical morphological field can be reduced by up to 90 per cent or even 99 per cent, depending on the nature of the problem.

When this solution (or outcome) space is synthesised, the resultant morphological field becomes an inference model, in which any parameter (or multiple parameters) can be selected as "input", and any others as "output". Thus, with computer support, the field can be turned into a laboratory with which one can designate initial conditions and examine alternative solutions (see Figure 3).

It is also important to heed Rittel and Webber's seventh criterion: "Part of the art of dealing with wicked problems is the art of not

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SCENARIO	Buyer behavior	Consumption patterns T=total cons. P= private import	Consumer sorting behavior (trends)	National environmental policy	Price of new raw material vs reclaimed material	Production technology: volume of materials required	Technology development: reclaiming technology	EU-directives for import and export of waste	Producer responsibility strategy
World ecological crisis	Willing to pay more for green products	T: Up P: Up	Voluntary (ideologically driven)	At the forefront; Holistic approach (Legal & econ.)	New: High Reclaimed: High	Much less than today	Very rapid increases	Less restricted than today	STRATEGY A
Raw Matetrial Depletion	Will to buy green, but will not pay more	T: Status Quo P: Up	Will sort for compensation/ reward	At forefront, but no holistic approach (only legal)	New: High Reclaimed: Low	Somewhat less than today	Substantial increases	Same as today	STRATEGY B
Current policies (Negative trend)	No interest in buying green products	T: Up P: Status Quo	Will sort if facing sanctions	Ideological, based on voluntary acceptance	New: Low Reclaimed: High	Same as today	Only marginal increases	More restrictive than today	STRATEGY C
Current policies (Positive trend)		T: Status Quo P: Status Quo	Will resist sorting	Least possible adaptation	New: Low Reclaimed: Low				NO ADEQUATE STRATEGY
Green-house effect (Stop emissions)									
Batman: High-tech solutions									
Dematerialized production (New materials)									
Green market (ideological paradise)									

Figure 3: Scenario-strategy model for a Swedish Extended Producer Responsibility system. The selected scenario (red) is defined by the following eight scenario parameters (dark blue). Compatible EPR strategies are shown in light blue.

knowing too early which type of solution to apply." In morphological analysis, we call this "remaining in the mess", i.e. keeping one's options open long enough to explore as many relationships in the problem topology as possible, before starting to formulate solutions. This can be a frustrating process for inveterate "problem-solvers", but is an absolutely necessary procedure when working with wicked problems and social messes.

Finally, the *process* of creating morphological inference models through facilitated group workshops is as important as the end-product—i.e. the model itself. As many stakeholders as possible should be engaged in the work, in order to create a common terminology, common problem concept and common modelling framework. Principal stakeholders and subject specialists should be brought together in a series of workshops to collectively 1) structure as much of the problem space as possible, 2) synthesise solution spaces, 3) explore multiple solutions on the basis of different drivers and interests and 4) analyse stakeholder structures. The different stakeholders do not have to agree on a single, common solution, but must be encouraged to understand each other's positions and contexts.

As is the case with all methods dealing with complex social planning problems, the results of a morphological analysis are no better than the quality of the inputs provided. However, even here, the morphological approach has some clear advantages. It expressly provides for a good deal of in-built "garbage detection", since poorly defined parameters and incomplete ranges of conditions are immediately revealed when one begins the task of cross-consistency assessment. These assessments simply cannot be made until the morphological field is well defined and the working group is in agreement about what these definitions mean. This type of garbage detection is extremely important when working with *wicked problems* and *social messes*.

Multidimensional Concept of Risks in Horizon Scanning and Futures Thinking

Sirkka Heinonen

The concept of risks plays an important role in futures studies and in a larger framework of all futures thinking. Risks are primarily linked with the notion of uncertainty that is an inherent quality of the future. Using futures research methodology in a systematic fashion, it is possible to alleviate uncertainties about the future. If you have developed ways of anticipating the future—whether through scenarios, Delphi, mega-trend analysis, weak signal identification, futures wheel, etc.—the resulting foresight intelligence helps to reveal various alternative futures. The second layer of analysis consists of efforts to distinguish major risks. After a specifically orientated process of risk horizon scanning, the next steps are identifying relevant risks, assessing, interpreting, understanding, managing and governing them.

WE LIVE IN A RISK SOCIETY

The world is full of risks where even the most trivial matter may escalate into a colossal tragedy at the blink of an eye. We have a popular song in Finland that speaks of the inevitable: "You cannot survive life" (in Finnish: "*Ei elämästä selviä hengissä*"). The same analogy applies to companies, organisations and nations. Risk is an immensely important force in the unfolding of the modern history.

Ulrich Beck's concept of a "risk society" has given us arguably the most adequate description of our current technological-cultural predicament. Beck sees society as one that is organised in response to risk—not as a reference to an increase of risk in society.[1] To him, risk is a systematic way of dealing with the hazards and insecurities induced and introduced by modernisation itself, and this is paralleled by increasing risk awareness as society becomes increasingly preoccupied with the future.

THE SOFT MULTIDIMENSIONAL THEORY OF RISKS

This paper presents a tentative "soft" multidimensional approach to addressing risks from different angles and dimensions—a theory of deconstructing the multidimensional concept of risks in risk assessment and horizon scanning to yield risk intelligence. The core claim is that risks can be addressed through the following strategic and operational framework and scanning space, which is constructed of several dimensions. This theory points out that an integrated analysis is needed to encompass all the following dimensions. Moreover, the qualitative and subjective nature of risks is also important to reflect upon in all risk analysis, to complete the "black holes" between isles of quantitative data and prognoses.

The first dimension of risks is the target dimension where the risks are reflected upon. They threaten either human security or environmental security. The respective security of humans and of the environment is strengthened in indirect proportion to the existence and realisation of looming risks. Naturally, these two targets get intertwined. The second dimension is the field

[1] Van Loon, J. (2002). *Risk and Technological Culture: Towards a Sociology of Virulence*. London: Routledge, p. 234. Also Beck, U. (1992). *Risk Society: Towards a New Modernity*. London: Sage.

dimension. Risks can be opened up through different angles or field dimensions for scrutiny. The following field dimensions can be studied:

- Political dimension.
- Economic dimension.
- Geographical dimension.
- Physical dimension.
- Ecological dimension.
- Mental dimension.
- Virtual dimension.
- Digital dimension.
- Social dimension.
- Technological dimension.
- Cultural dimension.

The third dimension to risk scanning and analysis are the dimensions of their dynamics, i.e. are the risks external or internal? How are the risks brought about? Are they coming externally, outside our own actions or boundaries, or are they self-generated internally consciously or unintentionally? There are risks such as natural disasters that have always had negative effects on human populations. They are perceived to be produced by non-human forces and are thus considered external risks. On the other hand, modern risks are the products of human activity. Beck refers to such manufactured risks when he speaks of a risk society. There is a significant level of human agency operating in the production and mitigation of manufactured risks, whereas natural risks lack the human agent. These two can also mingle—for example, climate change is a risk

that is to a certain degree produced and exacerbated through human action.

The fourth dimension is the size and visibility dimension. In this dimension, we can see significant, imminent risks on the horizon or emerging risks with minor visibility. The visibility dimension starts from latent or hidden risks, which become emergent, clearly visible risks. Fading risks are ones that disappear behind the horizon owing to technological or social innovations, economic or environmental progress, etc.

Last but not least is the impact dimension. Risks can be assessed by their potential impact. However, such impact analysis is demanding. The soft multidimensional theory of risks puts emphasis on imagining and analysing risks concerning various dimensions (DR) as described above. Such an integrated approach will then be applied to a framework of seven layers (imagining, identifying, assessing, interpreting, understanding, managing and governing) of processing risks with the aim of eventually and continuously creating and enhancing Risk Intelligence (RI). This approach is illustrated in Figure 4.

Figure 4: The multidimensional approach to risk analysis, resulting in Risk Intelligence

ON THE DEFINITIONS OF RISK

The word "risk" often refers vaguely, in non-technical contexts, to situations in which it is possible but not certain that some undesirable event or failure will occur. In technical contexts, the word has several more specialised uses and meanings. Five of these are particularly important since they are widely used across disciplines. Risk is defined as:

- An unwanted event which may or may not occur.
- The cause of an unwanted event which may or may not occur.
- The probability of an unwanted event which may or may not occur.
- The statistical expectation value of an unwanted event which may or may not occur.
- The fact that a decision is made under conditions of known probabilities ("decision under risk" as opposed to "decision under uncertainty").

In addition to the above five common meanings of "risk" there are several other more technical meanings, which are well-established in specialised fields of inquiry. According to the Stanford encyclopedia of philosophy (2007), the word "risk" comes from Latin "*risicare*", which means avoiding rocks (when sailing). This metaphor of nations as ships navigating the global sea, in sometimes very foggy conditions and trying to avoid treacherous rocks, is an illustrative image.

THE CHARACTERISTICS OF RISK

On closer examination, risk and the future share similar qualities. The future holds a spectre of promise and a huge menu of

possibilities. Of these potential futures, only a fraction will be realised. Similarly, of all the risks looming in the future, near or distant, only a certain number will be actualised. The more we put efforts in scanning global changes and exploring alternative futures, the more we are likely and able to envision risks as well. This logic is embedded in major foresight systems such as Singapore's Risk Assessment & Horizon Scanning system (RAHS), the Club of Rome's identification of global problems, and the Millennium Project under the World Federation of United Nations Association.

Risks are closely connected to probabilities as well. Alternative futures and scenarios can be assessed based on probability. However, the probability is closely dependent on those who make the evaluation. In futures research, one critical question is which experts have been engaged in a Delphi study. To a certain degree the outcome of the study is already determined by the choice of respondents. The more varied the background of participants, the more varied the results because of the different disciplines and worldviews. In other words, risk is "in the eye of the beholder".

Another key characteristic of risks is uncertainty. When there is a risk, there must be something that is unknown or that has an unknown outcome. Therefore, knowledge about risk is knowledge about the lack of knowledge. This combination of knowledge and the lack thereof contributes to making issues of risk complicated from an epistemological point of view. One of the principal axioms in modern systematic futures research is that you cannot predict the future. No one will know exactly how the world will look like in 2030. We can only anticipate and foresee the future with more or less enlightened "guesses"—forecasting scenarios or images. Besides, the value of forecasting future developments is not defined by the way it is realised, but by the impact it will have on strategies, decision-making and, accordingly, on the real state of

affairs to come. A forecast that anticipates the continuation of a negative trend or increasing risk may in time draw attention to the issue and lead to decisions that either eliminate or at least alleviate the threat in question. Thus, a forecast not realised may in fact be most valuable in certain cases. According to Schwartz, the art of long-term thinking and planning in an uncertain world can be practiced by imagining immersion in the future—rehearsing the future like actors in a drama to be played.[2] Thus, risks can also be "rehearsed" as a preparation drill.

Risks are also linked to vulnerability. This is the evocative point in Beck's characterisation of the modern world as a risk society. This even suggests that we might classify whole nations according to their risk "capital", i.e. a vulnerable nation has more risks looming than average in a certain term projected to the future. Of course, it is not the number of risks that is critical here, but the nature of risks, their preconditions and probability to be realised that would have to give basis to such assessment. While Fukuyama discusses trust societies and proposes to distinguish between low and high trust societies,[3] it is possible to approach the question of vulnerable societies or states. However, it must be emphasised that different states face different risks and resulting vulnerabilities. Hence, they should not only be compared with each other but within themselves. Thus, the dimension of vulnerability has nothing to do with the degree of development—if unmanaged, the most developed

[2] Schwartz, P. (1998). *The Art of the Long View: Planning for the Future in an Uncertain World*. Chichester: Wiley, p. 272.

[3] Fukuyama divides the world into high and low trust societies. He focuses on the issue of trust as the bond that reduces transaction costs, thus resulting in a more friction-less economy. According to him, in a high trust society it is easier to establish large companies. In low trust societies family companies are typical. Fukuyama, F. (1995). *Trust: The Social Virtues and the Creation of Prosperity*. New York: Free Press.

nations can have the most critical vulnerabilities due to their very development.

In this case, can mono-cultural and uniform societies be considered less vulnerable because trust is presumed to be prevalent in them? If a poly-culture is dominating, a trust society may instead be directed or turned into a control society where trust is lacking. The trust culture is in that case replaced by the control culture. This may in turn pave way for a "super-control" society where security requires a further empowered police force. Paradoxically, in a control society, security cannot be guaranteed. A "super-control" culture may even lead to dictatorship, which generates counter-reactions and social upheaval in the long-term. Thus, democracy and common culture is the key and a necessary condition to trust societies.

Further, the vulnerability to risks is increased when projected to the rapid and constant changes of the world. The complexity increases at the same pace as, for example, technology progresses towards ever more sophisticated systems. The world is a complex system, consisting of a multitude of nations, societies, cultures, economies, politics, technologies and environments. The world continues to change at a more rapid pace in all aspects of our culture: business, technology, medicine, security, terrorism, population, the environment. Canton argues that due to the rapid and radical change, we should start thinking differently about the future.[4] After 9/11 he saw a new complex future emerging—an "Extreme Future" of disruptions, risks, threats and perhaps new opportunities as well. Thus, critical security trends should be explored with such complexities in mind. Hammond also discusses critical security threats and pays attention to such issues as globalisation of crime,

[4] Canton, J. (2006). *The Extreme Future*. New York: Plume.

proliferation of dangerous technologies, urban unrest, inequity and instability.[5]

More importantly, in this complexity, our interconnectedness becomes accentuated. Hammond emphasises that as the world becomes ever more interconnected, instability in one place can have devastating effects elsewhere.[6] The more complex the world, the more important it is to pay attention to the interconnections between different states, activities, phenomena and policies. The nexus is always a potential source for emerging issues, new risks, and opportunities. Sajeva and Masera point out that the pervasive application of information and communication technologies have increased the interconnectivity among systems and nations, making risks to infrastructures more pressing and crucial for society.[7] They claim that even though critical infrastructures are among the most pressing risk-related issues of modern societies, the question of how to make decisions about those infrastructural risks has not been addressed seriously. It has also been emphasised that critical infrastructures like energy, information, water or food supply systems, for example, are highly interconnected and complex systems.[8] Risk assessment of such interdependent systems is challenging when the identification of the interdependencies as well as the potential consequences in case of disturbances is demanding. They suggest that novel proactive, systematic tools for risk assessment are needed.

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[5] Hammond, A. (1998). *Which World? Scenarios for the 21st Century. Global Destinies, Regional Choices*. Washington D.C.: Island Press/Shearwater Books.

[6] Ibid.

[7] Sajeva, M. and Masera, M. (2008, forthcoming). A Strategic Approach to Risk Governance of Critical Infrastructures. *International Journal of Critical Infrastructures*.

[8] Uusitalo, T., Koivisto, R. and Schmitz, W. (2008, forthcoming). Proactive Risk Assessment of Critical Infrastructures. ESREL conference paper.

RISKS AS OPPORTUNITIES

On the other hand, while risks can be threatening, they can also be opportunities depending, on the geographic or political context, or on timing. It is arguable that there is also a positive dimension attached to the concept of risk. This is associated with the notion of crisis. The Chinese character for "crisis" is said to have a twofold meaning—threat and opportunity. Similarly, a risk may be a catalyst for change, reform and renewal in a way that results in improving a system or generating new business. It must also be noted that human nature is not always averse to risk. At the individual level it is a well-known fact that some people are not afraid of facing risks and threats. They may even consider risks primarily worth taking, as a spice to life in the form of excitement and gambling. At the national level in politics and economics, risks are to be dispelled. Different cultures may, however, also react to risks in a different way, as traditions, values and attitudes vary.

Thus, risks have always been a natural part of our lives. It may never be possible to create a risk-free society, but it is possible to construct a highly artificial bacteria-free room. Masini points out that hazards have long been in the realm of engineerial analysis, but risk is highly subjective in relation to the knowledge of the variables.[9] The purpose of risk analysis is thus to capture the dimension of risk. However, risk analysis has been mainly applied to technological risks. Masini has suggested that low probability but high-risk effects, and vice versa, should be better taken into consideration in futures thinking.

[9] Masini, E. (1993). *Why Futures Studies?* London: Grey Seal Books.

RISKS WITHIN THE FRAMEWORK OF "POSITRENDS" AND "NEGATRENDS"

Risk analysis can be combined with traditional futures research methods. For example, trends and mega-trends could be examined and evaluated closely for all possible risks that may be involved. Perhaps a framework of "positrends" and "negatrends" may be helpful in this setting—for example, a (mega-)trend can be a "positrend" if it represents a universally acknowledged beneficial development such as increasing democratisation or increasing literacy. But a (mega-)trend is described as a "negatrend" if it represents a detrimental development line—for example, increasing global warming or an exacerbated digital divide. In some cases, a given trend may even be interpreted as a "positrend" and a "negatrend" at the same time. This may result either from the fact that the trend in question has bifurcated and some negative features are accumulating around it or in the context where the trend is positioned locally.[10] Through this framework of "positrends" and "negatrends", risks can be identified around a trend as it grows or takes a certain direction.

RISK ANALYSIS VIA WEAK SIGNALS

Besides trend analyses, the method of weak signals can also be applied for detecting risks. The Finnish Society for Futures Research (FSFR) recently opened up an experiment for identifying and analysing risks that are latent in social structures, processes, as well as global issues. A total of 165 weak signals of risk from 59 respondents were gathered and analysed in a workshop in early 2008. The signals were grouped under three classes: 1) systems, 2) values and cultures, and the 3) environment. A typical problem connected to the use of the weak signals method is the difficulty of

[10] Heinonen, S. (1995). *Information Society and Sustainable Development: From Risks to Opportunities*. Helsinki, Finland.

defining what a weak signal is.[11] Identifying, collecting and analysing weak signals is a fruitful process when it is done in an open source and open innovation mode. The harvest will be sufficiently diversified when participants to such a process represent different backgrounds and views at the outset.

FINNISH FUTURES RESEARCH AND PARLIAMENTARY FORESIGHT ACTIVITIES

Futures research can be utilised for risk assessment to a more systematic and diversified degree. Two examples of ongoing futures platforms are cases in point which could be connected to the earlier mentioned RAHS system (see Figure 5). The mission of the

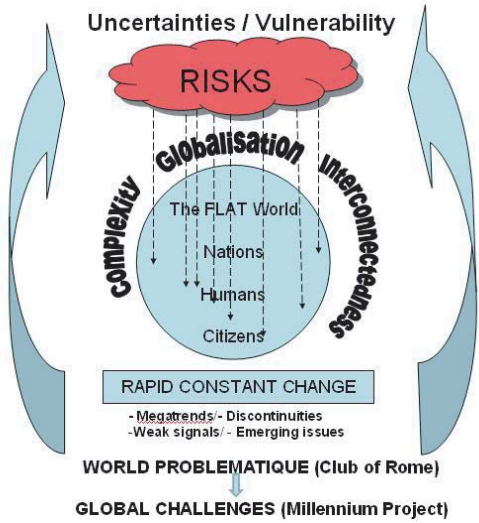

Figure 5: Emergence and identification of risks in the age of rapid globalisation and technological change

[11] For the weak signal method, see for example Hiltunen (2007), who defines weak signals as strange things that exist today and anticipate growing trends in the future.

Club of Rome is to identify what are the most pressing global problems (*world problematique*) that need to be addressed from a long-term, holistic and multidisciplinary perspective. By using futures research methodologies, concrete solutions (*world resolutique*) are sought for and propagated. Also, the Millennium Project has established an ongoing study of monitoring fifteen Global Challenges. These challenges provide a framework for assessing the global and local prospects for humanity. The challenges are interdependent: an improvement in one makes it easier to address others and, vice versa, deterioration in one makes it harder to address others.[12] This framework of challenges could also be used for monitoring possible risks—prevailing and emerging—for each challenge and for their interconnections. Of utmost and direct relevance for risk assessment and horizon scanning are challenges such as providing sufficient clean water to everyone, peace, reducing the threat of new and re-emerging diseases and immune micro-organisms, reducing ethnic conflicts, terrorism, the use of weapons of mass destruction, stopping transnational organisational crime networks from becoming more powerful and sophisticated global enterprises, and meeting growing energy demands safely and efficiently.

The pace of technological and social change along with the emergence of a group of global threats (of which global warming is probably the best known) have brought public awareness to the challenges of decision-making with respect to long-term developments. The need for anticipation and proactive action in all walks of life can in part explain the success that the field of futures studies in Finland has enjoyed during the last few decades, making it one of the most active countries in futures studies today. During the past 15 years, there has been rapid development in the Finnish futures research sector: The Committee for the Future within

[12] Glenn, J.C. and Gordon, T.J. (2007). State of the Future 2007. *The Millennium Project*. Washington, D.C.: World Federation of United Nations Associations.

the Parliament of Finland, unique in the world, started in 1993. One year earlier, the Finland Futures Research Centre (FFRC) was founded, as an organisation within the Turku School of Economics dedicated to scientific futures research. Following this, the Finland Futures Academy was founded in 1998 as a collaborative effort between 16 universities in Finland for teaching futures studies theories and methodologies. The Turku School of Economics also started a futures studies master programme in 2005 and a postgraduate programme in 2006.

CONCLUSIONS

Global foresight and risk anticipation have the same goal—they are both part of the futures-orientated mindset for alleviating uncertainty and vulnerability. In this capacity, if successful, they also give a competitive edge to nations, companies and citizens. This is because global foresight coupled with risk foresight means better preparation for the future—not just reacting to future events but proactively impacting future development. Both risk anticipation and foresight are based on two necessary pillars, i.e. knowledge and imagination.

By applying the soft multidimensional theory of risks, risks can be foreseen and interpreted in a sufficiently manifold way, as required by the complexity and interconnectedness of global challenges imposed by the *world problematique*. Putting effort into interpreting and understanding risks is a key to opening up windows of opportunities to *world resolutique*— concrete measures and policies in attempts to solve global problems. Seeing and identifying risks in advance is one thing, interpreting and understanding their nature in order to take measures for alleviating them is another. Both, however, are needed. Hence we should bear in mind that mankind is the greatest risk to nations, humankind and the planet. Human beings are victims of their own progress. The logic of con-

tinuous growth has resulted in rising oil and food prices, shortages of energy, water and food, and increasing civil unrest. Hence, risk is most imminent with the escalating potential of such issues. Multidisciplinary futures orientation and methodology are recommended for addressing global challenges, related risks and possible solutions. A soft multidimensional approach to risks opens up the complexities of risk analysis and takes it to the nexus of not only political, economic and technological considerations, but also of socio-cultural implications. After a futures research-based multidimensional scanning of risks, the road will be paved for risk prevention and risk alleviation.

Applying Complex Adaptive Systems Principles to Business Environments[1]

Cory Costanzo and Ian Littlejohn

OVERVIEW

In today's complex business world, change seems to be the only constant. The influence of the Internet on global markets, the emergence of new international markets, the scarcity of natural resources, the global ramifications of innovation, the introduction of new business models and the ever-increasing sophistication of consumers could, for example, lead to or cause unanticipated changes to business operations. As a result, companies are spending vast amounts of time and resources responding to changes in the business environment. This approach works on the premise that it might be possible to detect changes earlier and, therefore, businesses could respond quicker.

In essence, most organisations do require the ability to both monitor for and detect early indicators or "weak signals" suggesting changes. This early detection of changes could arguably lead to the improvement of strategy formulation and decision-making capabilities. Moreover, this ability to detect changes early could also enhance an organisation's business intelligence competence as

[1] The original version of this paper was published in the proceedings of the International Conference on Complex Systems 2006 in June 2006 and was subsequently updated in April 2008.

both opportunities and even threats within the business environment could be identified quickly and promptly. Some examples of how we have applied complex adaptive systems methods to organisational operations and the benefits that our clients have received include:

- *Strategy development and formulation*: Understanding the business environment and landscape within which the organisation operates.
- *Customer relationship management*: Insight into customer service and experience through the understanding and appreciation of the context within which a service is delivered and experienced.
- *Market analysis*: Improved market research and insight into new customer segments and markets.
- *New product development*: Facilitate the understanding of the context and situational use of products so as to provide valuable inputs into the design of new products, and the anticipating of, and hence meeting of, customers' existing and emerging needs.
- *Strategic redesign*: Refocusing of corporate and business unit strategies to direct resources towards business-critical strategic initiatives.

Additionally, since the primary focus of complex adaptive systems methods is on "system mapping", organisations would be able to identify possible threats and even opportunities from the indicators revealed through the mapping process. That said, before one can proceed to map a system effectively, an understanding of the following elements is both necessary and crucial:

- The *participants* within the system and their associated relationships and interactions.

- The dominant and influencing *forces* within the system and their respective relationships.
- The stable, emerging and changing *behaviours* present in the system.

In this paper, we will discuss:

- Why treating the business environment as a complex adaptive system allows us to create early detection capabilities.
- Why understanding the participants, forces, and behavioural (together with the relationships involved) patterns within a system allows us to better understand the environment.
- How changes in the environment could be detected through complex system mapping and thereby enhancing early detection capabilities.

LEVERAGING PRINCIPLES OF COMPLEX ADAPTIVE SYSTEMS

The principles of complexity could be used as a means for the mapping of the business environment, a highly complex adaptive system. It is also acts as a mechanism for the detection of both opportunity-yielding and threat-producing changes. The complex adaptive system is comprised of various participants whose interactions with one another often shape the way strategies are pursued. Essentially, based on the information gathered and feedback received from such interactions, participants then have to decide if any changes to their strategies are necessary.

In order to fully understand the complex adaptive system, i.e. the business environment, we need to first understand who the

participants in the system are and what interactions are involved. Generally, interaction patterns represent the behaviours that are present in the system. These interactions could lead to the development of relationships among the system's participants. Moreover, these participants also have the ability to influence and shape the forces that are present in the system, and often have a significant impact on the actions of other participants. Thus, we are able to map the business environment and represent it as a complex adaptive system by understanding:

- Who are the participants in a system?
- What is the nature of the participants' interaction and their resulting relationships?
- What are the prevailing environmental forces?

APPLICATIONS FOR EARLY DETECTION SYSTEMS

In essence, early detection capabilities (we refer to the applications as Early Detection Systems) would shape the way and degree that the dynamics of the marketplace or organisational environment are understood. For example, a mapping of an environment is usually created with the following in mind:

- *Participants* within the system and their associated relationships and interactions.
- Dominant and influencing *forces* within the system and their respective relationships.
- Stable, emerging, and changing *behaviours* present in the system.

Early Detection Systems can be deployed in a number of settings to support the intelligence requirements of an organisation. At the

decision-making levels, Early Detection Systems could help highlight opportunities and areas where innovations could flourish and risk management competency applications could be applied respectively. This would result in better-informed strategic formulation, design and implementation processes or actions. Among the many other possible applications of Early Detection Systems, it could also be harnessed for market research and analysis, customer insight and business development opportunity purposes. At a micro and organisational level, the Early Detection System could be used to evaluate workforce problems and support corporate programmes.

CONCEPTUAL MODEL FOR EARLY DETECTION SYSTEMS

The Early Detection System conceptual model treats the business environment as a complex adaptive system. The mapping of environments into a complex adaptive system evolves around four key "modules" or precepts. As shown in Figure 6, they include: i) Data

Figure 6: Conceptual Model Modules for an Early Detection System

capture and storage; ii) Sense-making and analytics; iii) Patterns and insight; and iv) Visualisation, reporting and query tools.

Data Capture and Storage

Before one can attempt to understand an environment fully, it is crucial to divert the focus to the gathering of data. This is an essential process, as the data collected will more than likely place the environment in question into context. Very often, *narratives* collected from "members" of an environment provide the best contextual data. These narratives are often detailed accounts of situations as they have been experienced. Hence, they are valuable context-building sources.

For example, a person's story or experience will include: i) Why things happened; ii) How they happened; and iii) Who was involved. From a complex adaptive systems perspective, such information provides important information about the participants that were present, the interactions that have occurred and the prevailing environmental forces. Narrative data can be gathered from interviews, focus group discussions and online surveys. Although narrative data is an important source of data for the mapping of complex adaptive systems, additional forms of unstructured data could also be collected from such sources as newspapers, magazines, media broadcasts, websites and reports.

That said, however, unstructured data needs to be stored differently from structured data. Most commonly, it is stored in a new generation of narrative knowledge base technology that can account for both forms of data. Additional information (metadata) can also be tagged to this material and can include such categories as: i) Source; ii) Author; iii) Date captured; and iv) Other user or business-defined tags. The narrative knowledge base provides an important central storage capability that allows users to access,

retrieve and work with the captured data. In an Early Detection System, key data elements are captured for each of the unstructured data pieces. This includes the agents ("participants"), the main topics and the main behaviours that are present in the data. Moreover, other and further information, such as facts and events, can also be entered and used for subsequent analyses.

Sense-making and Analytics

A combination of system tools and participant-based workshop techniques are used to assist sense-making activities. These activities help participants to make sense of large volumes of data rapidly. It usually begins with the clustering of data into classes and sub-classes, after which key elements of the complex system being studied would emerge and could be derived from the participants' interpretation, definition and prioritisation of the data.

In general, the activities and techniques developed for sense-making and analytical purposes aim to understand the following aspects of the complex system:

- Major participating agents ("participants").
- Strategies employed by the participants.
- Dominant and influencing environmental forces.
- Stable, emerging, and changing behaviours.

It is also important to understand the relationships between the different entities in the complex system. Therefore it is also crucial to ask:

- What are the relationships between the various participants of a given system?

- What are the relationships between the dominant and influencing forces?
- What are the relationships between the participants and the forces?

In general, the findings or results generated from the questions listed above could be used to construct a meaningful *event timeline* that displays the current situation's environment and the events that have led to the current situation. In essence, the resultant concepts and relationships form the ontology of the complex system. The information or data gathered does not remain static and could be updated to include, for example, new participants, additional environmental forces and relationship analyses.

Visualisation, Reporting and Query Tools

The benchmarking of a system's starting conditions is both fundamental and a prerequisite to the development of abilities to monitor for periodic system shifts. In fact, the application of early detection method always begins with a framing of the starting conditions present in the system in question. At the visualisation stage, we focus on developing a visual format of the starting conditions of the system elements and their subsequent relationships. Moreover, change detection and monitoring abilities could be developed, as a result, from the repeat application of the method and by leveraging on the visual-based analytic outputs. This is arguably so as the outputs could be monitored for changes or shifts in the system.

Visualisation tools provide graphical displays of the complex system that is being analysed. As data is compiled over time, the visualisation tools display the changing nature of the system. This

"changing nature" is especially reflected and pronounced through the time bar element, which provides an effective visual cycle of both the current situation and multiple past situations. Indeed, questions concerning "Which new participants have entered the system?", "Which participants have exited?", and "What are the evolving strategies of the participants?" could be easily visualised, and the changing nature of the relationships amongst the participants over time could be displayed and studied. Visual indicators display the number of data points associated with the participants, environmental forces and even behaviours at a given point in time. Users can then drill down into the narrative knowledge base to view the detail of the data that has been summarised by the visualisation tools.

Furthermore, an intuitively navigable taxonomy could be yielded from the combined use or application of both traditional search mechanism and bottom-up ontological structured data mining methods. The process of reading stories and experiences is essential in the generating of insight (see *Patterns and Insight* section below).

With regards to weak signals detection, changes (or the lack thereof) in the behaviours of a complex adaptive system's participants are often important signals to look out for. If stable behaviours are maintained or observed, then organisations are able to proceed straight to tactical planning activities and allocate resources according to current situational needs. However, if behaviours change constantly, organisations then need to exercise greater flexibility in their decisions, especially when determining which strategies to adopt and how resources should be allocated. This would probably include finding new products, services and even new business models or solution to address the challenges at hand.

Patterns and Insight

All in all, by combining the results and visuals derived from the various stages (i.e. sense-making, data capture and visualisation), one would be able to derive both powerful and meaningful patterns, descriptions and indicators of both emerging opportunities and threats. Moreover, reviewers or users of such data could also identify new patterns and form the narratives through their own querying and reading of the materials. The "connecting the dots" phenomenon occurs as soon as new insights are generated from the sense-making activities. The insights and patterns that are identified are then captured into the Early Detection System for further use and analysis.

Sense-making activities do not just create avenues for the mapping of a complex adaptive environment but also, to reiterate, analyse the participants, forces and behaviours to provide a meaningful understanding of the following:

- Which forces are affecting which participants?
- Which behaviours are predominant with which participants?
- Which behaviours are new or emerging?
- Which participants are entering or exist in the system?
- Are there new participants, and, if so, what behaviours are being exhibited?

Through the mapping of complex adaptive systems, not only are we able to derive pattern permutations depicting the various characteristics of a system, but we can also gain insights from the analysis, understanding and visualisation of existing and emerging relationships detected in the mappings. More importantly, by understanding the nature of behaviours, the influencing forces and the relationships between participants in a system, early detection

of new or changing participant strategies is enabled. This capability could be translated and lead to a very effective early detection capability, which could serve to aid the making of better informed strategic plans and innovations, and, similarly, lead to the identification of threats for risk management purposes.

Once patterns and insights are generated, additional workshops that focus on the report and further analysis of the convergence of the identified patterns are run. The workshops are important for the development of new insights as they provide valuable information that could potentially reap key data for learning information organisations on the best strategies to, for example, move forward and successfully address the challenges or patterns identified in the mappings.

That said, however, while gaining new insight can be both exciting and motivating, the insight itself could be meaningless if there is no concrete response or actions to resolve the problems and vigorously monitor the results. The convergence workshops are platforms where participants could share their insights and, consequently, design actions to address the problems together. This leaves and equips organisations with action plans that will help address the issues revealed by the early indicators before they cause any harm (threats) or cease to exist as an element of competitive advantage (opportunities).

MONITORING FOR CHANGE

Having established the goal of implementing a sustainable capability to address change, it is therefore critical to follow up with the designing and development of a complex environment monitoring system. This iterative analysis and review process utilises a sound monitoring plan that has been designed and instituted to track the ever-changing nature of the complex system and any initiatives

that the organisation may undertake in their attempt to influence the state or transition of a system.

The key to effective monitoring, especially in complex spaces, is not to place expectations on one-to-one tracking and data evolution over time. Since we are only able to evaluate a “slice” of the system at any one point in time, the “monitoring” of the system will rather consist of a chain-linked set of evaluation activities that frames the system for a given topic, from a specific set of perspectives and during a fixed timeframe. The “monitoring of results” is, in essence, the assessment of the findings that exist in the gaps between the various links of an activity chain. Hence, resultant strategic evaluations would need to take into account the shifts that may or may not be observed in the system.

As for initiatives that were designed to attack the elements of complex spaces, very real and tangible measurement criteria can be applied to monitor the performance of these activities. For example, based on the a “take-up” rates of newly launched credit cards, we could decide on the products to further invest in and therefore divert resources to, or, to simply treat it as a non-performing product and remove from the market entirely. All in all, the ability to readily accept the failure of or reinforce the success of one product, ultimately translates into a successful penetration of the complex marketplace.

Wild Cards—Preparing for the Unpredictable

Karlheinz Steinmueller

WILD CARDS IN THE FRAMEWORK OF RISK ASSESSMENT AND HORIZON SCANNING

In recent years, risk assessment and horizon scanning have gained increasing relevance for decision-makers. This is not accidental. In a closely connected, utterly complex and globalised world, unpredictable change has become a constant phenomenon. It can be argued that all spheres of life are accelerating due to unceasing technological and social innovations. Innovations drive economic development; they create opportunities and risks for economies, societies, and the natural environment. In most cases their impacts are uncertain. Under these conditions, conventional wisdom built on the experiences of former generations often depreciates. Likewise, governance has become increasingly difficult and risk management is simply a necessity nowadays.

But there are risks and there are risks. Some risks are well-behaved: their probability can be calculated and their impacts known. Other risks are elusive: they betray our efforts to calculate their probability, their impacts are mostly unknown, they are without precedence, and they hit us like a lightning bolt out of the blue. They are difficult to identify and even more difficult to manage, as exotic and implausible as they seem to be. Such risks we can term

"wild cards", and they pose a challenge for horizon scanning and risk assessment.

WILD CARDS: THE FUNDAMENTALS

The concept of wild cards was created in 1992 in a joint study written by the Copenhagen Institute for Futures Studies (Denmark), BIPE Conseil (France), and the Institute for the Future (USA). These three institutes proposed a definition that was focused on the business industry: "A wild card is a future development or event with a relatively low probability of occurrence but a likely high impact on the conduct of business."[1] John Petersen of the Arlington Institute (USA) extended it to social systems, defining wild cards as, "a low-probability, high impact event that is so large and/or arrives so fast that social systems are not able to effectively respond to it."[2]

The futurist community saw this concept as a much-needed addition to their methodological toolbox. It was seen as a concept to counterbalance the rather deterministic use of trends and "cross-cuts", a means to stimulate thinking out of the box, and to challenge common wisdom and established assumptions about the future. Since the seminal work of 1992, several researchers have elaborated on the concept and developed wild card methodologies.[3]

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[1] BIPE Conseil et al. (1992). *Wild Cards: A Multinational Perspective*. Palo Alto, CA: Institute for the Future, p. v.

[2] Petersen, J.L. (2000). *Out of the Blue: How to Anticipate Big Future Surprises*. Lanham: Madison Books.

[3] For more on "wild card" methodologies, see: Rockfellow, J.D. (1994). Wild Cards—Preparing for "The Big One". *The Futurist* 11, pp. 14–19; Petersen, J.L. (1997). The "Wild Cards" in Our Future: Preparing for the Improbable. *The Futurist* 13, pp. 43–47; Petersen. (1997, 2000). *Out of the Blue, Wild Cards and Other Big Surprises*. Washington: The Arlington Institute; Steinmüller, K. (1997). The Future as Wild Card—Towards a Methodology of the Unpredictable. In Kreibich, R. et al. (eds.). *Beyond 2000: Challenges for Futures Studies (Documentation of the SFZ Summer*

In addition, several catalogues of wild card events have since been proposed.[4]

As a rule, neither the likelihood nor the impact-potential of a wild card is sufficiently known in advance; both have to be roughly assessed when identifying an event as a wild card. With regards to probability, a qualitative evaluation is sufficient in order to determine that the event in question is improbable but not entirely impossible. In much the same way, a qualitative estimate of the impact is needed for the identification of wild cards and wide-ranging impacts should be expected. An in-depth evaluation of probabilities and of the likely impacts and consequences usually takes place later in the process.

The Finnish futurist Elina Hiltunen has recently argued that labelling "wild cards" as low-probability events is misleading since in the end even a perceived likely future may be in fact be rather unlikely.[5] One has to concede that the most plausible mainstream future is, as a rule, not very consistent, and that "objective" estimates of probabilities cannot be achieved, either for wild cards or for future scenarios in general. But low (*a priori* and perceived) probability and a

Academy 1996). SFZ-WerkstattBericht 20: Gelsenkirchen, pp. 98–104; Steinmüller. (1999). Wild Cards. *Eine neue Entwicklung in der internationalen Zukunftsforschung*. *Zukünfte* 27, pp. 51–53; Steinmüller. (2004). The future as Wild Card: A short introduction to a new concept. In Brockett, S. and Dahlström, M. (eds.). *Spatial Development Trends: Nordic Countries in a European Context*., pp. 193–202; Steinmüller. (2007). Thinking Out of the Box: Weak Signals and Wild Cards for European Regions. *Futura* 2/2007, pp 22–29; Mendonça S. et al. (2004). Wild cards, weak signals and organisational improvisation. *Futures* 36(2), pp. 201–218.

[4] For more on cataloguing "wild cards" see: Petersen. (1997). *Out of the Blue*; Steinmüller, A. and Steinmüller, K. (2004). *Wild Cards: Wenn das Unwahrscheinliche eintritt*. Hamburg: Murmann.

[5] Hiltunen, E. (2006). Was It a Wild Card or Just Our Blindness to Gradual Change? *Journal of Futures Studies* 11(2), pp. 61–74.

surprising character are interlinked characteristics of wild cards. Dropping one implies dropping the other. With hindsight you can easily claim that a certain wild card was likely, and that only deficiencies of perception led you to regard the event as improbable or even impossible. The main point of wild cards is, however, to take blind spots for granted in order to overcome them at least partially.

At first glance a wild card is something surprising; perhaps even shocking, and it is something that happens unexpectedly. “Surprise” is, however, an even more subjective category than probability. It depends on one’s worldview and is therefore not well-suited as a criterion. Nevertheless the question “What might surprise you?” is a good starting point for a wild card brainstorming session. The element of surprise frequently disappears during closer analysis.

In a way, the definition given above actually plays down the real value of the notion of wild cards. Characterising them by low probability and high impact misses one central point: Wild cards are shocking not only because they have really large impacts on business, they also shock us since they do not fit into our usual frame of reference. They run counter to our perception of the ordinary normal way things develop, and challenge the concepts with which we regard the world, perhaps even ridicule them.

Wild cards change our frame of reference, our mental map of the world. A case in point is the emergence of words with new meanings after a wild card has occurred: “super-terrorism”, “climate protection” or, to use some older ones, “HIV/AIDS”, “stagflation” and “glocalisation”. Therefore, wild cards not only change reality but also change our perception of reality and the concepts we apply to organise the data about the world around us. It is often observed that wild cards force us to rewrite the future, but this is only part

of the truth. They can even tempt us to rewrite the past. After a wild card occurs, we perceive past developments differently. Did they give rise to the wild card? What trends provided an environment favourable for the wild card? Were there weak signals that hinted at it?

Take the Chernobyl disaster as an example. This catastrophe was not only a reactor accident of a previously unknown dimension that was without precedent. It was also without any precedent because it changed the way most people now think about the supposedly "peaceful use of the atom". If the future is the space of our hopes and fears, our wishes and plans, or, more generally, our expectations, wild cards are shocks to this space. They are "future-quakes" that change the landscape of the future.

A SHORT TYPOLOGY

There are different types of wild cards. A breakthrough in high-temperature superconductivity has different causes and effects than radio-smog panic; a new pandemic disease evolves in different ways than a disruption of the Gulf Stream; political upheavals follow different patterns than the outbreak of a genetically-modified organism (GMO). Different aspects may be used to systematise wild cards.[6] These can be classified as follows:

- *Topic*: The subject of the wild card. We have to distinguish technological wild cards like fusion power or robots that become self-conscious, from political wild cards like terrorist attacks, revolts or assassinations.

[6] For more, see: Petersen. (1997). *Out of the Blue*; Mendonça et al., and Steinmüller & Steinmüller.

- *Reach*: Is the impact of a wild card restricted to one specific sphere of life, one industry, one region, or not? We have to distinguish global wild cards (e.g. an impact of an asteroid) from regional ones like unexpected aspects of climate change in a particular territory, industry-specific ones like the identification of new hazardous substances (e.g. the asbestos crisis), and wild cards affecting an entire national economy.
- *Plausibility*: Wild cards are, by definition, rather unlikely. However, we have to assess whether a wild card is highly improbable or simply not very probable. Another distinction that carries greater psychological weight is that some wild cards are plausible because they fit, like most natural disasters, into our worldview. Other wild cards are not plausible; they go against intuition and common sense without being, however, absolutely impossible. Seen from a methodological perspective, it might make sense to take even "impossible" wild cards into account because the demarcation line (often fuzzy at best) between the possible and the impossible is based on the knowledge available at the moment and on one's personal view of the world.
- *Time scale*: One can also distinguish wild cards which have immediate impacts like most disasters, and wild cards that have a certain gestation time that influence medium or longer-term developments like scientific breakthroughs.

WILD CARDS, TRENDS, AND WEAK SIGNALS

Wild cards erupt suddenly but, like a lightning bolt, they are not without causes. Frequently, wild cards result from trends, especially from trends with a non-linear characteristic (and trends are rarely linear). Possible catastrophes resulting from global warming are a point in case. If the temperature rises above a certain point—the "tipping point"—global atmospheric or maritime circulation patterns may suddenly change, with tremendous impacts on the entire

climate system (e.g. a new El Niño phenomena). The gradual, frequently unnoticed processes that can give rise to wild cards are sometimes termed "creeping catastrophes"[7] in contrast to acute, catastrophic events. After the event one may ask, "Was it a wild card or just our blindness to gradual change?"[8]

Perhaps more frequently, wild cards are caused by the interaction of trends. If it is difficult to predict the future evolution and possible impacts of a trend, it is even more difficult to forecast the outcome of complex trend-interactions. In most cases, no sophisticated models are available, and trend-interaction methods usually rely on an intuitive understanding of interactions, which is prone to blind spots or wishful thinking.

On the other hand, wild cards may wreck a trend, or turn it in another direction, or put a temporary halt to it, or give rise to completely new trends. After Chernobyl, trends in the construction of nuclear power plants were disrupted. After 9/11, markets for biometrical and surveillance technologies exploded. In some cases, a wild card produces a real torrent of secondary wild cards like the break-up of the Soviet Union and the resulting wars in the Caucasus region.

Another interesting point is the relation between wild cards and weak signals. Sometimes, the two concepts are confused.[9] Weak signals are what their name implies; they are nothing more than "signals" (i.e. signs, symptoms or indications). They hint at something, be it a new trend, a new issue or an "approaching" wild card. Weak signals therefore may herald the advent of a wild card, make

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[7] Böhret, C. (1990). *Folgen: Entwurf für eine aktive Politik gegen schleichende Katastrophen*. Opladen: Leske und Budrich.

[8] Hiltunen.

[9] Ibid.

them more plausible, or help us to assess their probability and impact. In comparison, wild cards stand by themselves as factors that shape our future. Naturally, even an event with severe impacts can be interpreted as a sign of something else. The US sub-prime loan crisis was a strong hint of a possible earthquake in the whole global financial system. It therefore depends on the frame of reference whether you interpret an event as a wild card (since it occurred surprisingly and with an important impact) or as a signal (since it might be a precursor of still more powerful events). The term "weak signal", however, should be avoided as wild cards are "strong" by definition.

THE LIFE-CYCLE OF A WILD CARD

Wild cards evolve in a specific manner and follow what could be termed a life-cycle. For a while they exist in a hidden, latent form. Then they suddenly erupt and manifest themselves. After that, one is confronted by their impacts. In principle, the following three stages form the life-cycle of a wild card:

- *Latency*: During this period, the wild card "grows" hidden, either due to some trend or to human plans and preparations for their execution or otherwise. In this stage the wild card may first produce weak signals, but usually these either are not detected, or, if detected, may be disregarded because of the "noise" of other weak signals or because of an unwillingness to receive their message. Sometimes a specific group of people are already discussing the wild card, but the general public, opinion leaders, managers or politicians do not take it seriously.
- *Eruption*: The wild card happens, suddenly manifesting itself as a disruptive event. If it is seen as a "signal", than it is a very strong one. Everybody is discussing the event: How could it

happen? Why was nobody prepared? Who is to blame for it? What are the consequences? The general public, decision-makers in government or business are all taken by surprise. Frequently, such as in cases of industrial disasters, there is a short period of denial, followed by non-systematic, inadequate and inappropriate reactions that are primarily "for show". Overreactions, panic or hype is common, and controversial interpretations of the event are given (e.g. conspiracy theories).

- *Normalisation*: For a period of time the impacts of the wild card spread throughout the particular system, producing shocks of second and higher orders. Measures that are taken are hopefully more adequate to the situation at hand. As time goes by, decision-makers and the general public get used to the new situation. For example, most stock prices move closer to pre-event values. As the wild card is integrated into the common worldview, a standard interpretation is generally accepted along with a paradigm change in regards to matters closely related to the wild card.

In some respects, the concept of wild cards is a counterpart to the concept of "chaos" in the theory of dynamic systems. Like this "chaos", wild cards place limits both on forecasting and planning and are the result of the inherent complexity of the system being analysed and of its environment. Like the bifurcations in chaos theory, they mark the beginning of new developments and diverging evolutionary paths.

One lesson of chaos theory is that non-linearity can lead to counter-intuitive system behaviours. Therefore, a basic rule for futures studies is not to depend on intuitively-convincing and plausible theories, but rather to take counter-intuitive system behaviours into account. This is possible by supplementing a study with a wild card analysis.

TOWARDS WILD CARD MANAGEMENT

At first, wild cards were introduced within the framework of scenario studies. As one of the steps of a scenario process, wild card analysis is used to test the stability of scenarios with respect to external shocks or internal disruptive factors that had been previously neglected or disregarded. More generally, wild cards can fulfil several functions in a scenario process:

- They can be used in order to estimate the resilience of a scenario to external disruptions.
- They can be used to compensate for potential weak points in the conceptual framework of the scenario.
- They can help the team constructing the scenarios to recognise alternatives and be open-minded to unexpected developments.
- Ultimately, they can also be used to counteract certain widespread faults such as a shortage of imaginative capacity, the predominance of wishful thinking or an overriding fixation on catastrophic scenarios.

In addition, wild cards are sometimes used to directly test the robustness of a strategy or to increase the risk-awareness of decision-makers. Similar to risk management, wild card management can be broken down into several steps starting with the identification of potential wild cards and an assessment of their probability and impact, leading finally to (counter-)measures. This process can be defined by the following elements:

- *Bounding*: The scope of the analysis is first defined.
- *Identification*: Wild cards are identified and selected according to specific criteria (relevance for the problem investigated, etc.). A portfolio of 'wild cards' is established.

- *Evaluation*: Favourable and unfavourable conditions for the occurrence of the selected wild cards are assessed as well as possible impacts.[10]
- *Strategy Building*: Finding strategies to minimise risks and to seize opportunities is the next step. It usually includes questions like: Can we prevent the wild card? Can we take advantage of its occurrence? Can we alleviate its impact? Are there weak signals that foreshadow the occurrence of the wild card?
- *Implementation*: Finally, measures have to be implemented and strategies communicated to relevant groups.

Quite generally, wild card management implies "thinking in advance". Sometimes wild card studies lead to establishing an early warning system that systematically identifies weak signals for a specific group of wild cards.[11] It is, of course, impossible to prepare for every conceivable wild card. But the discussion of wild cards, in the course of decision-making, can reduce the element of surprise when a real wild card does occur, and can generally increase the flexibility of response.

SOME PRACTICAL POINTS

What are the criteria for selecting a suitable set of wild cards? There is no all-encompassing answer to this question, and one can indicate only a few general rules based on previous experience. First, the wild card must be appropriate to the problem. A wild card need not necessarily stem from the central topical area of study, but it should nonetheless be associated with it. Wild cards that would be entirely without consequences will not help detect any additional information.

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[10] For an example of this see the "Arlington Impact Index", a set of criteria given by Petersen in *Out of the Blue* (1997).

[11] Nikander, I.O. (2002). *Early Warnings: A Phenomenon in Project Management*. Dissertation, Helsinki University of Technology.

Second, a wild card should be as original as possible and should be something which has not already been taken into account in another manner; its consequences should not be immediately apparent. Third, one should also think about wild cards that (in accordance with conventional thinking) are at the far edge of that which is just barely possible. In addition to these, one can also add some simple rules:

- The analysis should not be limited to too small a number of wild cards. Taking only three or four would imply that these events receive too much attention. The quality as well as the plausibility of the study could suffer. Having a sufficient numbers of distinct wild cards is a pre-condition for success. As a rule, one can find wild cards for every trend.
- "Negative" wild cards—those that presumably would not support the scenario constructed, but rather undermine it—should be given priority consideration as a test for the stability of the chosen scenario. Closer analysis may, however, prove that "supportive" wild cards can also have interesting counter-intuitive consequences. It therefore makes sense to not only look for "weird" risks, but also for unusual opportunities.
- In addition to wild cards with a strong contextual reference to the problems studied, it is also advisable to consider some wild cards that could cause disruptions in the external environment of the system in question.
- In order to avoid potential prejudices it may be useful, especially when identifying wild cards, to incorporate outside expertise into the study, either through interviews or by means of a workshop. An Internet forum or even a competition may be useful in collecting a large number of potential wild cards.[12]

[12] Rodenhäuser B. and Rodenhäuser, B. (2006). *Lass dich überraschen. Über das Management von Wild Cards. Research & Results* 3, pp. 34f.

CONCLUSION

The field of futures studies has experienced a number of remarkable developments in the last decades. Futurists have moved away from the planning optimism that characterised their earlier days and from far-reaching forecasts of the future. Thirty years ago, Herman Kahn sought to describe the next 200 years; by contrast, futures research today seeks to identify, in a pragmatic fashion, feasible roads into a future that will be worth living. But futurists have also learned that there is always a chance for dramatic events to change the whole map of the future.

Each individual wild card has a low probability, but there is a large number of possible wild cards and as time goes by this number is increasing. Established trends become more and more uncertain, their interactions less predictable, human actors pursue new plans, and each of these uncertainties, interactions and new lines of action can give rise to wild cards. If we look into the far future, the combined probability of all wild cards tends to 1. This implies that the probability of realisation of the standard or mainstream scenario approaches zero. In the long run, wild cards will shape the future.

Integrating wild cards into risk assessments can not only provide us with insights into possible disruptive changes, it can also lead towards a better understanding of existing trends and challenges. Wild cards open up new perspectives and provoke fresh thinking about future options, strategies, and measures. They are a new but powerful concept that can help horizon scanning go beyond perhaps too narrow a horizon.

Predicting the Future: It's Not Possible

John L. Petersen

Everyone knows that television weather forecasters can't accurately predict the weather a week from now. There is a basic set of reasons why the weather guessers have their hands full looking out further than about three days; these reasons also apply to those trying to predict what might happen in the geopolitical, technical and economic worlds. It turns out that trying to forecast the weather exemplifies the perils of forecasting in general, especially forecasting in subject areas that are of interest to intelligence professionals.

Why can't long-range weather be predicted? The problem is that weather systems, and all other things of global or national significance, are complex, non-linear and highly dynamic systems. Such systems are made up of an almost undeterminable collection of smaller components, interdependently interacting in many unfathomable ways and changing at high rates. Small minor events, interacting time after time with other events, can build into an event of major proportions—as illustrated by the often-quoted example of the "butterfly effect": the flap of a butterfly wing in Brazil interacts time after time with other events and ultimately builds into a hurricane in the Caribbean.

The same is the case with groups of people. Very small inputs, like a comment, may be entered into the system by a single individual.

If it is a rumour and the situation is ripe for it, the notion may grow into a compellingly powerful concept—a meme—and, in a very short period of time, sweep across huge areas. With the Internet, such ideas can now stir up a global storm in a matter of hours.

Trying to precisely anticipate the behaviour of such systems is futile. It may be possible to accurately guess an election outcome a couple of days before the event, but longer than that, things become so complicated that there is no way to accurately handicap the event before the fact (which is lost on pundits who try to suggest that polls taken months before an election have some sense of value; just ask Hillary Clinton). It is impossible to identify all of the inputs and anticipate how they might play out over time.

A number of principles about the behaviour of non-linear systems, drawn from the science of complexity, explain how such systems behave. Military strategist Larry Seaquist distilled them succinctly:[1]

- Being "aware" of their environment, complex adaptive systems manage themselves.
- Organisations (adaptive systems) generally tend to make themselves more complex as they are tested for "fitness" by Darwinian selection.
- Sophisticated system behaviours can emerge spontaneously and rapidly from a few simple, local rules.
- A small shift in internal rules, even by a single agent or a minor subsystem, may rapidly transform the behaviour of a large, complex system.

[1] Seaquist, L. The Complexity Ideas and Strategic Thinking. Draft of an unpublished paper.

- No one phenomenon or system can be operated on in isolation; to a greater or lesser degree, any change in one system engenders changes in others.
- In all systems, the space of possibilities is endless. A complex systems framework used during an international crisis would highlight the realities of the opposing system's past, its current state and how the systemic, co-adaptive interaction between our two countries (or more likely several) might shape the future of each of the engaged systems.

Among many other sources, Seaquist draws from the writings of physicist Ilya Prigogine who, shook up the framework of traditional physics by finding that predictability is an illusion and that the deterministic world of Newton and Descartes does not exist.[2] Far-fetched as this might sound at first, after consideration of what little we know about our ability to predict the behaviour of complex systems like the weather, it is not hard to yield to the common sense that suggests he is right.

If prediction is a waste of time, how best can we look toward the future? We live in a time when the rate of change is accelerating. The amount of information generated in the world is doubling every year and a half. Huge changes, unlike anything humankind has experienced before, are arrayed on the horizon. Big shifts in science, technology, geopolitics, the environment, energy, population, economics and social values are violently converging from different directions such that, in the next decade, every institution and approach to life will be fundamentally reassessed, shaken, torqued and reshaped. In this context, we are destined forever to be surprised if we cannot find some way of anticipating what might

[2] Perhaps the best summary of Prigogine's findings is found in *Brain/Mind* (May 1994).

be in our future. Furthermore, the surprises will come more quickly and grow increasingly larger.

The solution lies in understanding the cognitive psychology of how we make decisions about the future. In short, we are prisoners of our mental images of what we think might happen. If we have not thought about something, we will not consider it as an option. If, for example, the possibility of rapid climate change (not just global warming) is not in our mental set of images about what might happen, then none of the intelligence estimates or policy options that we produce will include that possibility. If the way we look at the Middle East has no alternative that includes the Israelis and the Palestinians making a peace deal, then our only estimates or policies for that part of the world will assume conflict of one kind or another. If we have not thought that Mercedes-Benz may well within two years bring out a conventional diesel engine car that runs largely on water, then we will see the role of energy in the world, the geopolitics of the Middle East and the problems of environmental pollution as variations of the past. We will not see the possible new future that will be.

The trick is to build a spectrum of plausible futures that are linked to each other and are as broad as possible. In that way, it is fair to assume that there is a high probability that the "real" future has been considered and that it is in our mental database. As in the case of the weather, as we approach the time of interest, an increasing number of indications will point to the situation that ultimately becomes manifest—for an infinitesimal fraction of time—reality.

The future is largely influenced by a small set of issues:

- *The availability of information*: What does one know?
- *Science*: How does one believe physical reality works?

- *Social values*: What does one personally believe about what one knows?
- *Technology*: What tools are available?
- *The physical context*: What is the influence of outside forces, such as the environment?

Notice that economics and politics are not included in this list. That is because how we spend our money and organise our governments is a direct derivative of the values we have, the tools that are available to us and the physical context within which we live. Economics and politics are not principal driving forces; they are merely a reflection of a deeper set of forces.

Each one of these issues is undergoing a high-speed, fundamental change. Information technology is rapidly altering who has information and the amount that is readily available. Quantum mechanics is rewriting the Newtonian view of how the universe works. Big shifts in national and global social values appear to be underway. Technology is exploding. The problems with global population growth and the waste and pollution that our industrial processes produce are getting worse.

Thus, to understand what the future holds, one must embrace the effects of these changing issues and forces. At this time, there is no computer powerful enough to do this and, as we have shown, systems dynamics suggests that rule-based, predictive mechanisms will never work. In the end, it is the individual mind that must make sense of the situation. So, one solution is to put the individual in a context where his or her mind can effectively assimilate as much knowledge as possible about the forces driving change, and then can use intuition and other mental capacities to see patterns and shapes in the seething world that is emerging.

This kind of vision-based planning is not like any approach that the intelligence community or the military has used in the past. Most military scenarios are based on things like economic or geopolitical trends, but vision-based planning is built directly upon the cognitive psychology of how decisions are made and the set of fundamental issues that appear to drive the larger system.

Both information and intuition, or judgement, contribute to decisions about the future. If the data is not complete, it does not matter how good the analysis is. The opposite—good information and poor judgement—is equally flawed. Both quantitative and qualitative inputs are required.

INFORMATION COLLECTION

First of all, it is critically important that the widest net be cast for information and trends, particularly when dealing with large, complex systems. This means looking far beyond one's specific area of interest. Because the components of the system are all interconnected, the political or military situation in a particular area is the result of far more than just a couple of trends, like the economy or politics. Breakthrough technologies, ecological disasters, cultural shifts, disease epidemics and population pressures, to name but a few trends—all these can produce rapid systemic response.

In times of high rates of change, like the present, one must look for smaller and smaller initial indicators of emerging trends. That means wandering around the intellectual fringes where change first shows up. In *The Art of the Long View*, Peter Schwartz from the Global Business Network has a nice section about his experience in looking for early indicators.[3]

[3] Schwartz, P. (1991). *The Art of the Long View*. New York: Doubleday.

Predetermined Events

Some things have higher levels of certainty, particularly those trends that are already underway. For example, the number of teenagers in the world in 10 years is something that can be reasonably anticipated (absent of course some extraordinary destructive global event, like a bird flu pandemic). If the Ogallaha aquifer, which supplies groundwater for much of the central part of the USA, is being depleted at a significantly greater rate than it is being replaced, then absent a dramatic change in the agricultural requirement for water or a major migration of people away from the area, it is reasonable to assume that in five years there will be less available groundwater. A systematic attempt must be made to identify such predetermined events that are relevant to the subject of interest.

Wild Cards

Perhaps the most catalytic events are those that give no early warning—wild cards. Some of these high-impact, low-probability events are certain to happen, we just do not know which ones will show up. If we insert as many reasonable wild cards as possible into our mental database, then we will look at the world in a different way, and potential indicators of change will take on a meaning that they would not have otherwise. At some early place in the vision-planning process, surprises must be considered.

Developing Judgement

Once a reasonable attempt has been made to scan the environment, then an intensive process must be undertaken to make sense of the information. That is accomplished by building a psychological framework on which the information can be hung and arrayed—a “spectrum of plausibility”.

System Development

The first step in building the framework is to identify the issues that are critical to the subject being considered. This is best done by assembling a number of individuals who have responsibility for studying the subject in a relatively short, highly interactive process to systematically develop a model of the underlying system being evaluated—like terrorism or infrastructure failure. This can be significantly enabled with technology like that in the Risk Assessment and Horizon Scanning (RAHS) system. Once the system is in place, an understanding of the potential behaviour modes of the system can be evaluated.

Scenarios

Next, scenarios can be developed by changing the potential behaviour of key, influential nodes within the system. Again, this process is facilitated by the RAHS toolkit.

One major input is that people make decisions that are largely formed by the values that they hold. Different individuals and groups will see the world in different ways, based on the tint of the "values glasses" through which they view the world.

It has been shown that certain psychologically defined groups within societies are most responsible for the new ideas that turn into major social trends. Members of one group—the inner-directed—look within themselves for direction. They are little concerned about where the rest of the social world is going. Therefore, they generate most of the new perspectives that turn into major social shifts, such as the environmental and anti-war movements.

The other major social influence on the future is the outer-directed group. That group takes most of their cues of self-worth from

external sources—other people, status symbols, etc. About three years after an idea or meme emerges from the inner-directed, the outer-directed will see its value in economic or other terms and embrace it, bringing it into the mainstream and turning it into a major trend.

If, for example, two scenarios are designed around an inner-directed and an outer-directed perspective, each will anchor extreme ends of a spectrum that reflects the predominant value influences on the subject under consideration. Then, the participant in the process or the analyst can begin to interpolate between the scenarios, positing alternative futures that are more or less inner- and outer-directed. The RAHS technology allows the development of large numbers of scenarios in a systematic manner.

Finding Common Opportunities and Hazards

Having constructed a cluster of futures, the participant or analyst then can look across the set and identify opportunities and hazards that are common to groups of futures, especially as they are related to the strengths and weaknesses of the nation or organisation undertaking the exercise. This collection of issues to be exploited or skirted can be used as a strategic foundation for engaging the future from a policy perspective, as well as assessing the potential implications of individual events that may arise from the different situations.

The process of building the scenarios makes the participants far more intimately and intuitively familiar with the underlying behaviour of the larger system than they were before. They have systematically run down dead ends, identified major decision points, considered implications, etc. They see the world in a different way. Now, articles in the news and intelligence reports can be put into a larger context and be evaluated as to how they are influencing the

direction of the subject. Potential trends or ways in which a subject group or individual might react to the events start to become self-evident, as the shape and texture of the context in which the subject exists comes more clearly into view. The process also produces better informed perspectives among analysts about how the subject might respond to wild cards.

CONCLUSION

This approach is one way to begin to appreciate some of the benefits of prediction without attempting it. It focuses on a new way of looking at how the world behaves that is not linear, but systemic. This approach is an applied form of systems thinking. Quantum mechanics says that everything in the world is connected to everything else. It is one big system. As the world increases in complexity and tempo, complete analysts will have to learn the principles that underlie this approach if they hope to make sense out of their piece of the system.

SECTION 3

Applications in Strategic Anticipation

Operationalising Risk Assessment and Horizon Scanning: A Case Study of Self-Radicalisation and its Early Detection[1]

Hoo Tiang Boon

INTRODUCTION

There can be no doubt that the issue of religious self-radicalisation is a clear and present danger today. On 24 January 2008, it was publicly disclosed that three "self-radicalised" individuals had been uncovered in Singapore.[2] Before that, less than a year ago, the first-ever reported instance of self-radicalisation in Singapore—the case of former law lecturer Abdul Basheer Abdul Kader—was revealed.[3] Meanwhile, on a global basis after 9/11, we are seeing more autonomous, "self-starter"[4] cells responsible for an increasing number of terrorist acts or plots around the world.

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[1] This paper is adapted from the author's talk, "Aiding the Analyst: The 'RAHS' Approach Towards Understanding Radicalisation and its Early Detection", at the CENS-Global Futures Forum Workshop on 4–5 February 2007.

[2] Zakir Hussain. (2008, January 24). Two "Self-Radicalised" Men Detained. *The Straits Times*.

[3] Popatlal, A. (2007, June 8). ISD Detains Self-Radicalised Singaporean. *Channel NewsAsia*. Retrieved at http://www.channelnewsasia.com/stories/singaporelocalnews/view/281101/1.html.

[4] Benjamin D. and Simon, S. (2005). *The Next Attack: The Failure of the War on Terror and Strategy for Getting it Right*. New York: Henry Holt.

Given this phenomenon, pertinent and larger questions loom: In the absence of direct recruitment or indoctrination from established terror groups, why do seemingly "unremarkable" and "normal" individuals become extreme enough to resort to political violence? What drives these people to become religious radicals? Are there common identifiable elements amongst these individuals that possibly suggest increased susceptibility to religious radicalisation? Is early warning even possible?

To these questions, there are no easy answers. That said, Singapore has designed the unique Risk Assessment and Horizon Scanning (RAHS) system, with the view of aiding analysts in grasping precisely such tough strategic issues. RAHS is not about replacing the analyst—it cannot ask questions on the analyst's behalf. Rather, it is about complementing and enhancing the analyst's cognitive processes. Fundamentally, RAHS seeks to create an environment in which domain knowledge can be captured, analysed systematically, retained and shared across multiple users.

This paper is therefore about the operationalisation of RAHS. More specifically, it aims to explore the potential utility of RAHS as a tool towards helping analysts develop better understandings and insights of self-radicalisation and its early detection. To this end, the paper will feature the following scope. First, it will embark on a brief definitional and theoretical overview about the radicalisation phenomenon writ large. This will be followed by a brief primer on Singapore's RAHS initiative. Third, the paper will then examine and evince how two key functionalities provided by the RAHS system—the *Scenario Builder* and *Ranking Builder*—can aid analysts in potentially generating useful insights about self-radicalisation and its early warning. In the last segment, the paper will give its concluding takeaways on the RAHS system.

RADICALISATION TALK

It would be useful to start first by discussing the issue at hand from its broader understanding and perspective: fundamentally, what exactly do we mean when we say "radicalisation"? Although at first glance this may seem fairly axiomatic, in truth interpretations abound. For the context of the study, this paper defines radicalisation as "a psychological process by which an individual experiences a significant personality change through internalising a revolutionary subculture".[5] In other words, during radicalisation, an individual essentially discards his old persona and starts to espouse "new ways of [fanatical] thinking, feeling and acting"[6]—drastic, extreme "subculturisation" in short.

But at what point would a person be considered radicalised, in the sense that this "subculturisation" process is complete? One line of thought contends that full radicalisation is complete only when an individual exhibits clear intent to take up arms and execute violence at so-called Jihadi "fronts"; this would be what some would call the final stage of "Jihadisation" or religious militancy.[7] The other more nuanced and less parsimonious interpretation sets the boundary at evidence of radical expression, but not necessarily expression relating to violence. This would therefore include radical but non-violent activities such as handing out of hate propaganda, promulgation of extremist narratives, showing visible fervent support for extremist causes, etc.

Both viewpoints, of course, have their own validity, depending on one's point of departure. But for the practical purpose of early

[5] Ramakrishna, K. (2007). Self-Radicalisation: The Case of Abdul Basheer Abdul Kader. *RSIS Commentaries* 61/2007.

[6] Ibid.

[7] Silber M. and Bhatt, A. (2007). *Radicalisation in the West: The Homegrown Threat*. New York: New York City Police Department.

warning, this paper is inclined to adopt the latter's formulation, because while every terrorist has undergone a radicalisation process, "not every extremist becomes a terrorist".[8] It is therefore prudent and vigilant to broaden the detection envelope and consider signatures of radicalisation that are not necessarily violent in nature. Besides, even if a radicalised individual does not manifest any clear intent for religious militancy, this person still possesses the potential to influence like-minded others to take the extra step of violence.[9]

Moving to the question of radicalisation forms, the conventional understanding is that radicalisation is a function of direct exposure and subjection to extremist ideological indoctrination from formal terror networks. In this conception, the key ingredient is the institutional and systematic ideological re-programming that goes on—whether surreptitiously or openly—which "cognitively turns" and radicalises the individual. This mode of radicalisation, organisational radicalisation, was the predominant comprehension of radicalisation in the past and is still very much relevant today. That said, recent trends have started to point to the fact that there is an increasing number of "self-radicalising" cliques or individuals that do not operate under the auspices of formal terror groups but nonetheless imbibe the value systems and agenda of these groups—the so-called terrorist "self-starterism" phenomenon.[10] Individuals of this ilk, also known by creative labels such as "do-it-yourself (DIY)" terrorists, "bunch of guys" and "freelancers", represent a form of radicalisation which is largely

[8] Mueller, R.S. III. (2006, June 23). Speech at the City Club of Cleveland, Cleveland, Ohio. Retrieved at http://www.fbi.gov/pressrel/speeches/mueller062306.htm

[9] Silber and Bhatt.

[10] Kirby, A. (2007). The London Bombers as "Self-Starter": A Case Study in Indigenous Radicalisation and the Emergence of Autonomous Cliques. *Studies in Conflict & Terrorism* 30, pp. 415–428.

autonomous and takes place without or with minimal direct involvement of formal terror groups.[11] The radicalising process and context, in contrast (with the organisational form), is one that is bottom-up rather than top-down. It is this form of radicalisation, the "self-starter" model, that will be the focus of the paper.

THE SINGAPORE RAHS INITIATIVE IN BRIEF[12]

The RAHS project was basically conceived in response to the strategic shocks—the 1997 Asian financial crisis and 2003 SARS situation—that beset Singapore out of the blue. These strategic surprises emphatically brought home the message that in an increasingly uncertain and complex milieu, there is an ineluctable need for Singapore to improve its capacity to better anticipate and prepare for strategic threats and jolts to the national security landscape.

While Singaporean policy-makers and planners have traditionally relied on scenario planning for long-range projection work, the financial and SARS crises clearly evinced the limitations of scenario planning as an early-warning tool. Especially for emerging strategic issues and threats on a shorter time horizon, i.e., two to five years, scenario planning proved to be a less than nimble ally. The other "anticipatory gap" relates to the weaknesses of solely relying on individual judgements to make sense of the plethora of incoming data. In today's "runaway world"[13] where events and their impacts

[11] Ibid.

[12] More information about the Singapore RAHS initiative can be obtained from the RAHS backgrounder (12 May 2008) in the same volume.

[13] The term "runaway world" was first coined by British sociologist Anthony Giddens.

diffuse from the horizon faster than ever, it is simply not enough—and far from prudent—to depend only on the single analyst's assessment; indeed, the analyst could be constrained by personal cognitive biases or mental paralysis due to sheer information overload.

It is in the context of these problems that RAHS emerged as a possible solution. In terms of the broad intent, RAHS seeks to complement—not supplant—scenario planning so that short-term horizons are not left out from the strategic calculus. But more than that, rather than relying on disparate, individual assessments made in isolation or silos, RAHS aims to achieve greater robustness and responsiveness in collective intelligence and foresight (of the government as a whole) by embedding strategic analysis into a common platform where a diverse and wider range of analytical perspectives are connected and shared. Seen in this light, RAHS is thus an attempt to engender both a "*whole-of-government*" approach as well as the "*wisdom of crowds*".[14]

To concretise RAHS, a suite of software tools has been designed. The first-cut working version of the system contains various useful functionalities and platforms; these include features like advanced search, entity/timeline/network analysis, cross-consistency matrix, scenario builder and ranking builder, *inter alia*. For the purposes of this study, however, the paper will not delve into the full range and specifics of the different functions; this is after all not a discourse of what the RAHS system can offer (that has been capably dis-

[14] The term "the wisdom of crowds" was pioneered by James Surowiecki (2004) in *The Wisdom of Crowds: Why the Many are Smarter than the Few and how Collective Wisdom Shapes Business, Economies, Societies and Nations*. New York: Random House.

cussed elsewhere).[15] Rather, this is about the practical ways in which RAHS[16] can be helpful to the analyst, and in particular, how it can potentially facilitate and stimulate a better understanding of self-radicalisation and its early detection. To this end, the spotlight will be on two key RAHS functions: the Scenario Builder and the Ranking Builder.

THE SCENARIO BUILDER: SYSTEM MODELLING OF THE SELF-RADICALISATION PROCESS

The conceptual lens of the RAHS Scenario Builder is the relatively established field of systems thinking. First developed by thought-leaders such as Jay Wright Forrester[17] and Peter Checkland[18], and popularised by Peter Senge in the influential book, "*The Fifth Discipline*"[19], systems thinking is "a way of understanding reality that emphasises the relationships among a system's parts, rather than the parts themselves". This approach focuses on cognition from a unified "whole" perspective and looks at the linkages and interconnections among the system's elements instead of the individual elements that make up the system. It also emphasises the dynamics of feedback rather than traditional linear cause and effect, because systems can in fact change in accordance

[15] For a more detailed technical discussion of the RAHS functionalities, see Foo Kok Jin, Wong Rong Fah, Ni De En, Leong Ming Wei and Leong Hoe Wai. Developing a Horizon Scanning System for Early Warning. Paper presented at the 12th International Command and Control Research and Technology Symposium.

[16] The terms "RAHS" and "RAHS system" are used interchangeably in this paper.

[17] Forrester, J.W. (1991). System Dynamics and the Lessons of 35 Years. In De Greene, K.B. (ed.). *The System Basis of Policy Making in the 1990s*.

[18] Checkland, P. (1993). *Systems Thinking, Systems Practice*. West Sussex: John Wiley & Sons.

[19] Senge, P. (1994). *The Fifth Discipline: The Art & Practice of the Learning Organisation*. New York: Doubleday.

to "returning inputs". So instead of the linear assumption that X results in Y, which in turn results in Z, and so on, systems thinking stresses the reality that Y can in fact "loop back" to X without necessarily leading to Z.[20] Referring back to this paper's case study, systems thinking can be seen as an approach to characterise the problem of self-radicalisation *in terms of a system*.

RAHS capitalises on the strength of systems thinking through the construction of system models via the Scenario Builder. In order to construct a system model of the self-radicalisation *problematique*, a number of prospective variables are first identified. Briefly, these are outlined as follows:

- The level of identification with the State.
- The extent of negative peer support, whether in a virtual or physical environment.
- The level of "resonance" with radical religious ideas.
- The extent of dissatisfaction with the extant political, economic and social status quo.
- The impact of personal "de-legitimating discovery".[21]
- The level of self-conformity with societal norms.
- The extent of (perceived) societal discrimination.

[20] See *RAHS Notes on Systems Thinking* (June 2007). The Arlington Institute.

[21] A "de-legitimating discovery" refers to an event or series of events that "call into question, undermine, or even shatter [erstwhile] culturally consistent [personal] beliefs, values, perceptions and expectations". See: Drummond, J.T. (2002). From the Northwest Imperative to Global Jihad: Social Psychological Aspects of the Construction of the Enemy, Political Violence, and Terror. In Stout, C.E. (ed.). *The Psychology of Terrorism: A Public Understanding, Volume 1*. Westport, CT: Praeger Publishers, pp. 49–95.

- The intensity of (internal) locus of control.[22]
- The level of access to "deviant" religious narratives.
- The extent of "humiliation-by-proxy".[23]

Now, while these elements can each have a bearing—to varying degrees—on the process of self-radicalisation, what the system model does is to cast and represent these variables in terms of their interrelationships and how their outcomes may then feedback into the system. One such possible system model (constructed using the Scenario Builder) is shown in Figure 7.

To better elucidate the featured system model, we can take the variable of personal dissatisfaction with the extant status quo as a case in point. Rather than to understand this variable only in terms of how it relates to the self-radicalisation process, the system model stresses the causal relationships between this variable and the other constituting elements. In other words, the degree in which an individual is personally frustrated with the existing societal status quo (and is thereby more likely to be susceptible to being radicalised) also correlates simultaneously with other peer variables such as the impact of personal "de-legitimating discovery"; the level of negative peer support; the level of "resonance" with radical religious ideology; the level of identification with the State; the extent of perceived societal discrimination; the level of

[22] The concept of "internal locus of control" was originally developed by Julian Rotter. It basically refers to an individual's perception about the underlying main causes of events in his/her life and whether this person believes his/her destiny is controlled by himself/herself or by "external forces" (such as fate, god or powerful others) See http://wilderdom.com/psychology/loc/LocusOfControlWhatIs.html.

[23] This refers to the vicarious sense of dishonour and shame that one feels even though the "offending" external event does not directly impact the person. See footnote 9.

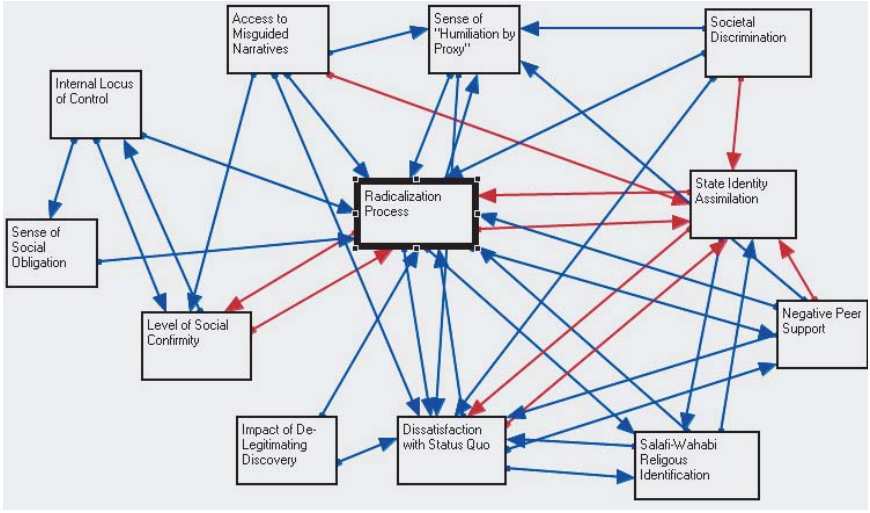

Figure 7: RAHS system model of the self-radicalisation process. The "blue" arrows represent relationships in the same direction (i.e. the level of variable Y rises/lowers in tandem with variable X) while the "red" arrows reflect relationships in the converse direction (i.e. the level of variable Y rises/lowers in opposition with variable X).

access to radical narratives; and the impact of "humiliation-by-proxy". Seen in this light, this means that system variables are rarely standalone entities. They can interact with one another and the dynamics of their interactions can have implications on the "root node" of self-radicalisation.

It is thus evident that system variables are never meant to be understood in isolation. Going back to the earlier example, it is presumptuous—and indeed, ludicrous—to equate an individual with a high level of status quo dissatisfaction as someone on the verge of being radicalised. While a correlation can exist, it doesn't mean that this one linkage is the central, be-all-and-end-all element that defines the question of self-radicalisation. There are other variables and inter-nodal connections in the mix as well, and that's precisely what the system model is trying to emphasise, and in so doing,

weave the various elements into a composite picture that tells a coherent story.

Perhaps it can be argued that the system model approach adopted by the Scenario Builder is reductionist in outlook and neglects specifics. But then again, system modelling is never about looking at specifics or individual case examples. Like any grand "big-picture" concept, system modelling is meaningful for providing a holistic perspective for strategic policy-making and sense-making. It may not be able to capture the specific instances or tactical nuances, but it is able to allow analysts to have a useful overview of all the interacting elements and networks of a strategic problem in just one glance.

THE RANKING BUILDER: A POTENTIAL EARLY WARNING PLATFORM FOR SELF-RADICALISATION?

The RAHS Ranking Builder is essentially a platform for evaluating a user-defined situation in a ranked hierarchical tree. Nodes are created and weighted based on user-specified rules or algorithms. Data is then fed into these nodes and aggregated based on user-defined weights to give values for higher level nodes, culminating eventually in a final index at the apex node (the user-defined problem).

The attributes of the Ranking Builder suggest that it may be applicable as a potential early warning indicator for self-radicalisation. For a start, it is possible to represent observable, user-defined, radicalisation "trip wires" in a weighted hierarchical structure (see Figure 8). Some prospective "trip wires" may include visible, empirical metrics such as a discernable change in personality; increased access to radical company and ideas; promulgation of extremist narratives; increased level of religious orthodoxy; and greater level of disassociation from the family. The list of potential "trip wires",

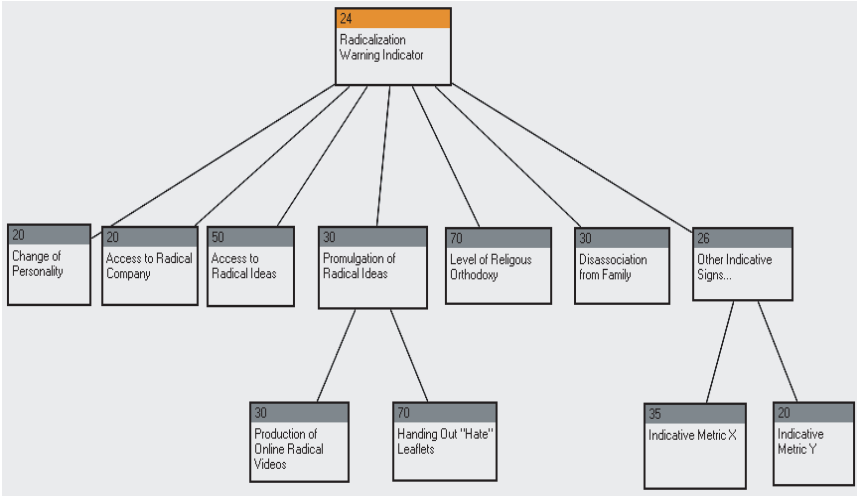

Figure 8: RAHS Ranking Tree for Early Warning of Self-Radicalisation

of course, doesn't need to end here. The analyst retains the prerogative of adding newer metrics (both higher and lower order nodes) to the tree.

These user-defined "trip wires" can serve as monitoring filters against a database of individuals being tracked for self-radicalisation. Raw surveillance data can be fed into the system and they would be interpreted, assessed and indexed based on the weighting algorithms that define these filters. As the primary information is being filtered and transferred up the tree, a final index reflecting a suspect's "radicalisation content" would be obtained. Should this final index value hover precariously close to or exceed a certain pre-defined "tipping point", the analyst would be alerted.

At this juncture, it is necessary to clarify that scores reflected in the ranking tree *are, by no means, definitive or deterministic; they are indicative at best*. After all, the reliability of the tallied

scores is largely dependent on the strength and suitability of the user-defined weighting rules, the type of user-specified metrics and the veracity of the incoming data. Still, the Ranking Builder comes as a structured and flexible approach towards the sense-making of radicalisation signals and patterns that are emanating across the horizon. Its results are meant to be understood only as a guide to complement the existing assessment or experience of the analyst.

CONCLUDING TAKEAWAYS: RAHS AS THE "COGNITIVE LUBRICANT" AND "COMMON DRAWING BOARD"

This paper has highlighted how the RAHS system can serve as a tool to aid analysts in mapping out the dynamics of self-radicalisation and its early warning. In particular, the Scenario Builder and Ranking Builder are two interesting platforms that may help facilitate and imbue a more systematic and structured approach towards shedding more light on the self-radicalisation conundrum. Analogically, in this respect, RAHS can be likened to as a "cognitive lubricant" that seeks to "smoothen the edges" of unstructured analysis and sense-making.

It is worth cautioning, however, that the RAHS system should never be seen as some kind of technological "silver bullet" for strategic analysis; such an ideal remains rightfully audacious. At the end of the day, the RAHS system is no more than just a tool of the analyst. It cannot replace the instinct, experience or domain knowledge of the analyst and it certainly cannot ask questions on behalf of the analyst. What the RAHS system can achieve, instead, is to create an environment in which expert and domain knowledge is captured, analysed systematically, retained and shared across multiple users. RAHS does this by networking analysts to the same analytical template, whereby constructed models can be viewed and modified by those within the same

network. A developed model (be it a system map or ranking tree) is therefore not the “end state”. Models are dynamic and can be changed and updated according to fresher inputs and new perspectives. The dynamic and networked nature of the system’s modelling structure means that, effectively, RAHS acts as a *common analytical drawing board* for analysts. This will be helpful towards the bridging of institutional silos as well as the collective analysis of strategic issues.

Enhanced Reasoning Techniques to Achieve Cognitive Precision[1]

David Snowden, Gary Klein, Chew Lock Pin and Cheryl Ann Teh

INTRODUCTION

The purpose of this research was to conduct a pilot study of techniques from Klein Associates and Cognitive Edge to improve military sense-making, specifically in the area of Cognitive Precision. The Future Systems Directorate (FSD), Ministry of Defence (Singapore), defines Cognitive Precision as the "collection and connection of the right dots", i.e. the relevant data. Several obstacles to Cognitive Precision were identified in the areas of: i) Seeing information (info overload, pattern entrainment, bounded awareness); ii) Sharing information (groupthink, compartmentalised knowledge); and iii) Acting on the interventions directly targeting these problems (abstraction of situation to a higher level, enforced alternative and hypothetical reasoning, greater diversity and externalisation of insights for discussion or critique, etc.). These interventions were tested with seven groups of military and intelligence personnel in the context of two "garden-path" type scenarios—a military planning task and an intelligence assessment task—within which were embedded weak signals for detection. While the experiment successfully demonstrated many of the above-mentioned obstacles, it was found, more importantly, that the interventions as

[1] This paper was originally presented at the 12th Annual International Command and Control Research & Technology Symposium.

a whole proved useful in amplifying and identifying weak signals which were otherwise seldom detected. The next step would be to systematically assess and select the most useful interventions to form an Anticipatory Thinking Model as a means to improve Cognitive Precision for sense-making.

Sense-making can be defined as "exploiting information under conditions of uncertainty, complexity and time pressure for awareness, understanding, planning and decision-making." With superior sense-making, it is expected that individuals and teams will be able to better handle situations despite uncertainty and information overload, make faster and better decisions with regard to the adversary, and finally, prevent fundamental surprise.

Under the umbrella of sense-making, FSD has identified six key desired outcomes to work towards in order to have superior sense-making for the Singapore Armed Forces. These are: Adaptivity, Cognitive Precision, As One, Reliable Instincts, Augmented Cognition and Rapid Cognition. Under each of these broad outcomes are several concept solutions in the form of processes, structures, technology tools and systems, etc., that can be applied to achieve the desired outcome. This experiment focused on the outcome of Cognitive Precision.

BACKGROUND

Cognitive Precision essentially means having teams and individuals well-aligned to reality and getting the most accurate, unbiased perspective of the problem by taking into account relevant weak signals before arriving at an unbiased hypothesis or solution to the problem. One main problem that hinders achievement of Cognitive Precision is insensitivity to weak signals. This historically well-documented phenomenon, most recently exemplified in events leading up to 9/11, is often colloquially referred to as pertaining to

problems in both "collecting"[2] and "connecting the dots". The ability to identify relevant pieces of information within a sea of "noise" is made harder by the effects of conditioning; with greater exposure to irrelevant, unimportant information, one's threshold of detection is raised, making it increasingly difficult to pick up the right signals. On the other end of the spectrum is the issue of hypersensitivity—being overly vigilant and cautious, hence falling prey to "false alarms".

WHAT CAUSES INSENSITIVITY TO WEAK SIGNALS?

Looking to the field of social and cognitive psychology, there is ample literature on cognitive biases and the instinctive use of heuristics in assessing situations and making decisions by individuals and teams. These include confirmation bias,[3] groupthink, primacy and "recency" effect, availability heuristic, etc. These biases contribute to inaccurate situation assessment and skewed decision-making and, when taken together, can often magnify a small error in judgment.

There also exists the problem of compartmentalised knowledge between individuals and teams, again exemplified by the events of 9/11, which saw the various US security agencies working separately and not sharing information, to the nation's detriment.

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[2] Libicki M. and Pfleeger, S.L. (2004). *Collecting the Dots: Problem Formulation and Solution Elements.* RAND Corporation Occasional Paper, OP-103-RC, 2004.

[3] Confirmation bias relates to actively seeking only information that confirms one's hypothesis even in the face of disconfirming evidence. A study on confirmation bias was previously conducted by FSD. See: *Countering Positive Confirmation Biases in Command Teams: An Experiment with Different Interventions*. Paper presented at the 10th ICCRT Symposium, Oct 2004. Retrieved at http://www.mindef.gov.sg/etc/medialib/imindef_media_library/photos/scme.Par.0024.File.tmp/13.pdf

The concept solution of Enhanced Reasoning is relevant here. This utilises reasoning techniques introduced at both team and individual levels to mitigate inherent biases, encourage the application of useful heuristics and facilitate the detection of weak signals towards achieving the best solution. Other solutions to Cognitive Precision are "Massive Sense-making" (exploiting computing power to process and identify patterns within large amounts of data, a form of automated, large-scale data mining) and "Wisdom of the Rest" (extracting opinions and insights from large numbers of experts and non-experts alike).

EXPERIMENT OBJECTIVES

The objective of this experiment was to assess the effectiveness of various interventions in improving the detection of weak signals at both team and individual levels. As mentioned earlier, this can be further broken down into several contributing problems, which the interventions are intended to solve.

Essentially, the issues underlying Cognitive Precision can be summarised into the "See-Attend-Act (Share)" model of sense-making (although this was only formalised post-experiment): *Do we see the data? Do we pay attention to the data? Are we able to act on the data?* In a team setting, underlying all this is the notion of sharing awareness, information or even opinions at any of the three levels.

To enable participants to better handle these questions, FSD, together with Klein Associates and Cognitive Edge, came up with several possible solution areas that were then implemented through various experimental interventions. These are:

- *Developing new perspectives on the situation*: Use of a high abstraction language would allow decision-makers to gain new perspectives on a situation, which is presumed to

facilitate the assimilation of more data and provide more flexibility during pre-planning. *Interventions: Attraction/Barrier framing; Crystal Ball.*

- *Breaking the normal linear patterns of planning and decision-making*: This could increase the "after-action" learning of a group and its ability to consider otherwise discounted events. *Intervention: Future Backward*.

- *Dissent*: The problem of compartmentalised knowledge between teams and individuals can be avoided by either "forcing" or encouraging knowledge-bearers to share their information and views. This should be done at different points, while parallel processing (planning and execution) is going on as a checking mechanism to ensure that common ground is maintained and that information flows between all of the parties involved. Placing decision-makers in a context where they confront failure without threat and are separated from the formal decision-making process, will reduce entrainment and increase the number of factors they take into account.

  Inherent cognitive biases, particularly confirmation bias and groupthink, may also be mitigated by reducing inherent fixation and encouraging dissenting views between individuals. Through dissent, teams are less inclined to readily adopt the dominant view of the situation, as this allows for the consideration of minority opinions within the group. On the individual level, exposure to differing opinions reduces the tendency to be fixated (or pattern-entrained) as individuals are now more likely to question their assessments and decisions upon hearing the opinions of others. *Interventions: Ritualised Dissent, Situation Awareness Calibration.*

INTERVENTIONS

A range of methods from Cognitive Edge and Klein Associates that were chosen as possible ways of improving weak signal detection,

and hence used as experimental interventions, are described as follows:

- *Crystal Ball*: The Crystal Ball exercise was developed by Marvin Cohen to enable constructive criticism of assessments.[4] When we critique our own assessments, we are hoping that we won't find any show-stoppers, any flaws that can't be fixed. In a team setting, people are often resistant to criticising the ideas of others. The Crystal Ball provides a format that supports a productive critique of assessments, leveraging input from all team members. With a Crystal Ball technique, the group is told that while they have the right information, the assessment they have made is incorrect. Then, through mental simulation, the group attempts to come up with alternate assessments based on the given information. The intent is to prevent fixation and force team members to think differently in order to uncover critical flaws and areas of concern that are otherwise ignored. Once this is done, the group can look for more than one possible solution.
- *Ritualised Dissent*: This method was developed in the Cynefin Centre to overcome problems of groupthink and pattern-entrainment. It should not be confused with the more commonly known method of Devil's Advocacy in which dissenting opinions are introduced. In Ritualised Dissent, different groups of people engage in the same process and then send a spokesperson to another group to present their ideas. Following completion of the presentation the spokesperson ritually places his/her back to the audience and is not allowed to explain, argue or justify their position while the audience engage in an all-out attack on their ideas. Unlike Devil's Advocate approaches, where the outsider's criticism can easily be rejected by the group, here the "devil's

[4] See a description in: Gary Klein. (1998). *Sources of Power: How People Make Decisions*. Cambridge, MA: MIT Press, pp. 69–70.

advocates" in each group have been through the same process. In effect, learning takes place in two ways: i) In being forced to listen without response, the person subject to attack is not mentally preparing a rebuttal (as would happen in normal discourse), since no rebuttal is allowed; and ii) The audience, in criticising the other person's position, often realises flaws in their own arguments. The ritual turning of the back by the person on the hot seat helps to depersonalise the criticism and to increase the attention of the person on the hot seat, who has no eye contact with the critics.

- *Attractors/Barriers (AB) Framing*: The Attractors/Barriers (AB) Method guides the decision-maker to view the features of the situation in terms of ways to facilitate or interfere with desired outcomes. In a complex system it is not possible to predict outcomes with any degree of consistency. As multiple agents (individuals, ideas, decisions, etc.) constantly interact with one another, the number of possible patterns that can form from the various interactions makes it impossible to predict outcomes. However, agent interaction takes place within barriers and around attractors, perhaps better understood as "attractors attract and barriers repel". The AB Method provides an analytic approach to a complex problem by getting the participants to describe the situation, not in terms of causality leading to predictable outcome, but instead in terms of describing the nature and type of attractors and barriers that are in play. In effect, the situation is described at a level of abstraction from reality to allow the decision-makers to focus on the evolutionary characteristics of an unpredictable space. Abstraction is a key aspect of human language and its evolution, and high levels of abstraction within a shared context allow for a more efficient way of describing a situation than low-abstraction techniques. The AB Method additionally focuses on those abstractions of a decision space which can be changed and which are tangible. The

approach is normally to provide a metaphor (the children's party, sharks at a beach, fences round swimming pools) to allow people to take on board the concept, and then have them describe the situation as a set of attractors and barriers, focusing on which they can control and which are beyond their control, which are stable and which are volatile, etc. Experience has shown that the approach only works when people are describing a position of (from their perspective) future uncertainty. It does not work when people attempt to explain the past because causality is already known.

- *Future Backwards*: Originally developed as an alternative to scenario planning, this intervention aims to extend the range of possibilities that people will consider. The process is fairly simple and can be run over several hours or 10–15 minutes depending on the consequence. The intention is to gather the maximum possible number of decision or "turning" points in the past and possible futures, thus emphasising interventions or decisions. The following sequence is recommended:

  i. The group identifies the "current state" as a limited number of decisions or situations that they face.

  ii. They then step backwards (facilitators have to monitor closely for stepping forwards) to the last significant set of decisions (a turning point) that gave rise to the current state of affairs.

  iii. Following this, they continue to step backwards through turning points until, from their perspective, there is no longer any significance. No guidance is given as to how long they should do this and the differences in time periods between different groups given the same task can be very useful.

iv. The group then identifies two possible future states: "Heaven" and "Hell", i.e. impossibly good or bad future states. They are instructed to make these incredible, i.e. not a real best and worst future.

v. Having achieved that they are then instructed to make the impossible futures "happen" by stepping backwards through turning points to a point *before* the current state, including, if desired, one major accident or surprising event.

The goal of this method is to extend the scanning range of the decision-making group. Cognitive Edge found that by having people engage in hypothetical reasoning around a highly certain event (e.g. a future state that is presented as a given), they work more diligently and creatively than when dealing with highly uncertain future states; this is a benefit of prospective hindsight.

- *Situation Awareness (SA) Calibration Exercise*: Situation Awareness (SA) refers to people's understanding of the environment (what they see and perceive around them) based on intelligence reports, threats, orders from HHQ, adjacent unit actions, etc. Good SA provides a basis for sound decision-making. If people's view of the world is inaccurate, their decisions will likely result in a sub-optimal outcome. The same is true for teams: if they fail to establish and maintain a common understanding of the dynamic battlefield, they will not be able to execute the Course of Action smoothly and accomplish the mission. The challenge in building SA in a team is that if everyone sees the world the same then the team loses a diversity of viewpoints. But if everyone sees the world differently then common ground breaks down and coordination becomes difficult.

  The SA Calibration Exercise provides participants with insight into how others view the battlefield. It helps them understand

the subtle cues and environmental factors that affect others' actions and decisions. The SA calibration exercise taps into key aspects of the mission—aspects where concordance is essential, such as goals of the mission. In order to obtain data, the exercises are interrupted and the following questions asked (of individuals in the exercise):

i. *What is the immediate goal of your squad/team?* This question examines how well the commander's intent was understood and remembered. Often, team members only report the big goal (e.g. win the war, take the city) and fail to report the immediate sub-goals (e.g. take the radio tower, suppress the sniper).

ii. *What are you doing to support this goal?* Team members must understand both the goal and what they are supposed to be doing to support that goal.

iii. *What are you concerned about?* This question could also be phrased, *"What are some factors that could hinder your unit from achieving your goal?"* This question helps uncover how participants are interpreting events on the battlefield or in a threat situation. Some participants are worried about their ability to achieve the immediate goal (e.g. "I'm worried the sniper will get me before I can get him") while other team members may express a broader range of concerns (e.g. "there's another sniper in another building," "civilian causalities," "am I doing my job right?").

iv. *What is the current threat location, size, and intention?* This question serves as a reality check on how each person had assessed the battlefield or situation. This illustrates how participants understand the importance of maintaining a "big picture" view and avoiding tunnel vision.

v. *What do you think the situation will look like in 24 hours (for the military scenario) or one month (for the homeland security scenario) and why?* The responses to this question can facilitate a discussion about how different pictures of the future battlefield are affecting current execution. This can lead to tweaking the plan or gathering lessons learned for the next exercise.

In addition to being an intervention, the SA Calibration Exercise is also a method of data collection, by providing experimenters with the ability to peer into an individual's cognitive sense-making processes and see how those individual processes were affecting the outcomes of the teams.

EXPERIMENT SETUP

Scenarios & Experiment Runs

Two scenarios were used in the experiment—one was a strategic/operational-level military planning task, the second was to assess a homeland security situation for a potential threat. Each scenario targeted the appropriate group of participants, i.e. the military scenario for military participants, and likewise for the homeland security scenario. The experiment runs were conducted to best observe effects of the Enhanced Reasoning techniques (if any) by first running the scenario for a length of time and subsequently introducing the various techniques as experimental interventions at appropriate points in time. In this way, a reasonably objective comparison could be made between individuals' and teams' ability to detect weak signals, as well as associated pre- and post-intervention behaviours. The expected effects of these various interventions were not made known to the participants prior to the runs in order to avoid the Hawthorne

effect.[5] Previous work by Cognitive Edge had established that sense-making techniques work best when the subjects are dealing with conditions of uncertainty, i.e. they have to be tested and developed in an environment as close as possible to real life rather than in any retrospective study or simulation.

- *Military Planning Scenario*: This was designed to bring out the naturalistic biases one would bring to such a situation, specifically falling for the "garden path"[6] laid out within the scenario. It was tailored from a standard Singapore Command and Staff College planning exercise that many participants would be familiar with and which would add to the probability of them making erroneous assumptions based on the most salient information available. In reality, the mode of enemy attack differed from what would be conventionally expected; this was suggested through pieces of information provided to the participants at the start, as well as through injects administered in the course of the scenario. Participants had to develop a credible plan encompassing all levels (strategic, operational and tactical) of war fighting, within the allocated time of approximately three hours, including time for interventions.
- *Homeland Security Scenario*: This was also tailored from a full-scale terrorist attack scenario generated by Singapore's Strategic Policy Office, with the timeline and number of elements compressed. In this case, participants did not have

[5] The Hawthorne effect is a phenomenon often quoted in organisational psychology and was first observed in the 1920s. It refers to changes or improvements in behaviour resulting from the mere fact that subjects knew they were being studied or observed.

[6] Being led down the garden path, i.e. mistakenly following a path that seems right but is actually wrong.

to formulate a response to the terrorist threat, but had to assess the rapidly evolving situation to best determine the nature, location, time, etc., of the imminent threat. Throughout the approximately three-hour runs, a large amount of information was almost continuously pumped to the participants, including information which was erroneous (conflicting) or irrelevant. Hence, the biggest challenge was to piece together the relevant information to arrive at an accurate situation assessment.

Subjects

There were seven groups of participants, each with four to five members. They were from both military and homeland security agencies and represented a diverse spread in terms of background, job responsibilities and experience. It was important to get participants whose daily roles involved military planning and situational assessment, so that they would be familiar with what the experiment entailed, and also in the hope that the interventions could be subsequently implemented into their work.

Data Collection

A few types of measures were employed for "data collection" to validate the effectiveness of the various techniques towards Cognitive Precision:

- Objective measures in the form of *Future Backward* and *SA Calibration* data provided "states of mind" of the participants, in terms of situation understanding and decisions made at various points in time.
- Subjective impressions of participants reflected in Narrative Captures and indexing of trust levels, team dynamics, expertise,

dissent, information scanning range, etc. Also, Assessment Questions were asked on new insights and if anything could have been avoided.

Narrative Capture

Narrative Capture was used to record the experiences of participants in story or anecdote form. At break points in the exercise, the participants on their own recorded incidents that they deemed noteworthy. This process allowed participants to capture their own thoughts and experiences from a uniquely individual perspective without mitigating group conformity behaviours coming into play. The narratives were then indexed by participants according to factors and themes of interest to the experiment. Personnel from Klein Associates and Cognitive Edge also made observations both during the experiment and via video capture for later observations.

RESULTS AND DISCUSSION

This experiment addressed the issue of Cognitive Precision, specifically that of improving weak signal detection. The interventions introduced in the course of the experiment runs were designed to overcome the problems of compartmentalised knowledge—cognitive biases such as groupthink, confirmation bias and so on (previously described) —that contribute to insensitivity to weak signals. Based on the "See-Attend-Act (Share)" model of sense-making described earlier, these interventions attempted to enable participants to perceive, pay attention to, share and, lastly, act on weak signals present in the environment, and hence respond more quickly and alertly to early signs of trouble.[7] The

[7] Klein, G. et al. (2005). Problem Detection. *Cognition, Technology and Work* 7(1), pp. 14–28.

results and discussion section is organised according to this model.

Seeing the Data—Did Anyone Notice the Weak Signals?

The Narrative Capture exercise elicited 77 anecdotes from 34 participants. Consistently across groups, certain individuals would notice weak signals early in the exercise. Typically, half the group detected the weak signals and in one experiment run, Narrative Capture showed that one individual had divined the enemy's intent (and the ultimate outcome of the scenario) by the end of the first run, even though very few signals were present. This was an unexpected finding, because as a group, they were not detecting or paying attention to those signals. This was corroborated by observational data where either discussion and dismissal of weak signals, or no mention of weak signals was observed. That individuals noticed weak signals early was an encouraging sign given the (intentional) high levels of obscurity applied to those signals in the exercises; however, the failure to *act* on the weak signals was a concern. This will be dealt with in a later section.

The *Crystal Ball Exercise* proved to be an effective intervention for forcing participants to think through alternative reasoning patterns and break free from pattern-entrainment at the group level. When participants were asked to give a current assessment of their situation, their responses reflected a "garden-path" thought process. When told their initial assessment was incorrect and they needed to provide alternative reasoning, it was found that people became much closer to the reality of what was happening, e.g. picking up key weak signals like the critical day for the homeland security scenario being Singapore's National Day.

Likewise, after interventions such as *AB Framing* and *Future Backwards (FB)* were introduced, there was an increase in individuals noticing weak signals early, as captured in narrative form. Additionally, the weak signals began to make a stronger appearance in whiteboard plans and in the calibration measures once interventions were in place. This was corroborated by an increase in the explicit discussion and consideration of possible alternative courses of action and likely events in the groups, as noted in recorded observations.

Attending to the Signals

FB and *AB Framing* were both used as interventions to improve the detection of, and attention paid to, weak signals. Additionally, both these techniques sought to improve the range of possible outcomes and alternative actions contained in the scenario with a view to stimulating inclusion of that information in flexible action plans. When compared with the control group, it was evident that interventions stimulated awareness of the weak signals and alternatives to varying degrees. The main success of *AB Framing* was in improving overall understanding of intent, whether behind a mission or for gathering information, with the creation of *AB* lists from various perspectives allowing groups to have more extensive discussion and a better understanding of the situation. This led them to consider more possibilities. *FB* improved scanning capability and understanding of possible unconsidered scenarios to an even greater extent. It also served as an after-action review (learning process) for the teams when conducted at the end of the experiment run.

After the *Crystal Ball Exercise*, participants continued their experiment run by evaluating the alternative explanations they had identified. It was observed that they subsequently paid more attention to conflicting information.

Sharing the Awareness—Differences between Individual and Team Views

At each of the three Narrative Captures, individual dissent from group opinion showed through clearly. As discussed above, there were early indications of weak signal detection. In addition, the individual narratives indicated that teams were not as well-calibrated as other measures (e.g. *SA Calibration*) and observations might indicate. Observations of team cohesion were somewhat moderated by observations of disparate views and dismissal of alternative points of view. One reason for this could be that *SA Calibration* measures were direct and structured with "expected answers" relatively evident to participants, whereas the Narrative Capture process is indirect and perhaps better allows for the expression of dissenting views. Narrative Capture data indicated there were several opinions within groups as to an assessment of the "current situation", the "proposed plan" and what might actually unfold. As interventions were introduced, the disparity between individual stories and the collective discussion (and group plan) appeared to diminish; this was particularly apparent when *Future Backwards* was conducted.

Perhaps the most significant observation arising from these interventions was that the level of debate, animation and dissenting voices increased during and after these interventions, particularly after *Future Backward* and *Ritualised Dissent* exercises. In some cases where participants had said nothing or very little in preceding interactions, they now took an active role and provided new insights and challenges for the group. While not all insights and points of view made it into plans, there was certainly a marked increase in incorporating a diversity of views, as compared to the group that did not use these interventions.

It was also observed that deference to rank appeared to lessen during these exercises, although this statement has no corroboration

in other measures and is simply an observation. Interestingly, *Future Backwards* was rated the most popular of the methods, creating high levels of engagement and post-event learning. While *AB Framing* was judged as conceptually difficult, it was still rated third amongst the interventions for usefulness and likelihood of being used.

Overall, *SA Calibration* data showed that the interventions resulted in a slight increase in calibration for two out of three teams that participated in the homeland scenario and three out of four teams that participated in the military scenario, and decreased calibration for the rest of the teams. Of the teams that benefited from the intervention, *SA Calibration* improved an average of 10 per cent. The challenge, therefore, is to find ways to improve these scores without reducing the useful diversity of viewpoints essential to effective team sense-making.

Acting on the Signals—Translating Awareness to Action

Even though teams were generally more explicitly aware of weak signals and alternatives (as indicated by Assessment Questions), this awareness had a significantly varied impact on the plans and behaviour of the teams, i.e. during the *Acting* stage of the "See-Attend-Act (Share)" model of sense-making. In two instances, following a *Ritualised Dissent* intervention, teams actively revised their plans to make provision for unexpected scenarios and built in more contingency. Additionally they began to question the state of the data received from superiors and consequently got relatively close in predicting the final outcome of the experiment.

At the other end of the scale, one team refused to accept any of the additional insights, even though these additional insights were provided by a team of external, senior ranking experts during a *Ritualised Dissent/Crystal Ball Exercise*, and did not include any of

the information in their plan. In fact, this group perceived that the expert panel had in fact corroborated their plan. This team proved an interesting example of group-think. As a group they appeared to be extremely confident and fixated in their approach. However, individual narrative capture and the use of Assessment Questions with this group individually (rather than as a group, as for all other teams), showed that the individual members varied significantly in their perspectives. One team member was relatively close in predicting the ultimate outcome and aware of the telling signals, yet this did not translate into any impact on the group's plans.

RECOMMENDATIONS ON INTERVENTIONS

- The *Crystal Ball* and *Ritualised Dissent* techniques should be formalised and their use institutionalised into situation assessment and two-sided type exercises. All of these are high-impact, low-time requirement methods. Other similar techniques can also be included to ensure variety and, consequently, novelty. If the same method is used consistently, it will become familiar and hence capable of being "gamed". Their formalisation should include an awareness that they work best when a problem is not broken down into sub-components and the solutions assembled (i.e. reductionist approaches to assessment and decision-making, which are common), but when groups work in parallel on the same issue and compare results.
- *AB Framing,* while shown to have considerable potential, requires additional development to reduce its conceptual nature (and the requirement for education). Though the different metaphors used to introduce the technique to participants helped considerably, ideally a non-conceptual and intuitive front end should generate *Attractor-Barrier* representation. Once this is achieved, further experiments can be scheduled to test its efficacy. One possible way to facilitate creation of *AB* representation is

through the use of narratives. Also, through the index structure of the narrative, such as in the RAHS software, the "See-Attend-Act (Share)" aspects of the sense-making model described earlier could be tested. Preliminary work was done in an experiment conducted by Dave Snowden and Alicia Juarrero in September 2006 with success; the prototypes of the software created for this purpose will be available as part of RAHS by March 2007.

- *Future Backwards* is ready to move into operations as a formal method for after-action review and should be linked to Narrative Capture, and narrative-based knowledge storage. As with the above, an experiment using the RAHS software to create a demonstrator could be set up and formal adoption considered thereafter.

CONCLUSION

An expected outcome of this collaboration with Klein Associates and Cognitive Edge on this sense-making experiment is an Anticipatory Thinking Model[8] that can be applied by individuals and teams in operational settings of military, peacekeeping, homeland security, etc. to achieve Cognitive Precision. The term *anticipatory* is used instead of the conventional "predictive", as the latter connotes a level of omniscience that does not usually exist in the inference of future events. In this experiment, we effectively started work on the creation and testing of such a model. The core of the model is *Attractors* and *Barriers*, i.e. what attracts effective anticipatory thinking, and what gets in the way? In this respect, it is important to note that attractors and barriers are not used as an

[8] Lazaroff M. and Snowden, D. (2006). Anticipatory Models for Counter Terrorism. In Popp R. and Yen, J. (eds.). *Emergent Information Technologies and Enabling Policies for Counter-Terrorism*. Wiley-IEEE Press.

alternative way of describing a decision space (as with the experimental intervention), but in a "meta-sense" for anticipatory thinking. By this token, some *barriers* to anticipatory thinking would be the problems identified earlier (e.g. cognitive biases, compartmentalised knowledge) while *attractors* could be based on the underlying principles of the interventative methods, such as alternative explanations of a situation, *Ritualised Dissent*, etc.

The "See-Attend-Act (Share) model" of sense-making was an interesting and important discovery from this experiment. However, as this was only formalised post-hoc, this experiment was not designed to assess the different impacts of the interventions on these three (or four) aspects of sense-making on increasing cognitive precision. A series of experiments should be set up to test this to greater detail, and FSD can consider the wider application of this distinction in their other sense-making experiments.

Looking for Weak Signals of a Change in Trends

John L. Casti and Leena Ilmola

MOOD MATTERS

The mood of a group—an institution, state, continent or the world—is for all practical purposes how that group feels about the future. Is the group optimistic, pessimistic or neutral? And to what degree? Of course, there are many futures. So this question has to be answered on the time scale appropriate for the kind of event we're concerned about. For instance, if our interest lies in a short time scale event such as the types of movies people will like next year, it would be useless to think about the mood of the population over a span of decades. But decades would be exactly the right time scale for a phenomenon like globalisation, which we'll consider later in the chapter.

SOCIAL MOOD

Use of social mood theory involves taking a non-deterministic view of social forecasting: Given a pattern of social mood changes over a specific time frame, we determine periods when the mood is positive or negative (optimistic or pessimistic about the future on that timescale). We then outline the possible *types* of events that might occur in these periods, and employ the social mood as a way of "biasing" what is more or less likely to actually occur. So the situation is much like weather forecasting. Many things *might* happen, but not all possibilities are equally likely. The

social mood allows us to assign relative likelihoods—that is, an ordering—to the various possibilities from most plausible to highly unlikely.

The notion of social mood offers a coherent framework for anticipating the way social events will unfold. It is based on the assumption that human behaviour changes as a result of forces inside the human system itself (endogenous nature of human systems) and not in reaction to external events.

Social mood theory asserts that the collective actions of the group stem from the beliefs of individuals composing that group. Interaction and communication with others leads to a kind of "group mind" having a collective view as to how promising the future looks on all time scales. This belief about the future is ultimately what constitutes the *social mood,* which in turn shapes the vast majority of group behaviours and actions. According to Robert R. Prechter Jr., who coined the term "socionomics" for this concept of social mood and its influence on behaviour, thoughts cause actions. When thoughts are collected together to form the social mood, Prechter's claim is that the social mood then causes, or at least biases, social actions.[1]

THE CENTRAL HYPOTHESIS OF SOCIONOMICS

Herding Impulse + Networks → Social Mood → Human Social Events

- *Herding Impulse*: Mammalian brains have evolved hard-wired circuitry impelling the possessor of such a brain to tend to cluster in groups with others of its species.

[1] Prechter, R. (1999). The Wave Principle of Human Social Behaviour and the New Science of Socionomics. Gainsville, GA: New Classics Library.

- *Networks*: A necessary factor in the emergence of a social mood is the existence of some kind of network structure linking members of the group. When all the connections are in place, individual properties, such as a belief about the future, can percolate throughout the population via a kind of information "contagion-and-infection" effect leading to an "epidemic" that we sense as the mood of the group. So the key ingredient in the formation of the social mood is the network linking the members of the population together, along with the transmission links by which information passes from one part of the network to another. With the right structures even a population of ants or electrons can form collective patterns that could be interpreted as a "mood".

- *Social Mood*: How does a population feel about the future as a population? The answer to this basic question, to all intents and purposes, *is* the social mood. Our approach has been to argue that a broad-based financial market average like the Dow Jones Industrial Average or, even better, the S&P 500 index, is a good "sociometer" for characterising and quantifying the mood of a population on all time scales. It is important to note that the whole idea of social mood is the same wherever you look; it is a property of a collection of human minds, not the product of a particular culture, political ideology or geographic location.

- *Social Actions and Events:* It is impossible to consistently and accurately forecast *specific* events, such as a presidential assassination or the popularity of a particular book or film. So our focus here is on collective social events rather than specific actions. Social mood theory focuses on classes of events within which specific trends or actions are simply representative examples of a general class of events.

The character of the types of events that take place in periods of positive social mood differs dramatically from what you can expect

to see when the mood is negative. So, for instance, when people are optimistic about the future (positive mood), everyday words like “unifying”, “liberating”, togetherness”, “tolerant”, and “coming together” describe the sorts of events we are likely to see. And their opposites, labels such as “fragmentation”, “separation”, “restricting”, and “bigoted/xenophobic” characterise the events that typically occur in negative mood periods.

SOCIOMETERS

But how do we measure the social mood? Public opinion surveys and questionnaires are biased, since they don’t reflect what people actually think or do. Nor do they take into account that people are influenced by others and don’t make their choices independently. The very essence of social cohesion is grouping together, the very opposite of standalone, independent decision-making.

Theory claims that there is a structure or pattern for how different classes of events ebb and flow over the course of time, and that it is possible to estimate the likelihood of a particular class coming to the fore at various times. The Central Hypothesis of Socionomics addresses classes of human events in a probabilistic—or perhaps we should say “possibilistic” —manner, rather than with certainty.

A seemingly counterintuitive aspect of the Central Hypothesis of Socionomics is the absence of any arrow pointing back from social events to the social mood. In other words, there is no feedback whatsoever from events to mood. The social mood precedes the event and creates an environment conducive to the event itself taking place. On the basis of the prevailing social mood alone, no one could have predicted the *specific* event of a presidential assassination or a terrorist attack in New York or London. But you certainly could have anticipated the relative likelihood of an event of this type on the basis of the social mood at the time.

Here is a somewhat light-hearted example to illustrate the general ideas thus far. History records many examples of societies seemingly compelled to leave a visible testament for the ages to its increasingly positive view of the future by creating the world's tallest building. In each case, construction begins on these behemoths as the social mood starts accelerating upward. But skyscrapers don't appear overnight, and by the time construction is actually completed several years later, the positive mood has always given way to a deeply pessimistic one. Figure 9 illustrates the three latest contenders in the skyscraper derby—Malaysia, Taiwan and Dubai—projected alongside a chart of the financial market averages in the respective countries. Bad things tend to happen in countries, especially to "little guys" who want to become "big guys", when they start trying to express their confidence in the future by erecting the world's tallest building.

This curse leads one to wonder about the future of Dubai, not to mention the fortunes of India, a strong advocate of globalisation. An architect from Delhi recently announced plans to build the world's tallest building, making the statement: "It is about status. It is about glorification. It is high time that people started realising that we too are a great nation." *Sic transit Gloria!*

THE CHALLENGE OF ANTICIPATING TURNING POINTS OF SOCIAL MOOD—EARLY SIGNS OF CHANGE

Futurologists have a tendency to forecast that tomorrow will be just like today, only a little better or a little worse depending on whether today is positive or negative. This is because there are good mathematical reasons for why it is almost always correct (if you take a small enough time step). However, there is no information content in such forecasts. What really count are the turning points, the places where the current trend is changing, not just the status quo.

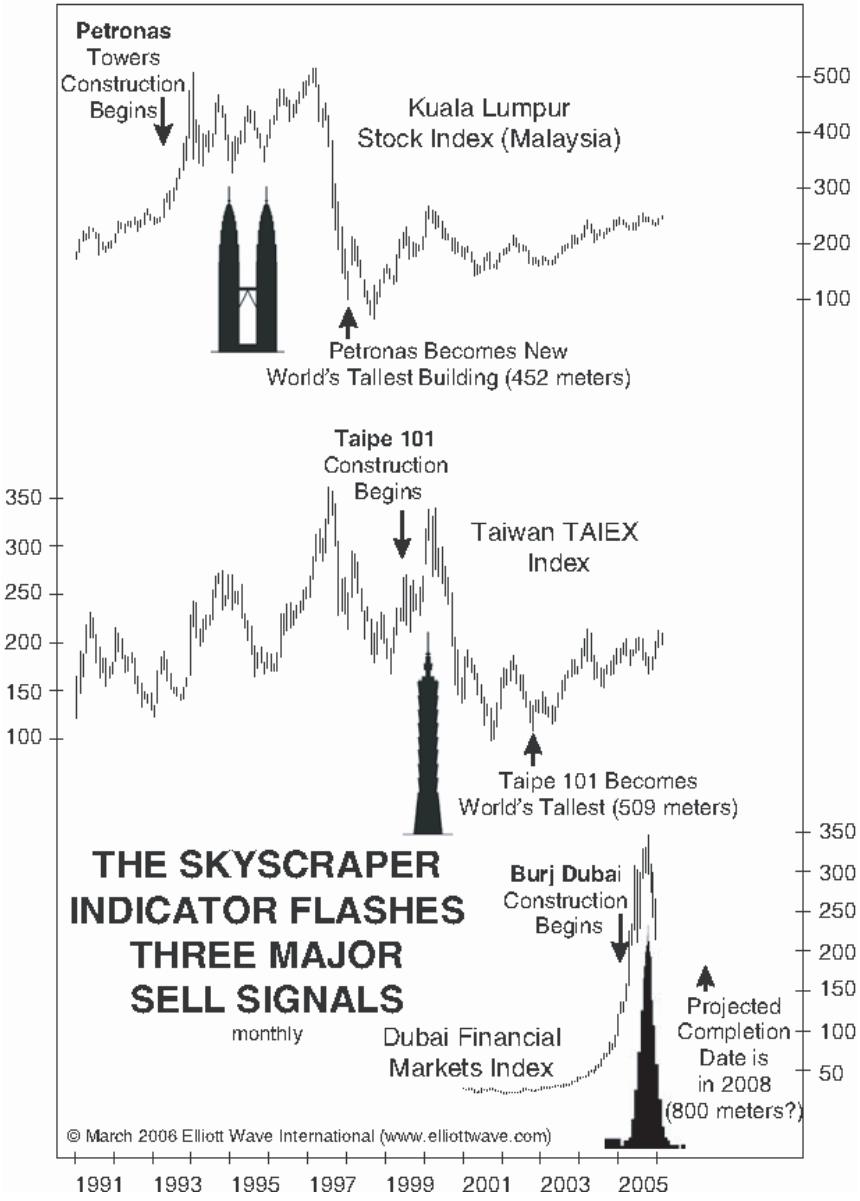

Figure 9: Financial markets indexes of Malaysia, Taiwan and Dubai plotted against The Skyscraper Indicator

Source: Elliot Wave International

The analysis of herding behaviour by movements in financial statistics gives a snapshot of the social mood at a particular point in time. But it does not predict whether the mood will remain stable or turn towards the opposite direction. Early signs of change are necessary to anticipate changes in social mood. To do so requires understanding both individual and collective perceptual and cognitive processes that shape social mood. As stated earlier, traditional scanning methods, such as studies based on documented data (Internet, media) and standard surveys, seldom reveal the process beyond actions or recognised needs. We need to capture early signs that are unstructured and have not yet been explicated. To reveal these early developments, we must understand the deep structure of information processing.

DETECTING EARLY SIGNS OF CHANGE FILTERS AND THE SENSE-MAKING PROCESS

Scanning for and making sense of early signs of change in the social mood is a multiphase process. The first challenge is to capture a signal of shift in the mood. Even if the theory of social mood provides an indicator of a desired type of early-warning signal, capturing the early "vibrations" is a challenge. Early signs of change seldom fit our current observations, especially when they involve an unexpected shift in social mood. Typically, weak signals are not noticed at all or are considered anomalies, because they do not fit into our current perceptual framework. This risk is higher when the data we are analysing consists of attitudes and shift of values. The theory of information filters provides a framework that helps us manage the scanning process.[2]

Early and unstructured information, such as initial changes in attitudes, have to pass through a set of connected filters that fall into

[2] Ansoff, I. (1979). *Strategic Management*. London: Macmillan.

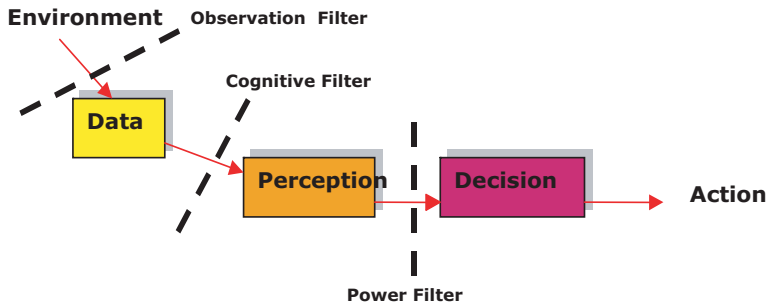

Figure 10: Three information filters by Igor Ansoff

three categories: *observation, cognitive* and *power* filters, as shown in Figure 10. Each of these stages filters out a part of the observed data. What remains is then used as input to the next phase.

Here is a brief outline of the three filters and the procedure for using them in identifying changes of the social mood.

Observation Filter

The observation filter defines the domain to be scanned. For efficiency, the anticipation process should have a narrow focus region for scanning. But that generates a bias. In the majority of scanning systems, the area to be observed is defined by past experience and especially by features that have had a significant impact in the past. The identity of the observer, the nature of his/her expertise and the purpose of the surveillance determine what sorts of rules of detection and categorisation are used; a risk scanner sees only risks, while the opportunity seeker sees only opportunities. The process is strongly “path-dependent” which means that a surveillance system generally observes things that have been observed before.

How then can the observation filter be opened up in order to scan the social mood? The diversity of participants involved in

observation is of critical importance. It is essential that an invitation is sent out to as diverse a sample as possible. The participants' brief has a strong effect on the focus of their field of observation. We can use ambiguous, brief, open-ended questions and encourage respondents to reveal their unstructured thoughts on identity and future expectations by stimulating them with probes and images.

Cognitive filter

The volume of information generated in scanning requires some form of consolidation. In the sense-making process, analysts' experiences and mental models define the data that is accepted. The acceptance of new ideas is hindered when information fails to support the current mental model.

How then can the cognitive filter be managed for the scan of the social mood? In the analysis of social mood, the interpretation is postponed for as long as possible in the process. Moreover, the interpretation framework is based on patterns of historical data defined by the sociometers discussed earlier. The early-signals data is analysed with Self-Organising Maps (an interpretation-free IT tool) and the dominant features of the data are identified and compared with historical pattern data. Moreover, the anticipatory power of the scan can be enhanced by deliberately processing those weak signs of change that do not fit into the dominant perception of the scanned group. The perceptions of early minorities reflect the direction of potential shifts in the social mood.

Power Filter

Novel information captured from the scanning system may cause changes in the power structure. Presenting ideas that are at odds

with current perception can risk one's own status as an expert or challenge the intellectual authority of others.

How then can the power filter be opened up? Maintaining the anonymity of the participants in a scanning process is an important way to open up the power filter. There also tends to be multiple voices when the interpretations of information and decisions are made at a later stage in the process.

ANTICIPATING THE SOCIAL MOOD

Forecasting the movement of the social mood is essentially a problem of pattern recognition. We must study the past to detect typical patterns of social mood as it relates to the area under investigation. This involves four steps:

Step 1: *Analysis of the available financial data*: This includes identification of the wave patterns in the relevant stock index data on different time scales (daily, monthly, annually and longer), in order to create a basis for forecasting trends into the future on these different scales. This is important as different types of social events unfold on very different scales, so we need this analysis on all scales in order to forecast the trends appropriate for particular types of events.

Step 2: *Pre-analysis of a sample of qualitative data for the relevant time frame*: Samples of published material such as leading newspapers, political and economics literature and official speeches relevant to the case under study are analysed. These analyses cluster potential key events and integrate them into hypothetical patterns of social mood.

Step 3: *Identification of significant events*: A group of social researchers familiar with the area in question identifies impor-

tant events in the time period appropriate for the issue being studied.

Step 4: *Pre-event social mood patterns*: Relevant qualitative data consisting of media and political narratives prior to each of the significant events is identified and the available quantitative data compared and analysed in depth. This phase reveals historically-based patterns in the development of social mood.

The patterns identified above will be used for the early recognition of signals of change in the social mood. As stated earlier, this interpretation framework is not able to predict specific future events. But it is able to anticipate the *types* of disrupting events that are more or less possible given the current state of the social mood.

A CASE STUDY—THE FUTURE OF GLOBALISATION

This study is an attempt to use the social mood framework to anticipate future shifts in the process of globalisation. Globalisation is defined here as the disappearance of barriers to the free flow of money, people, ideas and materials as a form of collective human social activity. Under the assumption that such activities are biased by the overall social mood of the world population, we must conclude that globalisation itself is biased by that mood.

The Global Futures Forum invited participants in the third Zurich Strategic Foresight and Warning seminar to take part in a specific scanning study for detecting early signs of change in the process of globalisation. The web-based tool used was the Signals Toolset developed by the Fountain Park Corporation. The invitation to the enquiry was sent to all of the participants of the Strategic Warning and Foresight Seminar held in Zurich in March 2007. Altogether, over 100 individuals provided input for the study. The purpose of

the study was to test a qualitative approach in the social mood framework.

Logic of the Methodology

The Signals Toolset used in this study consists of three elements: collection, evaluation and analysis of weak signals. The invitation to participate was sent by an e-mail that included a link to the web-based tool. All the responses were anonymous, but some background variables were gathered to assist the analysis.

Signals Collection

The respondent presented his/her thoughts as a narrative. The tool has three different templates that pose the same open question in three different ways. The first template presents the question while the second template poses the same question but with a randomly chosen stimulant that has no direct links to the theme under investigation (e.g. “I was surprised to hear experts comment ...”). The third template is used to trigger thinking and encourage the respondent to forego analytical thinking with the help of “distant thinking models” (e.g. “If you could fly ...”). Figure 11 shows how the questions were posed in the web-based tool.

Signal Assessment

The data collected is composed of diverse comments on possible signs of change. In order to facilitate analysis, this qualitative material has to be converted into quantitative form. This is done in a separate assessment stage in which respondents are asked to evaluate the collected material. The tool automatically provides each respondent with 20 randomly chosen signals from the collected

Figure 11: Three templates used in the signal collection stage

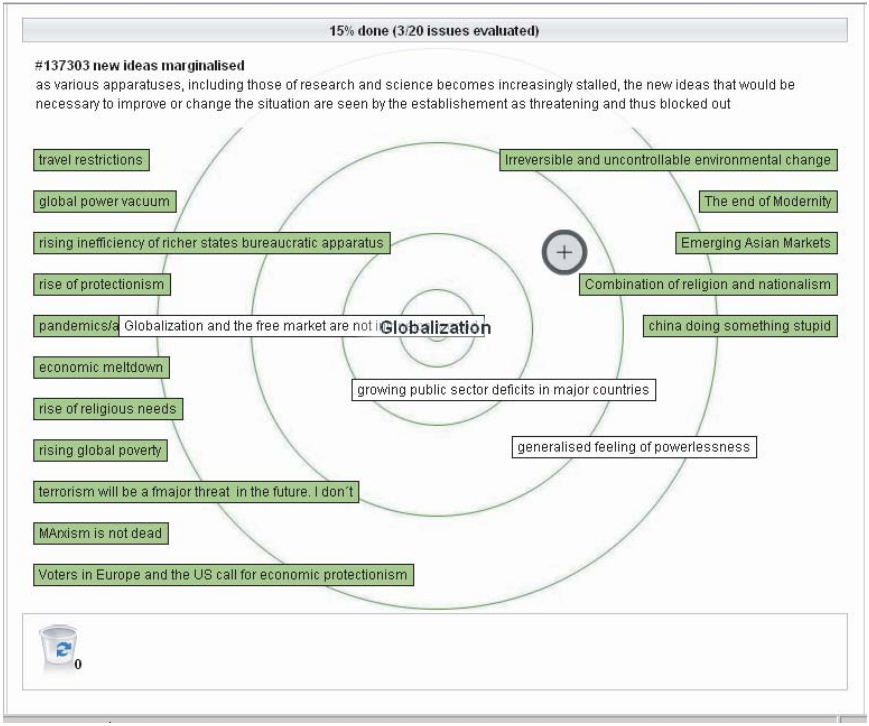

Figure 12: A cognitive map for evaluating the relevance of signals

material.[3] The method used for evaluation is a simple application of a cognitive map, in which the respondent is asked to position the signals close to the centre of the screen if they find the signal highly relevant to the issue under consideration and farther from the centre if the signal is seen as less relevant (see Figure 12). Arguments supporting one's views are not required, thus helping to keep the mental filters open.

[3] The respondent is able to click the comment to open it, and thus is able to read a respondent's comment— both the title and long descriptive narrative. The material is authentic and has not been edited.

ANALYSIS

The analysis has three stages: First, all the signals material produced is analysed and the observation filter of the respondents is defined. In the Globalisation Scan, the tool applied for this purpose was a Self-Organising Map (SOM) that classifies all the material according to a pre-determined conceptual framework. The next step is analysis of an automatically generated matrix report (see Figure 13) that articulates both the dominant perception of respondents on the theme under study and lists potential weak signals. The third step of the analysis—the only stage where human interpretation of the data come into play—produces a set of conclusions for understanding the dynamics of globalisation for the decision-making process.

The upper left-hand quadrant of the matrix lists signals that the majority of the respondents consider to be of high relevance (and deviation among respondents is low). The lower right-hand quadrant lists signals for which the standard deviation is high and an average judgment of relevance is low. This kind of evaluation pattern indicates potential weak signals that have passed the surveillance filter of at least a few respondents.

RESULTS OF THE GLOBALISATION SCAN

The question posed in the globalisation exercise was: What current conditions, trends, or uncertainties could affect the future direction of globalisation? All 353 signals produced were analysed using the SOM methodology. This is a text mining tool that clusters the data according to the frequency of the concepts used in comments. SOM also calculates the relationships and illustrates the role of the most frequent concepts and their relationships in the data. The SOM method can be used also for classification of qualitative data. In this case we applied the PESTE model

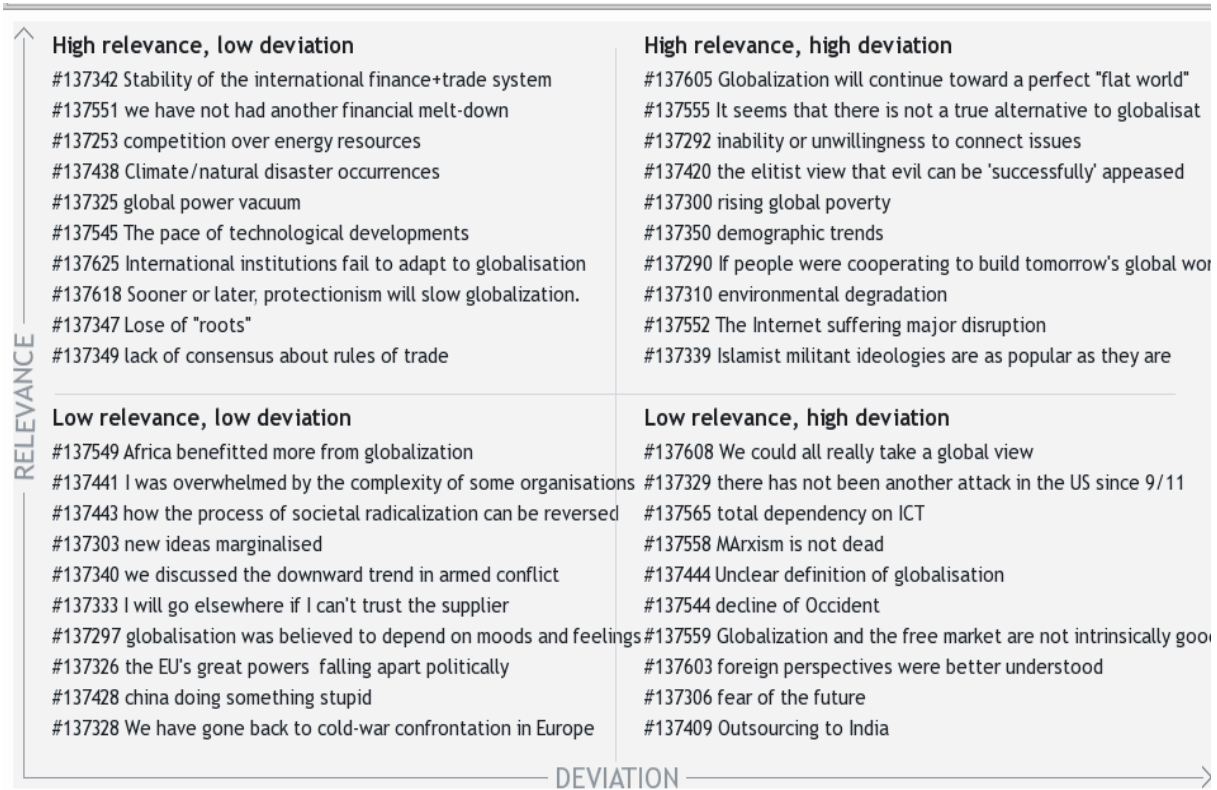

Figure 13: The matrix report presenting both the dominating mental model and potential weak signals

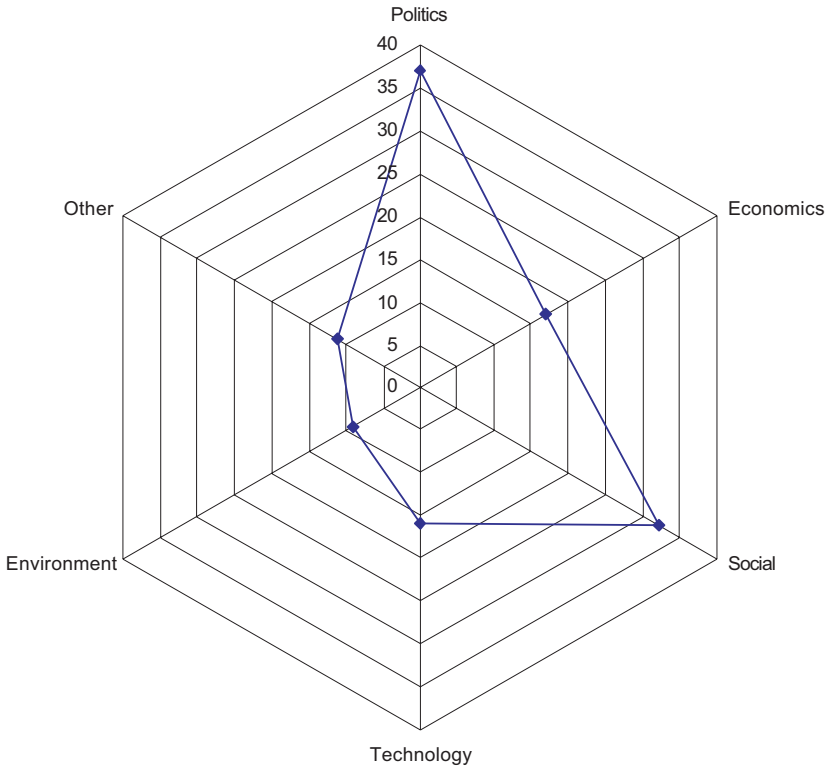

Figure 14: Illustration of observation filter according to the PESTE classification

developed by the Royal Dutch Shell scenarios team.[4] The classification graph (Figure 14) describes the observation filter of respondents, specifically the area they pay attention to when the globalisation theme is considered.

Respondents are clearly focused on both political and social issues. Environmental issues and globalisation were not linked in the data collected. Moreover, the number of technology-related comments is small. Thus globalisation is considered to be a political and a social issue.

[4] PESTE is an acronym for Political, Economic, Social, Technology and Environmental driving forces.

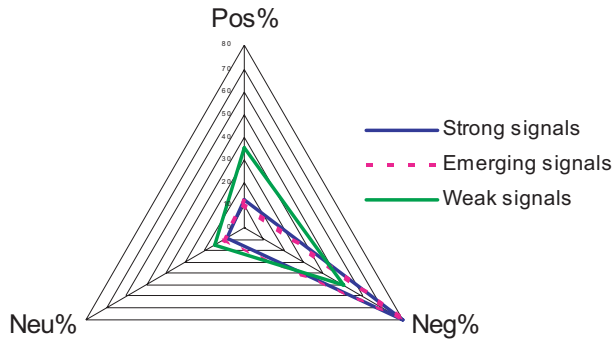

Figure 15: Social moods of assessed data

The SOM method was also used to analyse the peaks of the data—the top 50 signals that were agreed to be very important for globalisation, the top 30 emerging signals (signals that have relatively high relevance but whose deviation is also quite high), and the top 20 weak signals. These data were then arrayed against the social mood (Figure 15).

A positive mood (unifying, liberating, togetherness, supportive, open, happy, hard-working, manic, tolerant) indicates growth, while a negative mood (divisive, restricting, separation, opposing, closed, sad, lazy, depressive, bigoted) indicates contraction of economic activity. If globalisation is driven by the worldwide social mood, this data indicates its impending reversal, perhaps even its collapse.

Dominant Perceptions of Globalisation

The matrix report articulates both the dominant perception and the potential weak signals. According to our experience, it also explicates the structure of the thought patterns of the respondent group. The scatter diagram of all of the assessed data (Figure 16) shows that the number of comments that are in agreement is much larger than the number of deviating comments.

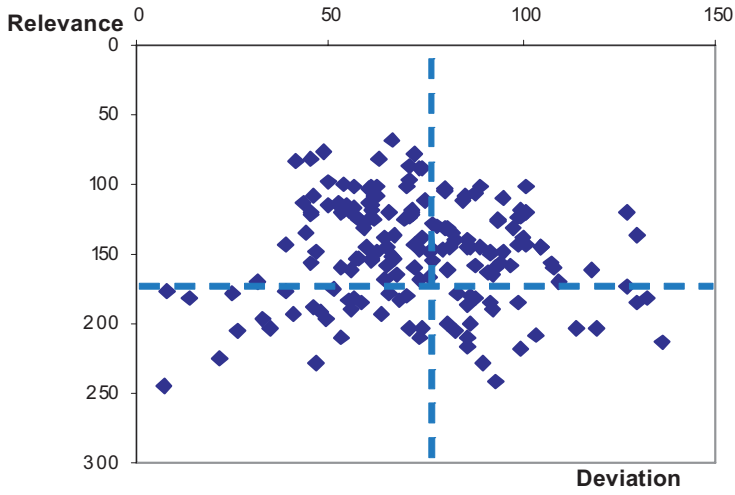

Figure 16: Scatter diagram of all of the signals assessed

The distribution of assessed comments indicates that even if the respondents originate in different countries and their role in foresight and national security organisations varies, their perspective on globalisation is homogenous to a large degree.

As shown in Figure 17, the top 50 strong signals (comments that everybody considered to be the most relevant for globalisation) provide us with quite a pessimistic view of globalisation. The key elements of the dominant perception of respondents indicate that increasing complexity is hurting globalisation because:

- The dependence on volatile financial systems (the Asian financial crisis, the impact of the rise of China) will result in protectionism and the uneven distribution of the benefits of globalisation.
- Governments are inefficient and lack control of their economies.

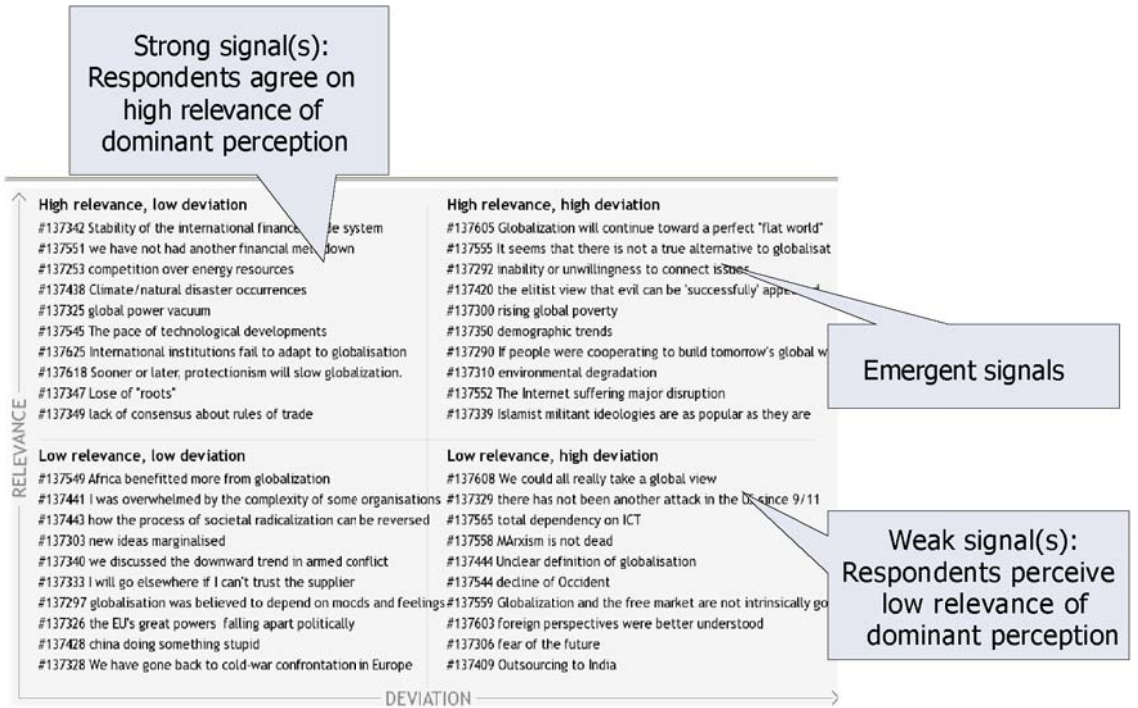

Figure 17: The matrix report and its interpretation key

- Migration is increasing and the loss of roots causes strong erosion of ethics.

The only positive indicator that tends to support globalisation is the rise of Asia, which is seen as a potential new engine driving globalisation forward.

The social mood of strong signals (see Figure 15) was even more negative than that of all the signals taken together. The respondents' role in this process is akin to that of a commentator on a narrative. However, they are powerless and vulnerable, as evident respectively from the absence of solutions presented and the strong threatening tone in their comments. The following comment illustrates this:

> *One mass casualty WMD attack could reverse globalisation. A terrorist WMD attack producing casualties in the hundreds of thousands, which is conceivable today, could set off a vicious cycle of closures and reprisals that in short order could produce a 'dark ages' world of gated communities and chaos.*

Emerging Issues?

In most of the studies, the group of emerging signals introduces new perspectives on the dominant mental model. In this study, the group of signals supported the view of strong signals—this may also be considered a sign of strong "groupthink". The only difference is that social issues have a more important role in this quadrant. Social themes of emerging signals are:

- A flat world, no universal values.
- Perception of complexity, interconnectedness, cooperation.
- Domestic pressures due to negative consequences of globalisation.
- Religion and nationalism.

Some environmental issues were also surfaced:

- Competition over energy and other resources.
- Environmental change, disasters, inability to deal with global warming.
- Globalisation is favourable for the environment, but requires technology.

This data indicates that social and environmental issues may provide globalisation with fast, or at least feasible, changes.

Weak Signals of Change

In most previous studies using the Signals Toolkit methodology, weak signals strongly contradict the dominant perception among respondents as a whole. In the globalisation study, the data is not so divergent, indicating once again a relatively homogenous perception of the globalisation process.

But these signals differ in comparison to the dominant perception in one key respect: they present a positive alternative in terms of the social mood criteria to the negative picture painted by the strong signals. The positive alternative springs from:

- Global view, learning, collaboration.
- No alternative to globalisation.
- We will find a way to pay for social security.
- Morality rules the use of nuclear weapons.
- Education for creative thinking.

- A more diverse global financial system leads to less dependency on one or few actors (or currencies).
- Fast opinion shifts as an opportunity (for instance, global warming).

This emergent brand of globalisation is also driven by alternative philosophies:

- Marxism → hedonism.
- Local philosophies.
- Breaking globalisation → generating something new.

The generic element behind most of the weak signals seems to be diversity, as encapsulated for instance in the comment:

> *There are so many monopolies ... Why do countries strive for dominance (creating monopolies, etc.) when diversity might well better serve us in the future (perhaps creating a more peaceful climate).*

Unlike skyscrapers, which are an inherently local phenomenon physically confined to a particular geographical space, globalisation, which approaches the world as one gigantic marketplace for solving the ills of humankind, is a collective social phenomenon that the foregoing analysis suggests is in the process of coming undone. The socionomics perspective can be employed to shed some light on this phenomenon. Since the driving forces behind globalisation are, to a large degree, American corporations, we can look at the Dow Jones Industrial Average (DJIA) from 1970 to the present as an indicator of the overall mood, since the New York Stock Exchange is still about the closest thing we have to a global financial market. Using this measure of social mood, Figure 18 shows that every single milestone in the path to globalisation from the launching of the basic idea at Davos in 1975

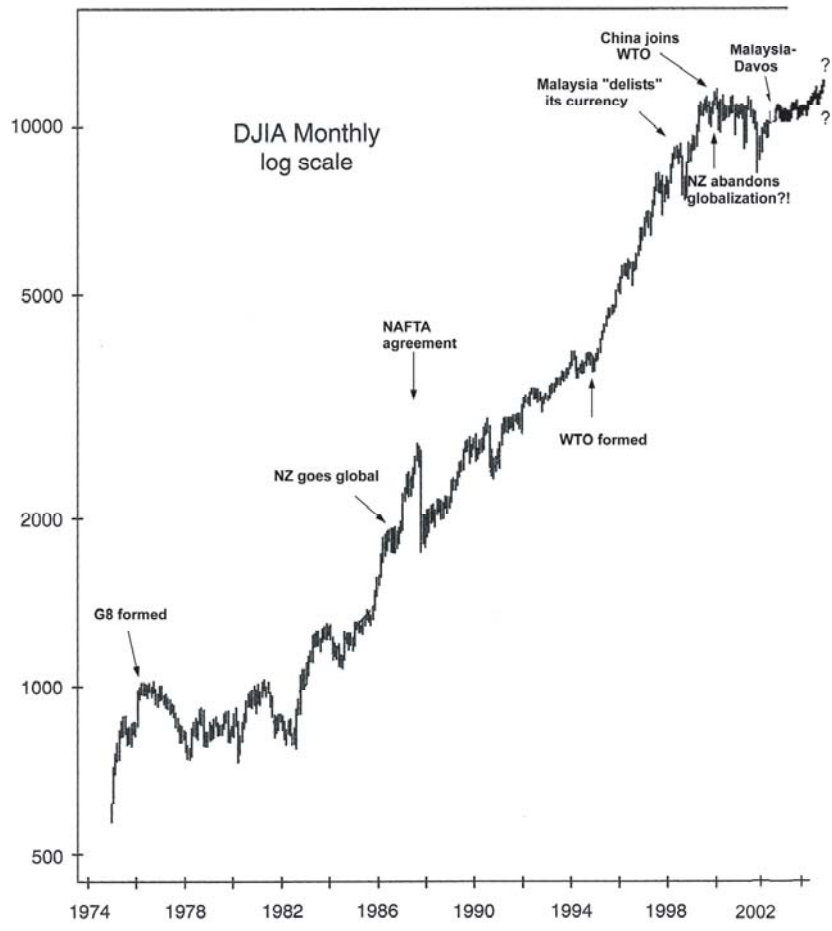

Figure 18: Globalisation milestones plotted against the Dow Jones Industrial Average, 1990–2002

to the formation of the World Trade Organisation (WTO) in 1996 to China's entry into the WTO in 2000 took place during a peak in social mood. We also see the ominous flattening out of this mood indicator beginning in about the year 2000—just when pundits, politicians and other "wise men" began beating the drum the loudest for the global marketplace. The situation today,

eight years later, gives a much softer beat to that drum. In fact, it is a beat that is almost inaudible at the time of writing (spring 2008).

CONCLUSIONS

The goal of this case study was to collect comprehensive data from experts in the Global Futures Forum on the phenomenon of globalisation. A second aim of the study was to test the qualitative approach for collecting data on the overall social mood.

New Layered Structure of Globalisation

This data collected indicates that several different layers to the structure of globalisation, each with different dynamics:

Layer 1: The comprehensive negative mood of the dominant mental model presented by strong signals indicates that the dominant understanding of globalisation may be fading.

Layer 2: The new element the emerging signals bring to the discussion is the potential role of diverse non-governmental organisations in sustaining globalisation despite numerous political and economic challenges.

Layer 3: Weak signals suggest novel combinations of existing and totally new global actors or philosophies that might also sustain globalisation.

Qualitative Scan for Social Mood

This study applied the social mood framework for the interpretation of data. The SOM method used for defining and pre-analysing

social mood categories proved to be an efficient and theoretically consistent method. The grid analysis of the early signs of change identified the existing perception of globalisation (layer 1) and the social mood typical for it while surfacing emergent aspects of globalisation (layers 2 and 3) that suggest a rising social mood.

One important limitation of the study should be noted. Without an opportunity for a qualitative analysis and case-specific pattern recognition of historical data, steps 1–4 of the interpretation process described in the above case study were not tested according to their full scope. Thus, we had to draw on the theory of social mood and an existing example of a sociometer. Globalisation was a good subject for this case since the phenomenon has been so widely studied. Consequently, existing theoretical considerations and sociometers serve as a pattern-recognition framework.

About the Contributors

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The National Security Coordination Centre (NSCC) is a unit of the government of Singapore, assigned the role of national security policy coordination and planning. This includes providing overall coordination and management of the Risk Assessment and Horizon Scanning (RAHS) programme, which has been identified as a key capability for Singapore.

Humera Khan is a co-founder and partner at Abacus Strategy Inc, providing strategy planning for non-profit and corporate clients. As Principal at the Arlington Institute, she managed the Theory and Operations group for the Singapore government Risk Assessment and Horizon Scanning project, designing and integrating methodologies to anticipate scenarios and risk assessment. She was also a major participant in simulation-based scenario planning and strategy formulation for government and Fortune 500 clients. She holds SM degrees in Technology and Policy and Nuclear Engineering, and SB degrees in Architecture and Nuclear Engineering from MIT, and an MA in Islamic Studies from Cordoba University.

Lam Chuan Leong is Senior Fellow at the Centre for Governance and Leadership, Civil Service College and Ambassador-at-Large with the Ministry of Foreign Affairs. He is also the Chairman of the Competition Commission of Singapore. His key areas of interest and expertise are in the application of general management theories, particularly in the context of complex systems. His career background has been in macro-economic management, trade and investment and science and technology policies.

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Tom Ritchey is a former Research Director for the Institution for Technology Foresight and Assessment at the Swedish National Defense Research Agency (FOI) in Stockholm. He is a methodologist and facilitator who works primarily with non-quantified decision support modelling—especially with General Morphological Analysis (MA), Bayesian Networks (BN) and Multi-Criteria Decision support. Since 1995 he has directed more than 80 projects involving computer-aided MA for Swedish government agencies, national and international NGOs and private companies. He is the founder of the Swedish Morphological Society and Director of Ritchey Consulting.

Sirkka Heinonen is Professor of Futures Research at Finland Futures Research Centre (FFRC, Turku School of Economics). Previously she was the Chief Research Scientist at VTT (the

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Cory Costanzo is an Associate Director with Abt Bio-Pharma Solutions, Inc. in Lexington, Massachusetts. He specialises in business consulting and new market and product strategies. He was previously with IBM Business Consulting Services and has years of dedicated experience in helping large institutions to evaluate, frame, and capture new markets in previously untapped areas of business. His clients have included industry leaders in the following areas: financial services, biotech, government (intelligence and defence), public health, agribusiness and information technology (software development and intra-organizational IT). He has an MBA from Northeastern University and a BA from Harvard University.

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Karlheinz Steinmueller is Scientific Director and Founding Partner of Z_punkt GmbH—The Foresight Company. He is responsible for corporate and public Foresight projects. He has been working as a future researcher since the early 1990s, for among others the Sekretariat für Zukunftsforschung (SFZ, Secretariat for Futures studies) in Gelsenkirchen, Germany. He has graduated in physics and has been working as a scientist and a freelance author of science fiction novels.

John L. Petersen is the President and Founder of The Arlington Institute, a think tank specializing in studying significant global trends to develop forward-thinking images of a positive future. He is best known for writing and thinking about high-impact surprises—wild cards—and the process of surprise anticipation. He is the author of *The Road to 2015* and co-author of the acclaimed essay *The Year 2000: Social Chaos or Social Transformation?* His current professional involvements include the development of sophisticated tools for anticipatory analysis and surprise anticipation, long-range strategic planning and helping leadership design new approaches for dealing with the future.

Hoo Tiang Boon is an Associate Research Fellow at the Centre of Excellence for National Security (CENS), S. Rajaratnam School of International Studies, Nanyang Technological University, Singapore. His current research explores topics such as horizon scanning concepts, "faint" signal detection, risk analysis of national security threats, intelligence studies, and transnational terrorism and radicalisation, and he has published frequently in these areas. He has also been invited to speak on a number of these issues at various local and international conferences. As a member of the Singapore RAHS consortium, he contributes actively to the RAHS initiative through his research work in the CENS RAHS programme.

David Snowden is a major figure in the movement towards integration of humanistic approaches to knowledge management and sense-making. He is generally held to be one of the leading practitioners and thinkers in the field of a naturalising (science-based) approach to decision theory and sense-making, and is well known for his work on the role of narrative and complexity theory in sense-making. He is Founder and Chief Scientific Officer of Cognitive Edge, which focuses on the development of the theory and practice of sense-making. The Cynefin framework, which lies at the heart of the approach, has been recognised by several commentators as one of the first practical applications of complexity theory to management science.

Gary Klein is Chief Scientist of Klein Associates, a group he formed in 1978 to better understand how to improve decision-making in individuals and teams. He is one of the founders of the field of Naturalistic Decision-Making. His work on recognitional decision-making has influenced the design of new systems and interfaces, and decision training programs. He has extended his work on decision-making to describe problem detection, option generation, sense-making, planning and replanning. In order to perform research on decision-making in field settings, he and his colleagues have developed new methods of Cognitive Task Analysis.

Chew Lock Pin is Deputy Head Naval Operations (C4IO), Republic of Singapore Navy. He has held appointments as Office Director, Future Systems Directorate (FSD) and Assistant Director, C4I Development, Defence Science and Technology Agency. In those capacities, he was intimately involved in the development of concepts and projects in the areas of Integrated Command and Control and Command Post Experimentation with the Singapore Armed Forces. In FSD, he was the portfolio manager for sense-making and was responsible for driving sense-making concept developments and experimentation. He has a Master of Technology Degree in Knowledge

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Cheryl Ann Teh was an Assistant Director at the Future Systems Directorate, Ministry of Defence, overseeing the sense-making portfolio until July 2008. Her role involved developing concepts and translating them into solutions to improve decision-making in the Singapore Armed Forces (SAF). Prior to this appointment, she spent two years as a consultant at the SAF Centre of Military Experimentation working on new war-fighting paradigms. A Defence Science and Technology Agency scholar, she graduated with a Bachelor of Science (Biological Engineering) as well as a Bachelor of Arts (Psychology) from Cornell University in 2003.

John L. Casti completed a doctorate in Mathematics from the University of Southern California in 1970. After tours of duty at The RAND Corporation and the University of Arizona, he left the USA in 1974 to take up a post as one of the first research staff members of the International Institute for Applied Systems Analysis (IIASA) in Vienna, Austria. With the exception of a break in the late 1970s and early 1980s to serve on the faculties of New York University and Princeton University, Casti worked at IIASA on problems of system modelling and applied systems analysis until the autumn of 1986. At that time he left to join the faculty of the Technical University of Vienna as a Professor in the Institute for Econometrics, Operations Research and System Theory. In 1992, Casti joined the Santa Fe Institute in Santa Fe, New Mexico as a resident researcher and was named to the Institute's faculty in 1993.

Leena Ilmola is one of the founding partners of Fountain Park and a leading innovator in the company. For over 20 years she worked as a management consultant in change management, merger processes and communications. Before joining Fountain

Park, she worked in Booz Allen Hamilton as a Nordic development director of one specific expertise area. She is also a successful entrepreneur; her previous company Promotiva Ltd. was a market leader in its own niche when it was sold to Carta Corporate Advisors in 1997.

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