# Heuristics and Human Decision-Making in Strategic Foresight:

## Behavioural Insights for an Improved Foresight Framework

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# Abstract

Drawing on literature from diverse fields of study on human perceptions of risk and decision-making under uncertainty, this investigation highlights some of the behavioural insights and implications that emerge for strategic foresight and scenario planning. From an extensive review and synthesis of the literature, themes in mental shortcuts, heuristics and biases that influence decision-making and perceptions of probabilities were generated and organized for further exploration through a concept mapping approach. Using narrative, findings were applied to and illuminated through a contemporary case study of proposed nuclear waste storage in an Ontario community. Behavioural insights were applied to two strategic foresight frameworks, and recommended improvements to existing models were presented and discussed.

Key words:

behavioral insight; heuristic; cognitive bias; decision-making; risk; uncertainty; foresight; scenario; nuclear

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# Dedication

For Myra and Merv Lahn - my admiration and appreciation continue to grow

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# Definitions:

**Affect** - a specific quality of *goodness* or *badness* that humans experience with or without consciousness (Slovic, 2007)

**Arational** - meaning not based on or governed by logical reasoning (Oxford Dictionary).

**Bias** - refers here to *cognitive* bias arising from information processing shortcuts. Such biases are patterns of deviation in judgment that occur in particular situations ("Cognitive bias," n.d.), and are distinguished here from *social* bias, or shortcuts people use to quickly make sense of social situations, or to interpret and understand other people and their actions

**Heuristics** - rapid, efficient and experience-based strategies for learning or solving problems. Mental shortcuts for information processing

**Personal Probability** - noted statistician and decision theorist, L. J. Savage suggested people assign probabilities to all events whether the probability is knowable or not

**Probability** - the quality or state of being probable; the extent to which something is likely to happen or be the case (Oxford Dictionary)

**Risk** – a situation involving exposure to hazard, where outcomes can be identified *and* probabilities assigned to various outcomes (Sunstein, 2007)

**Strategic Foresight** – "a systematic approach to gathering intelligence about possible futures and building shared visions, aimed at guiding and enabling present-day decisions" ("2020 Media Futures : Strategic Foresight," n.d.)

**Uncertainty** - where outcomes can be identified but no probabilities can be assigned (Sunstein, 2007)

# Preface

*"Planting Trees in the Desert May Halt Climate Change" Scotland (Boland, 2013)*

*"Can planting trees in the desert help save earth?" – Canada (Aulakh, 2013)*

*"Carbon farming: UAE deserts ideal for saving the earth" – United Arab Emirates (Matthews, 2013)*

*The global response to the research was overwhelmingly positive. Planting drought tolerant Jatropha trees in the empty deserts of Africa and the Middle East had been calculated by a team of scientists to provide a feasible and cost-effective way to mitigate climate change by sequestering climate-warming carbon dioxide from the atmosphere. The study by a team of German agricultural researchers proposed planting the highly drought resilient plantations specifically in coastal deserts so the small amount of irrigation required could be provided by a nearby desalination plant drawing water from the sea, rather than tapping into local water table. Over time, the trimmings from the trees would provide biofuel to power the desalination plants. An elegant solution.*

*The paper, published in July 2013 in Earth Systems Dynamics, the international online journal of the European Geosciences Union, reported the team's findings that a one hectare plantation of Jatropha could capture up to 25 tonnes of atmospheric carbon dioxide each year over a 20 year period (Becker, Wulfmeyer, Gebel, & Munch, 2013). That's roughly equivalent to all the carbon dioxide produced by motor vehicles in Germany absorbed by a forest covering just 3% of the Arabian Desert. It is little wonder, then, that reporters and bloggers from around the world and across traditional divides – from the oil rich Arabian Peninsula to the boreal forests of Canada – lauded the study as good news. There were occasional cautions that Jatropha might not be the best solution, since it is believed by some to be toxic to soils over time. But, as one article points out, "most of the land in such regions is not much good for anything else" (Matthews, 2013), anyway. Others pointed to early trials with Jatropha in India that suggest it might not thrive as easily as hoped, leading others to recommend Eucalyptus as a viable alternative.*

*In addition to carbon sequestration on a grand scale, the forest could also over time generate its own rain in the former desert, making the region more habitable and available for food production.*

*It seemed like a great idea.*

*This is where my major research project began – reading the news over morning coffee, feeling excited the world may have finally caught a break on this whole climate change thing. Trees were going to save us.*

*Except....*

*Except how could a German team plant trees in the Kalahari – who would have a say over such a strategy? And were these deserts actually empty? What about the people and complex ecosystems in the Kalahari and other desert regions – how would their voices be heard? I wondered how much is at stake for the local governments in their negotiations with international oil companies eager to find biofuel alternatives to oil and bitumen reserves. In the grand scheme, thwarting a coming climate crisis might supersede preservation of a few hectares of coastal desert known. But who would get to say?*

*I wondered who would determine this: who would have "some say" by contributing to the debate. And whose voices, both human and non-human, would not be heard in this discussion. I wanted to explore who would be afforded "a say" – a decision-making role – in this scenario. And who would have "the say" – the ultimate decision-making authority in all of this? What frameworks would they use to decide, and how could these possibly generate a fair assessment? Most importantly, how would a public benefit or common good be factored into the discussion and its outcomes?*

# 1. Introduction

This research project began with an exploration of how strategic foresight could improve decision-making for public benefit or a common good specifically within a scope of trans-boundary environmental concerns. The starting aim was to outline criteria for consideration when developing tools for such a lofty goal. But who would use this framework?

What emerged during data gathering was a recognition that communities (both geographic communities and communities of common interest or identity) frequently mobilize themselves or self organize (Meyer & Minkoff, 2004; Meyer, 2004; Shirky, 2008) in reaction to media stories and political and public policy decisions. Unsurprisingly, people react most to things that upset them. Everyday, people see news stories or hear ideas that shape their opinions, evoke reactions or trigger action.

Campaigns led by community members are often successful in influencing public policy (Slovic, 1997). But if many of such actions are triggered by information that is upsetting, are the decisions in which these campaigns are grounded the right decisions? Are they rational decisions - rational here meaning that they serve, and don't undermine, the long-term interests of the decision makers. Most importantly, in complex domains with high uncertainty, how can activists know their positions are the ones that will accomplish their deep or long-term objectives without causing worse or unintended consequences?

Environmental concerns pose extraordinary challenges, many of which are intractable problems of high complexity, multiple and competing stakeholder needs, long time delays, great geographic distances and disconnects between causes and outcomes. These factors confound human intuition and perceptions of cause, effect, control and responsibility. Such complex challenges have so far proved resistant to contemporary problem solving tools and approaches.

Complexity, uncertainty and risk perception make it challenging to evaluate options. Competing stakeholder needs and interests – often separated by political and geographic boundaries – complicate decision-making for policy makers and regulators accustomed to implementing optimization strategies. Simultaneously, competing maximization strategies of various stakeholders with differing levels of power, influence and authority exacerbate the challenges leading to what seems to play out as a tragedy of the commons. Massive natural systems are at work and we have incomplete understanding of their complex dynamics. This is a domain where a successful intervention can bring devastating unintended consequences: doing the wrong thing right (think cane toads in Australia) can be worse than doing nothing, or than doing the right thing poorly. Where environmental challenges are concerned, the harms may also be irreversible.

Foresight approaches, including the use of scenarios in a larger strategic foresight context, are proposed to support and improve decision-making under such complexity and uncertainty. Insofar as scenarios support people to think about multiple variables and elements simultaneously and within complex structures, they are tools well-suited to

thinking about complex problems (Kahn, 1962; Kees van der Heijden, 1996). Intuitively, this makes them ideal for supporting communities and the decision makers they influence to make more informed – and presumably better – decisions that consider both immediate and long-term objectives and outcomes for multiple stakeholders.

Strategic foresight typically involves input and feedback from multiple layers of participants contributing both individually and in small or larger groups. The level of engagement, and the balance of internal to external stakeholders vary by project, but in most cases a strategic foresight project will include some or all of the following at different stages:

- Individuals, including clients or commissioning agents, facilitators, researchers, contributors (authors, graphic designers), content and process experts, interviewees, interviewers
- Small groups, including a core team directing the project, senior managers, collaborators, key stakeholders, content experts, break-out sessions from larger groups
- Large groups of stakeholders, experts, "user" groups, members of the general public

The levels of participation are not mutually exclusive in that some individuals may participate through multiple roles, including as members of small or large groups, at various points in the process. The dynamics of people once they form groups has been well covered in foresight and scenario planning literature. What seems to be missing from the

literature, however, is a closer look at the individuals throughout the foresight process, both when they engage as individuals, and when they contribute through groups.

For example, what are the decision-making patterns and cultural and personal experiences individuals bring with them to this process? Apart from literature focusing specifically on facilitators, there is a dearth of information or insight available. The specific focus for this project are those decision-making elements – the emotional and mental "baggage" – formed long before people engage in a foresight project individually or in groups to contribute or sort information, to brainstorm, or represent their expertise, demographic or community of interest in an interview or consultation.

## 1.1 Problem Statement

Several fields of study tell us human decision-making is not always rational, logical or analytical. It is fraught with quirks. The mental shortcuts, considerations, justifications and intuitions we rely on when making choices carry systematic errors that can contribute to decisions that are not always in our best interests – especially over the long term and when we make decisions in situations of high uncertainty or real or perceived risks.

An understanding of individual decision-making, then, including perceptions of risk and probability that are fundamental to many decisions, can provide insights for positioning strategic foresight as a thinking approach in grappling with complex challenges that necessarily involve uncertainty because of the length of the time horizons and/or pace of

change in the domain being explored.

Strategic foresight holds promise by offering support for expansive thinking and creative problem solving. What is yet unclear is if these tools can be optimized for the normal and somewhat predictable foibles of individual human decision-making that may limit such expansion.

This project, then, aims to contribute toward (re)designing a strategic foresight approach that considers and accounts for heuristics in individual decision-making. It asks the question: How might strategic foresight approaches be improved by accounting for or even embracing the predictably "irrational" (or arational) strategies of human decision-making?

## 1.2 Approach

This inquiry will draw from literature on cognitive, social and clinical psychology as well as behavioural economics, negotiations theory, decision theory and standard economics. It is an exploration through multiple lenses of the complexities of human individual decision-making and judgments of risk, uncertainty and probability. The aim is to introduce an integrated, transdisciplinary investigation of a complex issue: human individual decision-making in strategic foresight.

Throughout the paper, environmental challenges are used as a lens to explore the interplay of these domains since these pose complex challenges that frequently confound human

decision-making and problem-solving skills and abilities.

This project will:

1) Look at a variety of insights into human individual decision-making, and
2) Attempt to map and make sense of some of the themes among them before
3) Exploring these in relation to time-tested foresight frameworks, and
4) Highlighting some of the implications that may emerge for strategic foresight practitioners.

For the sake of providing a starting place for subsequent discussions, the project will attempt to draw from these insights recommendations that contribute toward improved processes for integrating the domains of human decision-making into effective foresight practice.

# 2. Research Questions

This project aims to explore the following:

1) What informs and influences individual human decision-making in situations of uncertainty and risk?
2) How do these decision-making frameworks interact with strategic foresight approaches to problem solving?
3) How might foresight approaches be improved by incorporating these insights into individual human decision-making?

These insights will be applied to a set of recommendations for improving a standard strategic foresight framework.

# 3. Methods

Primary and secondary research was used in this inquiry to respond to the research questions. The paper draws on literature from cognitive, social and clinical psychology, behavioural economics, negotiations theory, decision theory and standard economics to generate a framework for reconsidering the interplay of individual decision-making and scenario planning.

Three methods of data collection, analysis and synthesis were applied:

## 3.1 Resource Review

Academic and mainstream literature resources, as well as well-known web resources, were searched and reviewed for the domains of inquiry central to this inquiry, including individual decision-making, heuristics and cognitive biases, scenario planning, and judgment in environmental concerns. Bibliographies from key resources related to and surfaced through the search were also searched.

## 3.2 Concept Mapping

Concept mapping as a tool is well-suited to retaining the complexity of an inquiry space while converging on priority areas (Carleton, Cockayne, & Tahvanainen, 2013; Cockayne, n.d.). It is a graphical mixed-methods approach that supports visual organizing of ideas and relationships among them (Ader & Mellenbergh, 1999). Concepts that emerged from the

review and synthesis were organized as notions and relations by the investigator within the context frame, and mapped to identify priority areas from the broad inquiry to be brought forward for further assessment. The coding system used supported a hierarchical synthesis, beginning with the diverse concepts in individual decision making from the initial review and organizing them in a cascade of increasing generalization. Elements of high specificity or with multiple contributing factors were coded as lower order, while those recognized as causing or contributing to the lower order effects were coded as more general, cardinal or higher order concepts. The highest order concepts were selected as the priority ones for further processing.

A second similar system of coding and organizing was applied to the priority concepts to rate the discernibility of the reference point for the cognitive biases, and the predictability of the direction in which they shift perceptions. Predictability here refers to the potential for practitioners to accurately anticipate the direction of the bias in a strategic foresight setting. An additional coding exercise rated the stickiness or tenacity of the bias effect – specifically, its susceptibility to influence by a practitioner in a strategic planning setting.

## 3.3 Narrative

Kees van der Heijden (1996) outlines the importance of scenarios as a cognitive, perceptive and reflective tool for presenting multiple pieces of information simultaneously within a structure and context, calling attention to elements and relationships that might be overlooked, and thinking through concepts creatively. In *Scenarios: The Art of the Strategic*

*Conversation*, he highlights the essential role of a storyline "in which events unfold over time through a progression of cause and effect" (Kees van der Heijden, 1996, p. 133) for organizing complex information in efficient and memorable ways. One of the fathers of scenario planning, Herman Kahn (1962), encouraged role-playing in combination with scenarios to further aid in imagining the information.

This project incorporates a narrative storyline as a tool for supporting readers to organize, reflect on, imagine, retain and share the information presented in the paper. The narrative uses nuclear energy as a lens to explore the interplay of these domains, Perceptions of nuclear power appeared continuously in the literature on both scenario planning and cognitive bias over the 60 year scope of the research review (Deutch & Moniz, 2003; Fischhoff, Slovic, & Lichtenstein, 1979; Kajenthira, Holmes, & McDonnell, 2012; Slovic, Layman, & Flynn, 1991; Weinberg, 1977).

## *Narrative 1 - Introduction to the Deep Geologic Repository (DGR)*

*On the eastern shore of Lake Huron, Kincardine, Ontario is currently undergoing a decision-making process and public review where decisions made in the present could have an impact on an irreversible scale. The proposed Deep Geologic Repository Project for Low and Intermediate Level Radioactive Waste (DGR) would store waste from the Bruce Nuclear Plant 1.2 kilometres from the Lake Huron shore in rock authorities insist is highly stable. Under this plan, the radioactive waste – considered dangerous for 100,000 years – would be buried in planned perpetuity on the shoreline of one the world's largest freshwater lakes. The Great Lakes system supplies drinking water for 40 million people, and irrigation and industry to tens of millions more downstream. The facility would be actively monitored for 10 years, then sealed and considered a success. The community is divided on the proposed plan – the municipality has approved it, while some community members have started a campaign to "Stop the Great Lakes Nuclear Dump" next to Lake Huron.*

*Is this plan a good idea?*

# 4. Individual Decision-Making in Uncertainty

Decision-making theory is a domain of inquiry unto itself with a focus primarily on normative models for making good, statistically informed decisions. Standard economics modeling of decision-making has spawned investigation from psychological perspectives into what *really* happens when humans face uncertainty. The Nobel-winning Prospect Theory launched research into this question which has become the domain of cognitive psychology and the contemporary behavioural economics field (Kahneman & Tversky, 1979; Tversky & Kahneman, 1974).

With the aim of answering the larger question of how foresight approaches might be improved by incorporating insights into individual human decision-making, this study explores first what informs and influences individual human decision-making in complex situations that are the domain of strategic foresight. This investigation will focus primarily on the heuristics and cognitive biases that shape individual human perceptions, judgments and decision-making in uncertainty.

## 4.1 Individual Human Decision-making

An assumption common to most theories of decision-making is that good decisions require reflection, objectivity, and careful consideration of options with an understanding of potential outcomes. In reality, decision makers are humans, so decision-making processes are imbued with and fettered to all the foibles and evolutionary legacies of human

psychology, including how people form mental maps, perceive risk, and rely on mental shortcuts to assess probabilities, judge risks, and make choices.

## 4.2 Two Systems of Thinking

A prevailing theme in research into human decision-making hinges on a two-system understanding of thinking (Epstein, 1994; Kahneman, 2011; Sunstein, 2007) that outlines both an automatic, instinctive, experience-informed system, and an analytic, reflective system more typically associated with *thinking*. Such analytic processing is slow thinking that requires effort, conscious application of rules, probabilities, and calculations (Kahneman, 2011). Experience-based decision-making, by contrast, is fast and automatic, relating to new situations through images, emotions and memories (our own or vicarious experiences). Research by psychologist Paul Slovic and colleagues over many years emphasizes that *affect* – a sense that something is positive or negative – plays a fundamental role in experiential decision-making and its adaptive ability to process and provide actionable information instantaneously (Fischhoff et al., 1979; Slovic, Finucane, Peters, & MacGregor, 2004; Slovic, 1997).

These two widely recognized systems are not mutually exclusive, instead operating simultaneously and with mutual reliance. Contemporary wisdom and research suggests good decision-making relies on integration of the two systems to guide and temper each other (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic et al., 2004).

## 4.3 Normative Models

**When the facts change, I change my mind. What do you do, sir?**

John Maynard Keynes

Normative models of decision-making outline how decisions would be made if "homo economicus" were weighing choices: they are models of how humans *should* make decisions. Such models, including Expected Utility Theory from standard economics, outline how a purely rational decision maker should behave in a set of circumstances to produce good decisions. These analytic models hinge on justification of decisions through logic, evidence, and analysis, and propose a state where "behavior is mediated by conscious appraisal of events" (Slovic et al., 2004).

### 4.3.1 Analytic Decision-making

Normative models of decision-making correspond with what has been termed the *rational system* of thinking (Epstein, 1994; Finucane et al., 2000; Gilovich & Griffin, 2002; Kahneman, 2011), and is perhaps more accurately and neutrally referred to as the reflective or analytic system (Finucane et al., 2000; Kahneman, 2011; Slovic et al., 2004).

In a rational, analytic decision making process, normative models assume each decision involves:

1) A set of possible actions
2) A set of possible future states of the world

3) Information on the probability of different future states of the world, and
4) Information about the outcomes of possible action under future states of the world.

- (Marx & Weber, 2012, p. 103)

An accurate and informed judgment of possibility and probability, then, is fundamental to rational decision-making. If these elements are flawed, the decisions that ensue will have those flaws embedded in them.

## *Narrative 2 - Analytic Judgment and Decision-Making*

*Statistics and information on nuclear power in Ontario*

*Timeline: nuclear power produced in Ontario for approximately 40 years*

*Nuclear reactors in Ontario: 20*

*Energy produced: approximately 50% of Ontario's electricity*

*Greenhouse gas emissions from nuclear reactors during operation: none*

*Bruce Nuclear Generating Station*

*Where: Township of Kincardine (Inverhuron and Tiverton), in Bruce County, Ontario*

*Size: largest nuclear power plant in the world, by number of operational reactors*

*Reactors: 8 CANDU reactors*

*Constructed: 1970-1987*

*Operated by: Bruce Power (private), by long-term lease with Ontario Power Generation (OPG) (crown)*

*Employees at power station: approximately 3,800 – largest employer in Bruce Country*

*Population of township: 11,200*

*Current monitoring and security at Bruce plant*

*Regular monitoring for radiation in:*

- *milk samples from local farms (weekly)*
- *drinking water at local treatment plants (sampled twice daily, and tested weekly)*
- *ground water at several surface, shallow and deep well locations*
- *additional analysis of aquatic sediment, fish, livestock feed, honey, eggs, fruits, vegetables*

*Security force: Bruce Nuclear Response Team is equivalent in size to security (SWAT) force in cities of 100,000 people*

*In the event of an emergency: the Municipality of Kincardine will coordinate response*

*Storage of waste materials*

*Current storage of spent fuel rods from Bruce plant: in pools at the Bruce site*

*Current storage of intermediate-level radioactive material for all 20 of Ontario's reactors: in concrete and steel vaults below the ground surface at the Western Waste Management Facility on the Bruce site*

*Current storage of low-level radioactive materials for all 20 of Ontario's reactors: in 11 buildings at the Western Waste Management Facility on the Bruce site*

*Proposed Deep Geologic Repository*

*Purpose: long-term storage for waste from nuclear power generation*

*Location: 680 metres beneath current Bruce plant site*

*Type of material to be stored: low- to intermediate-level radioactive waste*

*Amount: 200,000 cubic metres, plus proposed expansion for additional 135,000 cubic metres*

*Period for which material will remain radioactive: 100,000 years*

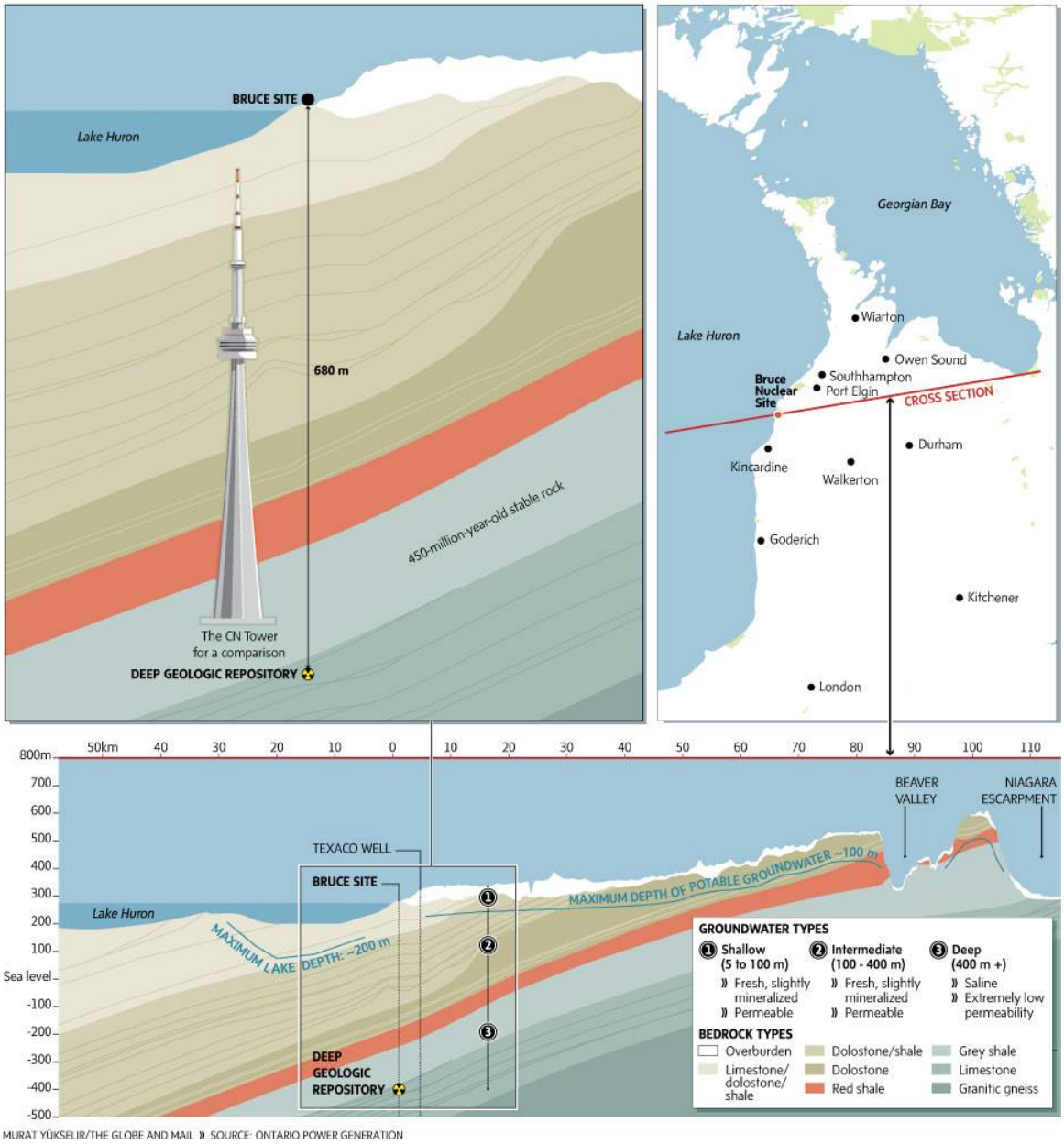
*Age of rock formation: 450 million years*

*Proposed timeline of monitoring plan: 300 years*

*Question: Is the DGR an optimal solution to nuclear waste storage?*

*Figure 1 - Deep Geologic Repository*

*From http://www.theglobeandmail.com/news/national/infographic-ontarios-1-billion-plan-to-bury-its-nuclear-waste/article14297942/*




MURAT YÜKSELIR/THE GLOBE AND MAIL » SOURCE: ONTARIO POWER GENERATION

## 4.4 Descriptive Models

Theories that attempt to model how people make decisions in real world situations are descriptive models, and include Kahneman and Tversky's Prospect Theory (Kahneman & Tversky, 1979), the Theory of Context-Dependent Choice (Krantz & Kunreuther, 2007), and the field of behavioural economics more broadly. These correspond with automatic, experiential thinking, which is sometimes referred to as *irrational* thinking and may also be called *arational*, or not explained by reason.

### 4.4.1 Experiential Decision-making

This is the faster system that uses images, metaphors and associations for information processing. In a two-system theory of thinking, the experiential system supports immediate action through affective processing of information that lets humans anticipate future outcomes of potential actions in immediately recognizable codes of *good* or *bad*, or *pleasure*-causing or *pain*-causing, rather than processing stimuli analytically (Epstein, 1994; Finucane et al., 2000; Gilovich & Griffin, 2002; Kahneman, 2011).

In circumstances where outputs of the two systems are in conflict, behaviour is often determined by the experiential affective processing system because it is vivid and operates instantaneously, delivering output earlier than the reflective system (Marx & Weber, 2012, p. 103). This is particularly salient in situations that involve complexity or uncertainty.

## 4.5 Uncertainty, Probability and Risk Perception

Contemporary evidence-based notions of risk hold that risk is an objective, measurable reality (Kajenthira et al., 2012). While acknowledging that dangers are real and present in the world, many scholars regard risk as a social and cultural construct as much as an external reality (Bradbury, 1989; Loewenstein, Weber, Hsee, & Welch, 2001; Slovic et al., 2004; Slovic, 1997; Weber, 2006). To illustrate this point, Slovic (1997, p. 280) highlights that scientific or evidence-based assessments of risk are grounded in theoretical frameworks and models. The structure of such models is subjective, and the content hinges on assumptions and judgments. As such, he and colleagues have suggested, scientific models of risk are still *models* of risk perception similar in concept to those formed by non-scientists or non-economists.

For the purposes of this paper, risk here is defined as situations where outcomes can be identified *and* probabilities assigned to various outcomes (Sunstein, 2007).[1] In statistical models, probabilities can be assigned to most things, leaving very few true *uncertainties* (Sunstein, 2007). Similarly, individuals tend to assign a "personal probability" to outcomes, leaving few things truly uncertain from an individual or lay perspective, as well (Savage, 1954).

[1] Risk is distinguished here from uncertainty, which occurs when outcomes can be identified but no probabilities assigned to those outcomes (Sunstein, 2007)

### 4.5.1 Risk Perception Varies Between Experts and Laypeople

> **Although the controversy about location of the high-level nuclear waste repository generates powerful emotions, large numbers of people seem amazingly unconcerned about the fact that high-level nuclear waste is currently being stored at nuclear reactors that are in close proximity to major population centers. Referring to the current controversy about the (U.S.) Department of Energy's nuclear waste disposal plans for Yucca Mountain (Nevada), Slovic, Flynn, and Layman (1991) described officials from the Department of Energy, the nuclear industry, and their technical experts as "profoundly puzzled, frustrated, and disturbed by public opposition that many of them consider to be based on irrationality and ignorance".**
>
> - (Loewenstein et al., 2001, p. 1603)

Perceived risk involves social and cultural construction as well as predictable psychological effects. As mentioned above, risk is qualitatively perceived, but may also be quantitatively derived with existing statistical models (Kajenthira et al., 2012). This phenomenon means risk is frequently perceived differently by "experts" and laypeople, or non-experts in a given domain. Slovic (1997) highlights earlier literature that extends this argument by suggesting lay perceptions and expert perceptions of risk are commonly dichotomous. He observed that "experts are seen as purveying risk assessments, characterized as objective, analytic, wise, and rational – based upon the *real risks.* In contrast, the public is seen to rely upon *perceptions of risk* that are subjective, often hypothetical, emotional, foolish, and irrational" (Slovic, 1997, p. 179).

An investigation of risk perception in various stakeholder communities (scientists, local villagers, and plant workers) regarding risks from a chemical plant in Kazakhstan known as a site of regional mercury contamination (Kajenthira et al., 2012) confirmed that the qualitative risk perceptions of laypeople are likely to vary from quantitatively established risks even in a context of knowledge translation, transparency and communication of risks.

One key distinction is the technical assessments of risk that "experts" employ, including those using cost-benefit analysis tools, tend to limit impacts from risk events to *direct* impacts like mortality and morbidity, while laypeople also include in their mental risk models of risk a sense of equity over time (to future generations) and in space (NIMBYism)[2] or across demographics (Kasperson et al., 1988). Additionally, Kasperson and colleagues highlight that the *secondary* repercussions of risk events, and those that are socially amplified, are often neglected in traditional cost-benefit models, but are considered in assessments by laypeople. Experts focus on individual risk elements while non-experts consider the *burden* of risk.[3]

While experts frequently assess risks and probabilities with analytic tools that overcome strictly experiential assessment, extensive research suggests experts are not immune to the impact of heuristics on their perceptions of risk (see Example 1, below).

### 4.5.2 Social Amplification of Risk

Perceptions of risk can also be socially amplified or attenuated as information about risk events is communicated, received, reproduced and spread through social and cultural structures and channels (Kasperson et al., 1988). Social amplification of risk occurs when communicating and meaning-making trigger self-reinforcing loops and thereby generate an over-estimation of risk probability or impact. The inverse is also possible, resulting in underestimation of risk or impact when social mechanisms limit recognition of a risk and

[2] Not In My Back Yard, wherein people reject changes in their neighbourhood or community
[3] See Appendix B for Burden of Risk

its repercussions. Attenuation of risk is recognized as an adaptive mechanism for humans, helping to tune out the constant risks of navigating daily life, but as Kasperson et al (1988) point out, downplaying risks doesn't offer protection from their adverse effects or the consequences of being ill-prepared for such risk events.

**Example 1. Expert Judgment Impacted by Heuristics**

Slovic and colleagues (2004) asked forensic psychologists and psychiatrists to judge the likelihood that a patient would engage in violent behaviour after being discharged from hospital. When presented with a risk that was framed as a *relative frequency*, such as "of every 100 patients similar to Mr. Jones, 10 are estimated to commit an act of violence to others", clinicians judged the patient to be more dangerous than those who were told the equivalent risk, framed as *probability*, that "Patients similar to Mr. Jones are estimated to have a 10% chance of committing an act of violence to others."

From their research:

"Follow-up studies showed that representations of risk in the form of individual probabilities of 10%…led to relatively benign images of one person, unlikely to harm anyone, whereas the "equivalent" frequentistic representations created frightening images of violent patients (e.g. "Some guy going crazy and killing someone")."

(Slovic et al., 2004, pp. 316–7).

Scenarios and narratives that are vivid increase the likelihood of producing such affect-laden judgments (Hendrickx, Vlek, & Oppewal, 1989; Slovic et al., 2004; Vlek & Keren, 1992).

## *Narrative 3 - Experts and laypeople vary in perceptions of risk*

*Public perceptions of risk have been found to determine the priorities and legislative agendas of regulatory bodies such as the Environmental Protection Agency (US), much to the distress of agency technical experts who argue that other hazards deserve higher priority.*
*- (Slovic, 1997, p. 278)*

***Would you bury poison next to your well?***
*- Stop the Great Lakes Nuclear Dump*

*In the years following the Three Mile Island nuclear accident in 1979, nuclear power plants around the world were subjected to increased safety checks that required them to be shut down and restarted more frequently; however, it is these start-up and shut down phases that pose the greatest risks (Kasperson et al., 1988).*

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*Public perceptions of probability and risk include elements that fall outside the standard frameworks of expert analysts. While technical risk assessments include probabilities of individual factors, lay judgments also tend to include the burden of risk (the combination of multiple risk factors in a domain), trust in those providing information, fairness, concern for multiple generations, and a sense of common or community good. The following passage is drawn directly from community-produced resources[4], employing language that frames the Kincardine Deep Geologic Repository situation from the Stop the Great Lakes Nuclear Dump perspective, and illustrating elements of risk considered within this framework.*

*"Reasons To Be Concerned*

1. *Radioactive Waste Beside Lake Huron?*

   *Any risk of radioactive nuclear waste contaminating the Great Lakes is too great a risk to take and need not be taken. Ontario Power Generation, the applicant, states this underground dump "is not likely to result in any significant residual adverse effects to human health or the environment, including Lake Huron and the Great Lakes." Is "not likely" good enough? Any risk of buried nuclear waste entering the largest body of fresh water in the world is too great a risk to take, and need not be taken.*

[4] http://www.stopthegreatlakesnucleardump.com/

2. *Buried Radioactive Waste is Forever Toxic*

   *Some intermediate level radioactive nuclear waste remains toxic for 100,000 years.*

3. *This Rock is Right?*

   *No scientist or geologist can provide us with a 100,000-year guarantee. An underground nuclear waste dump in limestone is unproven and unprecedented.*

4. *OPG Faith In Computer Modelling*

   *Computer models cannot predict what will happen in 100,000 years; the models cannot be validated or verified.*

5. *International Impacts Ignored*

   *Burying radioactive nuclear waste beside the Great Lakes could impact 40 million people.*

6. *Highly Controversial Dump Site Selection*

   *There was no process to look at any other locations for the low and intermediate level Nuclear Waste Dump in Canada. Ontario Power Generation did not consider ANY other sites for this nuclear waste dump except right beside the Great Lakes. Is this responsible?*

7. *2nd Dump Planned*

   *The Kincardine Nuclear Waste Dump will pave the way for a high level Nuclear Waste Dump to store highly toxic radioactive spent nuclear fuel.*

8. *OPG claims it has done its homework, yet the Joint Review Panel's own consultant, Dr. Duinker, concluded that OPG's analysis was "not credible, not defensible, not clear, not reliable, inappropriate.""*

*Consistent with research by Lowenstein (2001) and Slovic (1997), the framing of risks, uncertainties and probabilities from this perspective considers:*

- *The risk of a worst-case scenario is human-made, making it an unnecessary risk*
- *Risks over long time horizons and for multiple generations*
- *Likelihood of substantial - not just incremental - changes over long time horizons*
- *Unknown unknowns - risks that can't be predicted with current tools*
- *Fairness related to: geo-political disparities; local burden of risk; human-made (unnecessary)*
- *Credibility and trustworthiness of the source*

*Figure 2 - Site of Great Lakes Nuclear Dump*
*Image from stopthegreatlakesnucleardump.com*


*The visual representation of the situation from the Stop the Great Lakes Nuclear Dump communication materials suggests an ecosystem or watershed approach to considering risks, with complex dynamics and networked effects across geographic breadth embedded in the choice of image. Contrast this with the highly localized vertical slice visualization of risks presented by the Ontario Power Generation in Figure 1 (p.18).*

# 5. Foresight in Complex Decision-Making

Strategic foresight is defined for the purposes of this paper as:

> **A systematic approach to gathering intelligence about possible futures and building shared visions, aimed at guiding and enabling present-day decisions**
>
> - from 2020 Media Futures[5]

Foresight approaches are used to support consideration of a multitude of future possibilities rather than to accurately predict or project a single future outcome. Accordingly, the approach varies with the express goals of a foresight project (Bishop, Hines, & Collins, 2007; Höjer, Ahlroth, Dreborg, & Ekvall, 2008; Kees van der Heijden, 1996). To clarify and improve alignment between the objectives of a project and the approach employed, Borjeson et al (2006) proposed a typology of three categories of scenarios: predictive, exploratory and normative as follows:

- **Predictive scenarios**, including forecasts and "what if" scenarios, ask what *will* happen. They focus on imagining what *will* happen *if…*?
- **Exploratory scenarios** aim to explore what *can* or *might* happen, usually along longer timelines and with substantial (not incremental) shifts taken into consideration. These types are used primarily to *prepare* for various futures, or *assess* consequences of various strategic choices

[5] The multi-industry foresight project, 2020 Media Futures, led by sLab at OCADU ("2020 Media Futures : Strategic Foresight," n.d.)

- **Normative scenarios** aim to *preserve* through adaptation, or *transform* toward a desired future. In either case, a target is identified, with scenarios informing strategies to achieve a desired state.

More generally, strategic foresight does not aim to outline or predict what has been termed the *official future*, or what the future might look like if a straight line were drawn from present trends out to a point 20 years from now, for example. Instead, a foresight approach can be expected to help unearth, imagine, describe, think about, discuss, share and plan for the interplay of what we *think* we know about the future, and that which is yet *uncertain*. What underpins this is an assumption that, absent frameworks to think creatively about the future and what it might hold, exposure to unimagined risks and surprises increases.

**Scenarios are designed to stretch our thinking about the opportunities and threats that the future might hold, and to weigh those opportunities and threats carefully when making both short-term and long-term strategic decisions**

- (Scearce & Fulton, 2004)

Strategic foresight encourages user involvement in shaping solutions to complex problems, provides shared vocabulary among stakeholders, supports robust consideration of alternatives, and shifts frames of reference to longer time horizons than standard strategic planning. Using scenarios in this context as thinking tools supports consideration of multiple factors simultaneously (Kahn, 1962; Kees van der Heijden, 1996). Advantages of using foresight in complex challenges include:

1) Increased understanding of key uncertainties

2) Incorporation of alternative perspectives into planning, and

3) Greater resilience of decisions to surprise.

- from (Peterson, Cumming, & Carpenter, 2003)

In many highly complex problem situations, standard tools used for optimal decision-making[6] lose their value because high uncertainty associated with the problems makes comparing and evaluating alternatives ineffective (Ludwig, 2002). When uncertainty is high, and level of control over variables is low, strategic foresight provides a framework for anticipating and adapting to coming changes.

## 5.1 Foresight Process: Six-Step Framework

Strategic foresight projects may include quantitative research, and almost always involve substantial qualitative data gathering and processing. Qualitative methods may include secondary research, interviews, surveys, and small or large group workshop-style steps such as brainstorming, sorting, ranking, and variations of other group input and feedback tools. Subject matter- or process-specific experts may be engaged in foresight projects on an individual level, through a Delphi[7] process or as participants in groups. A project may also

[6] An optimal decision is one such that no other available decision options lead to a better outcome. In order to compare different decision outcomes, relative utility is assigned to each of them. If there is uncertainty in what the outcome will be, the *optimal* decision maximizes the expected utility (utility averaged over all possible outcomes of a decision). From Wikipedia (http://en.wikipedia.org/wiki/Optimal_decision)

[7] Delphi here refers to a structured, interactive hybrid qualitative/quantitative research method that relies on a panel of experts responding to focus questions in repeated rounds

involve broader groups of stakeholders participating on various levels to generate, test and/or analyze and use scenarios.

The process and approach vary depending on project goals but at a basic level a foresight process that uses scenarios involves roughly six steps that are iterative and interactive. While Peter Bishop and colleagues presented a thorough overview of various ways scenarios are developed, describing two dozen distinct techniques (Bishop et al., 2007), for the purposes of exploring ideas and supporting future discussion, this paper takes as a reference point what Bishop and colleagues suggested is the most common approach, with foundations in the scenario planning processes for business stemming from Royal Dutch/Shell and Global Business Networks (Bishop et al., 2007; P. Schwartz, 1991; Kees van der Heijden, 1996).

A time-tested six-step version based on this classic process is outlined here. It should be familiar to practitioners of strategic foresight and scenario planning, providing a common touch point for further exploration and discussion. For illustrative purposes, the steps are presented in a linear fashion, while in reality the processes may not follow a straight path.

### 5.1.1 Define the problem or domain

In this stage, the project is clarified. Parameters are established to clarify who will participate and at what level, which may include a core team, facilitators, interviewees, and broader stakeholder participants. The focus question for the exploration of possible futures

is generated. Peterson et al (2003, p. 361) highlight that the "focal issue should emerge from a negotiations among participants in the planning process." A core team and key stakeholders will be involved at this stage. Others may be involved depending on the specific project goals and type.

### 5.1.2 Define the system

Using the defined domain, participants in the process capture what is *known*, including mapping the (eco)system, linkages, influences, dynamics of the problem domain. The problem definition may be redefined if the proposed question turns out to not be the right one once the problem domain is mapped onto its complex system. Internal and external environment scanning is conducted to better understand the current situation. Researchers, interviewers, facilitators, core team members, collaborators, key stakeholders, experts, and broader stakeholder groups may be engaged at this stage to generate, analyze and/or communicate information.

### 5.1.3 Generate alternatives

Horizon scanning may be used to explore what is known about the future of the system and its dynamics, as well as to identify deeper drivers that might influence the system over time. Information is analyzed and prioritized to establish key uncertainties or unknowns in the domain. From interactions among what is fairly certain about the future of the domain and what is identified as uncertain, a set of possible and plausible futures emerges.

Variations may include identifying criteria or principles of a desired future, and/or undesirable and status quo versions of the future. This step builds the matrix or frame for scenarios. This phase may also build a set of personae (amalgams or archetypes of people in the domain) for the following stages. Researchers, interviewers, facilitators, core team members, collaborators, key stakeholders, experts, and broader stakeholder groups may be engaged at this stage to generate, analyze and/or communicate information.

### 5.1.4 Build scenarios

The multiple scenarios should be provocative, unexpected, challenging, plausible, and internally consistent. They are often presented in narrative, and sometimes populated with personae to make the scenarios human-centred, vivid, and believable to stakeholders. The scenarios must have meaning for those who will use them. Contributors to this stage may include authors and/or designers or artists to generate and illustrate the scenarios in various media.

### 5.1.5 Test for consistency, and refine

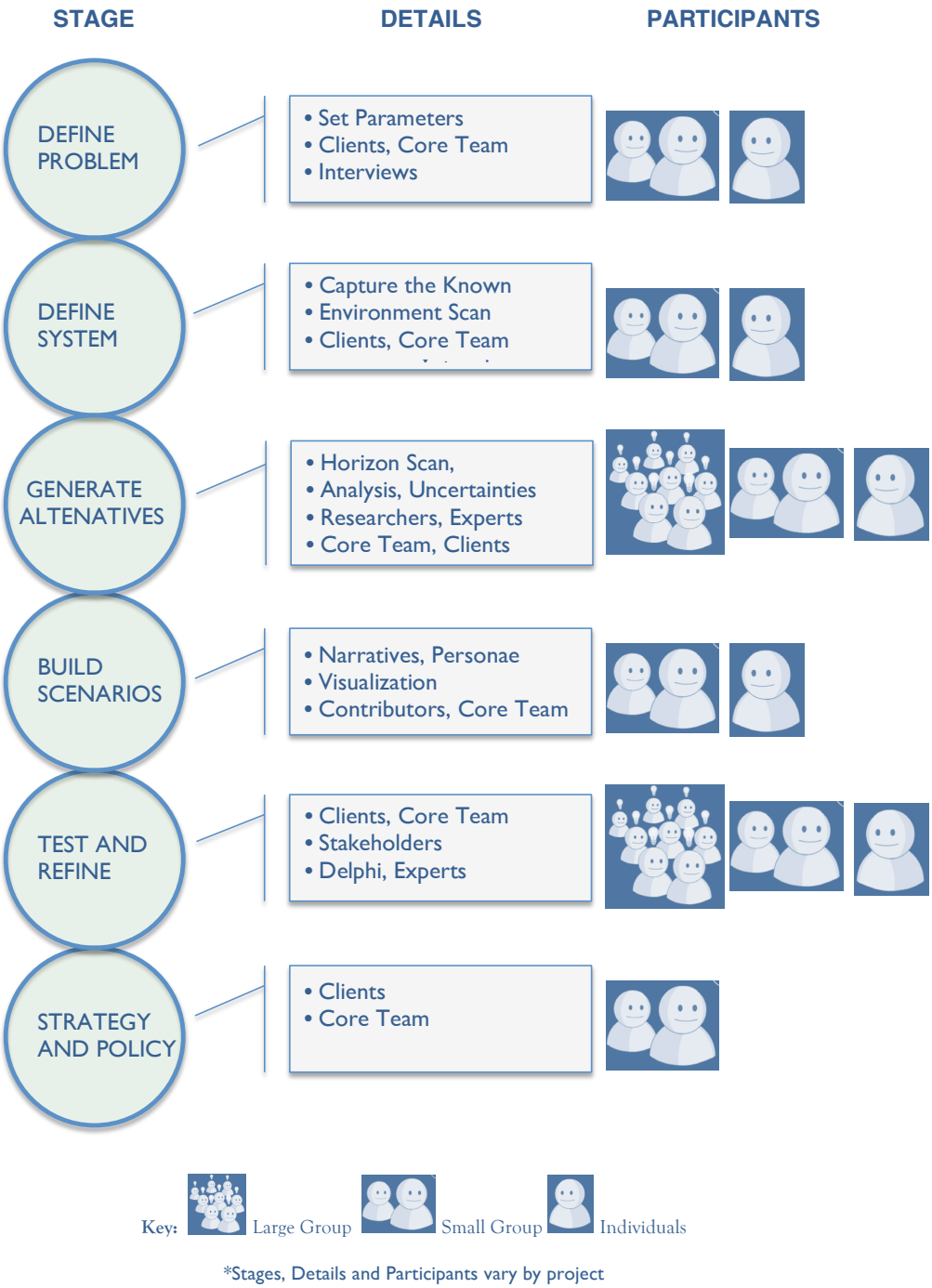
Testing may involve quantitative validation, Delphi (expert) assessment, and review by clients and/or broader stakeholders. Depending on the goals and commissioning agents of the project, public consultation may be included. The aim is to ensure the scenarios have internal consistency and plausibility when confronted with real world users. A core team, facilitators, collaborators, researchers, expert contributors, and broader stakeholder may

contribute at this stage.

### 5.1.6 Test policies or strategies

The scenarios may be used to consider strategic implications. They may be used to propose new strategies, or to test or analyze different options and assess how distinct actions might fare in different circumstances. In some cases, scenarios may be used to determine or improve resilience by identifying strategies or policies that thrive in all scenarios. In other projects, the aim is to maximize benefits by taking steps to manifest a desired future. Participation in this phase varies: it may be restricted to reports and/or presentations to internal users, clients or commissioning agents, or may include communication and knowledge transfer to a broader audience.

**Figure 3 - Six-Step Foresight Process**
Including Individual and Group Touch Points
Figures by Kirk Clyne



## 5.2 Developing Scenarios

Most scenarios are developed with human judgment playing a major role in informing and shaping them – this is the *art* part of taking a long view[8]. Scenarios vary in the rigour or consistency of their methodological underpinning, with many using a systems approach to provide a wireframe on which to hang intuition to produce a (semi-) replicable sense of direction. Almost all scenario development techniques described and categorized by Bishop, Hines and Collins (2007) require some stage of human input or feedback (brainstorming, mapping, proposing implications, weighing options) to develop the kernels that, once wrapped in narrative, become scenarios.

That narrative, itself, is designed with human users in mind. Scenarios are typically crafted to resonate with human decision makers, using drama, narrative, and visualization to ensure the multiple futures are plausible, memorable and rendered on a human scale while simultaneously provoking users through elements that are discomfiting. With the stated purpose of supporting thinking about and imagining the future(s), the media that deliver these messages engage us at an emotional or affective level.

## 5.3 Groups in Foresight

Foresight projects typically engage small groups, and occasionally large ones. Groups in foresight range from a core team guiding the process, clients, key stakeholders or experts

[8] The Art of the Long View (P. Schwartz, 1991) and Scenarios: The Art of Strategic Conversation (Kees van der Heijden, 1996)

providing input and/or feedback, to broader stakeholder or public consultations. The type and size of groups participating in a foresight project vary with the goals of the project. Much of the strategic foresight literature focuses on group elements of the process, and many scholars and practitioners emphasize that engaging stakeholders in a strategic foresight project is critical for building shared understanding through the process of scenario building (Bojer, Roehl, Knuth, & Magner, 2008; Kahane, 2012; Peterson et al., 2003; K van der Heijden, Bradfield, Burt, Cairns, & Wright, 2002). In others projects, however, group elements are a component of the *structure* of the process, but are not central to the goals. Group engagement in such projects is more a means to an end, than an important end in itself.

Regardless of the project goals, when people come together in groups, various social mechanisms come into play. Exploring these in depth is beyond the scope of this research, but there is substantial research on group dynamics both within foresight (and scenario planning in particular), and in complementary domains of inquiry.

Among key understandings in studies of group interactions is a recognition that groups are complex. In what Clay Shirky refers to as "the grim logic of group complexity," a group's complexity increases faster than its actual size (2008, p. 28). As he illustrates, between two people, only one agreement is required, while to coordinate four people requires six agreements as everyone has to be aligned with each of the others. Accordingly, coordinating four people is potentially *six times* more challenging than seeking agreement between two participants. By the time 10 people are involved in the group, Shirky

calculates, 45 different agreements are required to move forward. His example focuses on choosing a movie among a group of friends but lends some insight into the complexity of making decisions about higher consequence situations that affect many individuals.

That foresight and scenario planning have been demonstrated to succeed in harnessing this complexity for group learning and strategic conversations is an achievement in its own right. What is less clearly defined and explored in the literature is the role of *individuals* in strategic foresight.

## 5.4 Individuals in Foresight

Although receiving much less attention than groups in the foresight and scenario planning literature, individuals provide input, feedback, facilitation and interpretation at each step of a strategic foresight project. Individuals in a project may include clients, facilitators, advisors, researchers, experts, authors, designers, interviewers and interviewees, and other stakeholders in the domain.

Individuals come to, and participate in, group processes with established frameworks that inform what and how they see and don't see. The content of these frameworks is unique to the individual, but many of the mechanisms that form these perceptions, and the shortcuts used to process information are fairly predictable phenomena that incline most people toward similar systemic logic and judgment errors that affect decision-making.

Since strategic foresight is typically an approach for grappling with uncertainty, the first question of this research project focuses on how individuals think and process information in uncertainty.

# 6. Heuristics: Shortcuts for Decisions in Risk and Uncertainty

**A heuristic is just answering a difficult question by answering an easy one**

- Daniel Kahneman[9]

Heuristics are simple and efficient rules and shortcuts for quickly and intuitively forming judgments, assessing probabilities and making decisions. These are broadly believed to be adaptive strategies from an evolutionary perspective, supporting instantaneous and efficient decision-making and synthesis of novel experience and information.

While they are both normal and in many ways beneficial, as shortcuts, heuristics contribute to systematic deviations from human logic by cutting corners in information processing. Cognitive biases are the systematic errors that can result from such shortcuts[10]. Many of these systematic deviations have proven to be predictable since investigation into the phenomena began in earnest with Tversky and Kahneman in their Nobel-winning research into what they termed Prospect Theory. The original three heuristics they outlined were *availability*, *representativeness* and *framing* (Kahneman & Tversky, 1979; Tversky &

[9] In interview with legal scholar and colleague, Cass Sunstein ("Nobel laureate Daniel Kahneman discusses life and work in behavioral economics," 2014)

[10] Cognitive bias is distinguished here from social bias, or the shortcuts people use to quickly make sense of social situations, and interpret and understand other people and their actions

Kahneman, 1986). They later added the *affect* heuristic proposed by Slovic and colleagues. (Gilovich & Griffin, 2002; Slovic, 2007). To answer the first research question of this paper, "What informs and influences individual human decision-making in situations of uncertainty and risk?", these phenomena and their implications for foresight projects will be explored further, below.

Many identified heuristics factor into human perceptions of probabilities and risks. In addition to mental models of risk, for example, Paul Slovic and colleagues, who have been examining risk perception for 30 years, assert that our perceptions of risk are informed both by what we *think* about an activity or technology as well as how we *feel* about it. Slovic and colleagues added the affect *heuristic,* associated with an instantaneous positive or negative sensing, to the automatic human perceptions of risk (Fischhoff et al., 1979; Slovic et al., 2004, 1991). Predictably, when humans have preconceived positive feelings toward something, the tendency is to judge risks associated with the thing as low and benefits associated with it as high. The reverse also seems true in that something held in negative esteem will be judged as high risk with low benefits. The key insight here is that the affective response to a stimulus "comes prior to, and *directs*, judgments of risk and benefit" rather than being *formed by* risk assessment (Slovic et al., 2004, p. 315).

Marx and Weber highlight that risks, then, are represented to us quickly and subconsciously as feelings experienced as an early warning system, as in a "gut reaction" (2012, pp. 102–3). Emotional responses to perceived risk or hazards, can and do diverge from the slower, cognitive, analytical evaluations of those same risks (Fischhoff et al., 1979;

Loewenstein et al., 2001; Slovic et al., 2004).

In their introduction to the foundational collection, *Heuristics and Biases: Then and Now*, Gilovich and Griffin categorize heuristics into "general purpose" heuristics, and more special-purpose heuristics, or those that have been added as discourse has matured into a robust inter- and cross- disciplinary inquiry (2002, p. 17).

This paper highlights phenomena that surfaced within the earliest scope of this project – namely, an exploration of heuristics specific to environmental concerns and with possible implications for strategic foresight. From that reference point and the decision-making literature (in particular the literature specific to risk perception and judgment of probabilities), 22 articulated heuristics, biases, effects and fallacies with some impact on judgment of risk or decision-making in uncertainty emerged (see Table 1). Some of these are specialized phenomena, and others more general heuristics (Gilovich & Griffin, 2002).

**Table 1 Cognitive Biases, Heuristics, Effects and Risk Perception**

| | Phenomenon | Described As |
|---|---|---|
| 1 | Affect | Perceptions of risk are influenced by whether they have (personal) positive or negative emotional associations |
| 2 | Anchor and Adjust | Tendency to rely too heavily on one piece of information when making decisions |
| 3 | Asymmetry Principle | When events are invisible or poorly defined, they carry little or no weight in shaping attitudes and opinions. When events are vivid, they carry disproportionate weight in forming judgments |
| 4 | Availability | Tendency to overestimate likelihood of events that have greater availability in memory. Tendency to ascribe undo importance to things that can be recalled |
| 5 | Confirmation Bias | Tendency to favour information that confirms existing beliefs |
| 6 | Dread Risk | Tendency to perceive risks as higher and benefits as lower for events that trigger dread (a visceral negative reaction) |
| 7 | Endowment Effect | Placing a higher value on goods one owns than those he/she does not |
| 8 | Escalation of Commitment (Sunk Cost) | Tendency to justify increased investment in a decision based on cumulative prior investment |
| 9 | Finite Pool of Worry | Theory states people have a limited capacity to worry so that as worry about one hazard increases, worry about other hazards decreases |
| 10 | Framing | Drawing different conclusions from the same information depending on how or by whom the information is presented |
| 11 | Insufficient Reason | When people lack information about probabilities they act as if all probabilities are equally likely |
| 12 | Introspection / Justification | Thinking about reasons for a decision can interfere with decision making and lead to poor choices or undesired outcomes |
| 13 | Loss Aversion | Tendency to prefer avoiding losses to acquiring gains |
| 14 | Overconfidence | Where confidence in judgments is greater than their accuracy, especially when confidence is high |
| 15 | Proportion Dominance | Attributes presented as a proportion / percentage of something, or as a probability are easier to assess or judge |
| 16 | Psychic Numbing | An inability to gauge change as the magnitude of stimulus increases |
| 17 | Representativeness | Tendency to judge or justify probabilities on the basis of resemblance |
| 18 | Sensitivity to Small Changes | High sensitivity to numbers and changes close to zero, and low sensitivity to large changes and those further from zero |
| 19 | Single Action Bias | Tendency to take a single action to mitigate threats even when a multi-pronged response would have clear advantages |
| 20 | Status Quo Bias | Preference for things to stay the same – where the current state is the baseline for loss aversion |
| 21 | Trade-offs | Tendency to avoid decisions altogether – even simple, low risk decisions – when faced with more than one attractive option |
| 22 | Zero-risk bias | Preference for reducing small risks to zero over a greater reduction in a larger overall risk |

# 7. Heuristics and Strategic Foresight

The aim of this project is to inform a redesign of strategic foresight approaches to account for and embrace insights into heuristics and cognitive biases in human decision-making. Toward this end, what follows is an exploration of the second research question: "How do these decision-making frameworks interplay with strategic foresight approaches to problem solving?"

From the literature review and synthesis so far, it can be inferred that heuristics, and the biases to which they contribute, affect individual perceptions of risk and probability, while judgment and perception of risk and probability inform human decision-making and the ability to make "good" decisions. How might this be important for strategic foresight? To answer this – the second question – this inquiry turns to the touch points where individual judgments and decisions enter the strategic foresight space (see Six Step Process in Section 5, and Figure 1).

## 7.1 Prioritizing Heuristics: Comparative Analysis

### 7.1.1 Concept Mapping and Ordering

To prioritize the phenomena for this further investigation, this investigator applied concept mapping to organize the information along the following criteria:

1) Clustered by association (including different terms for similar phenomenon)

2) Ordered hierarchically when a phenomenon was attributed/able in the literature to a higher order phenomenon, it was considered a lower (more specific) order (See Appendix A for the cascade diagram of this concept map)

This process revealed six heuristics (the highest order) to which the other biases, effects and fallacies could be attributed (see Table 2 for details). These six are taken to be the priority phenomena for further investigation (presented alphabetically):

- affect
- anchor and adjust
- availability
- framing
- loss aversion
- representativeness

Additionally, one anomaly emerged. The notion of "dread" risk that, although not considered a heuristic, contributed to several other phenomena, and also emerged as salient for its role in shaping public perceptions of risk in public policy decisions. In order to not lose the potential value to strategic foresight of insight into this outlier, dread risk is also treated as a priority for further exploration here.

**Table 2 Ordering Heuristics, Cognitive Biases, and Effects**

| | Phenomenon | Explained In Part By | Order |
|---|---|---|---|
| 1 | **Affect** | --- | **Broad** |
| 2 | **Anchor and Adjust** | --- | **Broad** |
| 3 | Asymmetry Principle | Dread, Affect | Specific |
| 4 | **Availability** | --- | **Broad** |
| 5 | Confirmation Bias | Availability | Specific |
| 6 | **Dread Risk**[11] | Affect | **Broad** |
| 7 | Endowment Effect | Loss Aversion | Specific |
| 8 | Escalation of Commitment / Sunk Costs) | Loss Aversion | Specific |
| 9 | Finite Pool of Worry | Affect, Dread | Specific |
| 10 | **Framing** | --- | **Broad** |
| 11 | Insufficient Reason | Framing, Anchor, Affect | Specific |
| 12 | Introspection / Justification | Availability, Framing | Specific |
| 13 | **Loss Aversion** | --- | **Broad** |
| 14 | Overconfidence | Availability | Specific |
| 15 | Proportion Dominance | Representativeness, Anchor | Specific |
| 16 | Psychic Numbing | Dread, Affect | Specific |
| 17 | **Representativeness** | --- | **Broad** |
| 18 | Sensitivity to Small Changes | Anchor, Representativeness | Specific |
| 19 | Single Action Bias | Dread, Affect | Specific |
| 20 | Status Quo Bias | Loss Aversion, Framing | Specific |
| 21 | Trade-offs | Introspection, Justification | Specific |
| 22 | Zero-risk bias | Anchor | Specific |

When a phenomenon was attributed/able in the literature to a higher (broader or more more general) order phenomenon, it was considered a lower (more specific) order. Those classified here as *Broad* phenomena were not attributable in the literature to other phenomena, and were prioritized for further investigation. The *Specific* phenomena appear in Appendix B.

[11] "Dread" risk is not considered a heuristic, so it is not highest level in the order; however, it contributes specifically to many of the phenomena and themes that emerged in the environmental and public policy literature, so it is classified here as a Broad Order. It is the only non-heuristic in this classification.

## 7.2 Priority Heuristics

The heuristics that emerged from the resource review and coding, and concept mapping are described (alphabetically) in greater detail here. (For descriptions of the remaining phenomena, see Appendix B.) The underlying assumption here is that if practitioners of foresight can account for the higher order, more general phenomena in scenario planning approaches, the associated lower order (more specialized) phenomena will be similarly accounted for.

### 7.2.1 Affect Heuristic

**Emotions circumvent rational cost-benefit analysis.** - Daniel Kahneman[12]

All images in our personal experiences are tagged subconsciously with an *affect*, a sense of goodness or badness, or a potential to cause pleasure or pain (Slovic et al., 2004, p. 314), and we tap into this store of affective impressions when making judgments (Finucane et al., 2000). Because the affective system of information processing is faster than the reflective system, judgments are formed *first* by affect. One outcome of this Affect Heuristic is insensitivity to probabilities when potential future outcomes are linked to a strong affective meaning (good or bad). In such circumstances we fall prey to a sense of *possibility* rather than *probability* (Slovic et al., 2004).

[12] ("Nobel laureate Daniel Kahneman discusses life and work in behavioral economics," 2014)

### 7.2.2 Anchoring and Adjusting

In Anchoring and Adjusting (aka Anchoring, or Adjusting from an Anchor) people use an initial piece of information to make subsequent judgments. Further judgments are *adjusted* from this established *anchor*, or reference point (Tversky & Kahneman, 1974). This is a particularly pervasive phenomenon. Studies by Kahneman and others (Gilovich & Griffin, 2002) have found that even when research subjects are informed of the anchoring effect and its impact on their choices they still show limited ability to avoid it. Financial incentives are similarly unlikely to shift participants away from the strong hold of an anchor. Anchoring factors into negotiation strategies since participants in a negotiation are likely to anchor and adjust from the opening offers in the negotiation. Sunstein suggests that a related lower order phenomenon, the Status Quo Bias, is the specific manifestation whereby the baseline against which events are adjusted is the present state (2007, pp. 131–2) (see Appendix B for the Status Quo Bias).

### 7.2.3 Availability

Availability suggests that if something can be recalled, it will be given undue significance when predicting the likelihood of other events. Additionally, the ease of recall influences predictions of the likelihood or frequency of occurrence: if something is easily recalled, it may be perceived as more common or more likely to occur (Bradfield, 2008; Sunstein, 2005; Weber, 2006). Additionally, events are more available the more recently they have been experienced. This effect can disproportionately affect estimations of rare events, since these are by nature less likely to have occurred in recent memory. By contrast, if a rare

event has occurred recently, its likelihood of occurring in general will be overestimated. The Affect Heuristic may be responsible for the observed phenomenon that memories seem to be more available if or because they are associated with an emotional impact or positive or negative mental images (Marx & Weber, 2012, p. 109). Because of this emotional component, Slovic et al (Slovic, 2007) have suggested that much of what has been attributed to Availability may be better understood through the Affect Heuristic.

By contrast, suppressing this rapid affective system by "thinking too hard" can also impair judgment: research by Wilson and Schooler (1991) demonstrated through various studies that the quality (compared against experts) of decision-making was affected negatively by asking decision makers to think about the advantages and disadvantages of their options prior to making a choice. The researchers concluded that thinking about pros and cons of decisions created distractions in the choice process by focusing attention on "non-optimal criteria" to the extent that individuals based their decisions at least in part on those criteria (Wilson & Schooler, 1991).[13]

### 7.2.4 Dread Risk

**Studies showed that feelings of dread were the major determiner of public perception and acceptance of risk for a wide range of hazards**

- (Fischhoff et al., 1979; Slovic et al., 2004).

[13] see **Introspection** and **Justification**, and **Trade-Offs** in Appendix B

Dread Risk is a subcategory of Affect. When Slovic and colleagues (1997) explored affective evaluations of risk, their research found perceptions of risk may have little grounding in consequences or their probabilities. Instead, they, and Weber (2006) identified two types of factors that people sense which inform risk perception: dread-related risks and other risks. Their research suggests a sense of dread is related to a perceived lack of control or fairness, involuntariness, and a potential for catastrophic impact of an event. Thinking about these types of hazards (nuclear reactor accidents, for example) trigger immediate physiological responses including accelerated heart rate. Risks in the "other" category do not trigger these anxiety responses.

Marx and Weber (Marx & Weber, 2012; Weber, 2006) cite additional research that delves into this two-factor hypothesis specifically around climate change and perceptions of risk. The findings suggest when people perceive climate change as a gradual shift over a long time frame, there is a sense the risks are knowable and controllable - or at least that they afford time to adapt. By contrast, when climate change is perceived as potentially abrupt with unpredictable and catastrophic shifts, people are triggered on a more emotional and dread-inducing level. Level of dread in this case seems to correlate directly with willingness to act to mitigate risk.

In another illustrative example, researchers found people are willing to pay more to avoid emotionally laden hazards. Sunstein (2007) cites an example from Loewenstein (2001) wherein research subjects were willing to pay more for flight insurance to cover losses from "terrorism" exclusively than for insurance to cover losses resulting from "all causes". This

defies logical reasoning but can be explained by Affect and Dread Risk in that "all risk" does not trigger dread, while "terrorism", by definition and in practice, does.

Dread Risk may partially account for Single Action Bias,[14] the tendency to take only a single action to mitigate threats. Even when a multi-pronged response would have clear advantages, people are inclined to engage in only a single mitigating action. Research by Marx and Weber (2012) suggests this may be because that one step removes the "hazard flag" – or mitigates the sense of dread – that provoked a response.

### 7.2.5 Framing

Framing is the tendency to draw different conclusions from the same information depending on how or by whom the information is presented (Gilovich & Griffin, 2002; Kahneman & Tversky, 1979; Tversky & Kahneman, 1986). In particular, people tend to respond differently to choices depending on whether they are presented as a loss or as a gain. The tendency is to avoid risk when a positive (gain) frame is presented but seek risks when a negative (loss) frame is presented. Additionally, when an attribute is presented as a probability, it is perceived as more benign and less compelling than when the same information is framed as relative frequency, (Slovic et al., 2004).

[14] See Appendix B

### 7.2.6 Loss Aversion

Loss Aversion and the well-known Endowment Effect[15] refer to the tendencies described in Prospect Theory to experience losses as more significant than gains (Gilovich & Griffin, 2002; Kahneman & Tversky, 1979). In other words, losses hurt more than gains satisfy us (Tversky & Kahneman, 1986). Kahneman and colleagues have demonstrated repeatedly that once subjects have a thing, even with a money back guarantee, returning it is experienced as a loss. Loss Aversion can lead to greater regret for outcomes of actions than of inaction (Tversky & Kahneman, 1974). A related lower order phenomenon, the Status Quo Bias, is the specific manifestation whereby the status quo is the baseline against which we measure gains and losses, so that a loss against the status quo is perceived as more bad than a gain from the status quo seems good (Sunstein, 2007, pp. 131–2).

From both Tversky and Kahneman (1986) and Schwartz (2004) we learn that in situations with uncertainty or risk, people are inclined to prefer small, certain gains over larger less certain ones. Along the same lines, people are inclined to risk substantial possible losses to avoid small, certain ones.

### 7.2.7 Representativeness

The Representativeness Heuristic (aka the Similarity Heuristic) is the tendency to assign probability to uncertain events based on how similar those events are to one's mental map and understanding of causation within that map (Bradfield, 2008; Kahneman & Tversky,

[15] See Appendix B

1979). The tendency is to judge something as belonging to a class based on a few salient characteristics without accounting for the base rates (probabilities) of those characteristics. The more representative a thing is of a "parent" or prototype, the more likely people are to exaggerate probability of its occurrence despite the fact representativeness (being closer to an available stereotype) does not make it more likely. Representativeness leads to false logic that ignores probabilities, and a perception that random occurrences are causal patterns (Thaler & Sunstein, 2009).

The **Asymmetry Principle** posits it is easier to lose or destroy trust than to build it. Slovic (1997) highlighted that incidents that damage trust are usually clearly defined. They are events or moments that are noticeable and noted (the **Availability Heuristic**), while the types of things that build trust are not easily observable. He gives this example:

**"How many positive events are represented by the safe operation of a nuclear power plant for one day? Dozens of events? Hundreds? When events are invisible or poorly defined, they carry little or no weight in shaping our attitudes and opinions"** (1997, p. 302).

Slovic's research suggests trust-destroying events have a disproportionate impact on perception of probability and risk. This is an adaptive mechanism, given that learning quickly what not to trust can improve chances of survival. In simple problems, the heuristic is clearly advantageous (eg. How likely is a bear to attack while it fishes for salmon?); however, in more complex problems it may contribute to errors in assessment of probability (eg. What should be done with nuclear waste?).

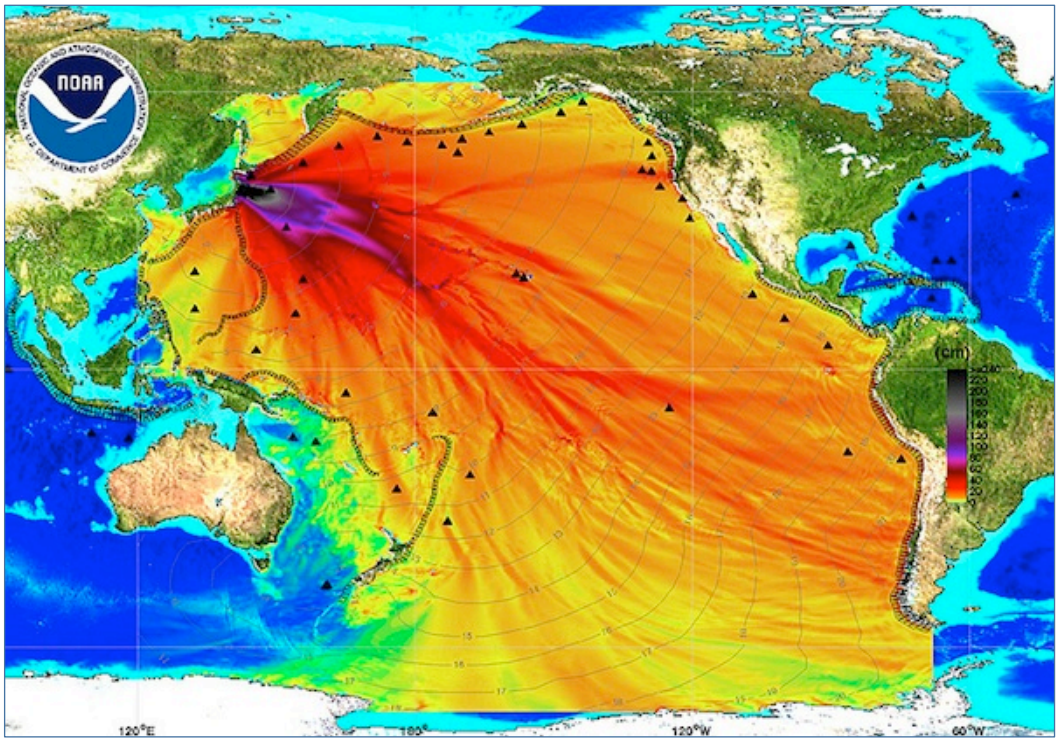
## *Narrative 4 - Experiential Judgment and Decision-Making*

*The 2011 Tohuku East Japan earthquake and resulting tsunami caused a variety of failures at the Fukushima Daiichi Nuclear Power Plant which resulted in radioactive emissions to the atmosphere. The earthquake occurred on March 11th at 14:26 Japan Standard Time (JST), the tsunami about one hour later at 15:41, and by 16:36 a nuclear emergency was reported. By the early morning hours of March 12th, radioactive emissions were occurring from the plant.*

*- From http://sos.noaa.gov/Datasets/dataset.php?id=332*

*Is burying nuclear waste 1 km from one of the largest fresh water lakes in the world a good idea?*

***Figure 4 Fukushima***
*Image courtesy NOAA Centre for Tsunami Research*



*The map in Figure 4*[16] *models the maximum wave amplitudes of the Tohoku tsunami following the March 11, 2011 Honshu earthquake in Japan. This version of the image without labels has been circulated and interpreted widely as a map of radiation dissemination from the Fukushima Daiichi Nuclear Power Station that was crippled during the earthquake and tsunami events. When presented in such a context, the dramatic, vivid map is experientially coded with an enduring and, likely, dread-inducing association. The visceral impact of the first encounter with the image is difficult to undo or re-code with additional information or analysis.*

*Images like this, news stories and blogs of the devastating and dangerous Fukushima Daiichi story have been widely available for the three years since the natural disaster and nuclear meltdown. They are so common it is hard to imagine someone in North America not having heard or seen them. And they are vivid enough it is unlikely they have not left viewers affected with strong (presumably) negative and visceral associations. The Fukushima Daiichi story is recent, vivid, and dread-inducing, making it highly available to recall.*

*High availability and dread associations are likely to be a broadly-shared reference point. In the small Kincardine township where one third of the community works at the nuclear power plant, and where everyone draws drinking water from the lake or local wells, it is almost guaranteed these stories would have caught the attention of community members, policy makers and technical specialists in the field, alike. The story continues to appear regularly in news cycle, reinforcing earlier images and associations, and keeping them fresh, powerful and anxiety-producing.*

*In future considerations related to nuclear power or radioactivity in Kincardine and elsewhere, this case will provide a common reference point that may affect the risk perceptions of anyone touching the issue.*

[16] Model amplitudes calculated with the MOST forecast model. Filled colors show maximum computed tsunami amplitude in cm during 24 hours of wave propagation. Black contours show computed tsunami arrival time. http://nctr.pmel.noaa.gov/honshu20110311/

## 7.3 Heuristics In Judgment and Perceptions of Risk

Having inferred the hierarchical order of the effects in the concept map (see Table 2, and Appendix A) and through this process selected the seven effects of greatest significance for this inquiry, the phenomena were further explored by:

- Coding for predictability of the *direction* of the bias, and
- Coding for predictability of the *reference point* of the bias

The level of certainty with which the direction of the effect and the reference point(s) for the ensuing bias vary in their predictability, with the higher order phenomena varying in predictability of the direction and reference point of bias. By contrast, at least some of the lower order effects not brought forward in this discussion share the characteristic that both direction *and* reference point are known or knowable. In Zero Risk Bias[18], for example, which refers to the tendency to prefer reducing a small risk to zero even when this distracts from having a more statistically significant impact by choosing a greater reduction of a larger risk, both the direction of the effect and its reference point can be discerned. Similarly, in Status Quo Bias[19], defined as a preference for things to stay the same, and for using the current state as the reference point, both the direction of the effect and its reference point can be discerned.

[18] See Appendix B
[19] See Appendix B

From this exploration of the higher order phenomena, three distinct patterns emerged that can be applied toward the third question of how to improve foresight by incorporating insights into individual decision-making:

1) Where the direction is predictable but the reference point is complex or difficult to know
2) Where the direction is difficult to predict but the reference point can be known
3) Where the direction is difficult to predict and the reference point is difficult to know

Each category has implications for strategic foresight projects. They are explored further here, below.

### 7.3.1 Predictability of Direction of Bias from a Reference Point

Many of the phenomena have a predictable direction of bias from a reference point. For example, some heuristics contribute consistently toward over-estimating probabilities, while others shift perceptions toward under-estimations.

The impacts on judgment and perceptions of probability and risk identified with the priority heuristics were outlined, then coded by the investigator for the level of predictability (coded low, medium or high) in a foresight setting of such shifts. The key coding question was: If a reference point were known, how likely is it in a foresight setting that the direction of impact on judgment of the bias could be discerned?

See Table 3 for a summary.

### 7.3.2 Predictability of Reference Point

While the *direction* of shift in perception of risk or probability is predictable in many cases, how predictable is the *reference point* or static position for this shift? Predictability of the reference point was coded here based on several criteria:

- Along a continuum of universality to individuality (high-low)
- Whether or not the reference point can be established by the foresight process, itself (high-low).

Where the reference point is expected to be universal and consistent across individuals or domains, the reference point was coded as having high predictability. Where the reference point is established by and within the foresight process, it was coded as having high predictability. With phenomena where a reference point is highly individualistic and/or heavily grounded in individual experience outside the foresight setting, the predictability was coded as low. In some cases, the predictability of the reference point varied by context – these were coded as medium.

See Table 3 for a summary.

Table 3 Predictability of Bias and Reference Point of Heuristics

| Phenomenon | Description of Known Bias | Predictability of Shift | Predictability of Reference Point |
|---|---|---|---|
| Affect | Insensitivity to probabilities when affect is strong (either positive or negative) | Medium | Low |
| **Anchor and Adjust** | Tendency not to shift far from an anchor in any direction | **High** | **High** |
| Availability | When events are easy to recall probability is exaggerated. Probability of rare events is under-estimated unless there is recent experience of the event, in which case probability is exaggerated | **High** | Low |
| **Dread Risk** | The higher the dread associated with event, the higher its perceived risks and lower its perceived benefits | **High** | **Medium** |
| **Framing** | Tendency to avoid risk when a frame is positive, and prefer risks when negative | **High** | **High** |
| **Loss Aversion** | Preference for small, certain gains over large uncertain ones, and large, uncertain losses over small certain ones | **High** | **Medium** |
| Representativeness | Tendency to exaggerate probability when elements perceived as similar | Medium | Low |

Implications of a predictable shift and identifiable reference point are discussed in the following section, with accompanying recommendations.

# 8. Discussion

The aim of this investigation is to provide recommendations for improving foresight approaches by incorporating transdisciplinary insights from the domains of individual human decision-making and judgments in situations of uncertainty and risk to current foresight frameworks. Having established that heuristics and related biases have substantial and predicable influences on individual perceptions of risk and judgment of probabilities, this paper turns now to the questions of 1) the impact of these phenomena on strategic foresight practice, and 2) recommendations for improving strategic foresight frameworks through these insights.

The discussion and recommendations presented below use two primary perspectives to support this integration toward improved strategic foresight frameworks: the first aligns implications of heuristics with project goals, and the second with a standard six-step process as outlined in Section 5 and Figure 3.

## 8.1 Project Goals

The impact of heuristics and biases on strategic foresight projects will vary according to the aims of the project per the three-type typology outlined by Borjeson and colleagues that categorizes project objectives as Predictive, Exploratory or Normative (2006).

### 8.1.1 Predictive scenarios

Predictive scenario projects ask what will happen *if…*? Whatever is placed after the "if" in this framework establishes the anchor for the remaining query. Any further foresight investigation in such a process will be fettered to this reference point, and adjustments from this anchor are anticipated to be incremental in scope and scale. This is true of both tools that build from the present toward the future(s), and those, like backcasting, that set an anchor in a far future and work backward strategically. Foresight exercises can shift the anchors through intentional and repeated cycles so participants adjust from a different set of reference points, but in each cycle participants will still be bound to the anchors once they are in place.

Similarly, the stated "if" establishes a status quo for the project against which losses and gains will be measured. A subconscious tendency to preserve this starting point is likely to remain at play for whatever exploration follows, with participants influenced by a tendency to avoid losses associated with this reference point (even if the status quo is considered imperfect) over any gains that might be explored.

Whether the framing of this reference is positive or negative will also influence the decisions that can be considered. Knowing that predictable tendencies in decision-making lead people to *avoid* risks when the frame is positive and to *seek* risks when the frame is negative although the information presented is the same[20] should inform choices

[20] For example, patients tend to make different choices when a physician presents the *survival* rates of an operation versus the rates of *adverse outcomes* of the same procedure, even though the information is the same regardless of this framing.

practitioners make when framing the project and information communicated to any participants.

Note that anchoring and framing effects impact both expert and non-expert judgments. Both effects are difficult to mitigate.

### 8.1.2 Exploratory scenarios

To consider what might or could happen across long timelines, and to consider substantial (rather than just incremental) shifts requires the type of expansive thinking commonly associated with strategic foresight. In such projects, an overt aim is to liberate thinking and decision-making from the bonds and boundaries of the present. Anchors, then, are particularly limiting to this type of project. Given that adjusting from an anchor is a tenacious effect that limits true expansive thinking and imagining, a process that *simulates* such liberation may be a reasonable expectation of foresight. Recognizing that each cycle may not be able to free thinkers from an anchor, but can establish new ones adjusted from previous reference points, it is worth considering that carefully facilitated and repeated cycles of establishing and adjusting anchors could produce an effect consistent with these aims.

As in predictive scenarios, insights into anchoring and framing should be thoughtfully considered to achieve alignment with specific project objectives. Since the framing of information can influence whether subsequent choices are risk-seeking or risk-averse, for

example, practitioners should consider the likelihood that a *neutral* exploration may not be possible, and account for this in project design.

Horizon scans that typically inform exploratory scenarios may be prone to the impacts of affect and dread risks. This is true of researchers, facilitators, and core team members, as well as informants who contribute inputs to the framework of an exploratory project. The predictable effect demonstrated by Slovic and colleagues' extensive research into dread and other perceptions of risk is that individuals have a tendency to avoid or under- represent events that do not trigger a visceral or dread reaction, while over-representing elements that do have a strong negative affect. This is a salient insight for researchers scanning for signals and trends, as well as for contributors who render scenarios in various media. At both of these points in the foresight process, affect may skew what is noticed, ignored or privileged and moved forward in the process.

While reference points for affect are individual, complex, multivariate, and not established within the framework of the foresight project in the way anchors and framing can be, they may yet be knowable in a useful way. Depending on project objectives and the focus question, it may be useful and reasonable to scan for elements or events that are associated with a strong affective response across the domain. Since affect is demonstrated to *precede* and shape assessment of benefits and risks, affective associations have a substantial impact on subsequent judgments. Scanning for known triggers that may cause friction in the project by skewing risk and probability assessments may be of value.

Affect has also been demonstrated to impact the availability heuristic. Along these lines, what is available (recently experienced and/or powerfully associated and therefore easily recalled) may be overestimated, or ascribed undo importance. In exploratory projects, this phenomenon may impact the process at any touch point where individuals are engaged (see Figure 3), including in scans, and steps to make sense of data.

### 8.1.3 Normative scenarios

The goals of normative projects are to preserve or to transform. Both share a stage in the process that establishes a target or *desired* future. Normative projects, then, have two anchor points – one in the present, and one in the desired future. The present anchor will establish the status quo and the baseline against which losses and gains will be assessed in the present. As with predictive scenarios, there will be a tendency to preserve this starting point regardless of known flaws, with participants tending to avoid losses from this reference point. This friction, predictably, will be disproportionate to the assessment of any anticipated gains.

Choosing a desired future typically involves an exploratory phase to generate and assess options toward identifying the elements, criteria or principles that inform the desired future state. The considerations outlined for exploratory projects hold for normative ones, as well, during this phase of the project.

Unique to normative projects is the establishment of a second, future anchor that will establish its own reference points and associated biases. Once this point is identified,

participants may experience an aversion to any perceived losses related to the desired future, even as more information or options with better outcomes emerge. This may contribute to a strong pull among participants in the process toward aligning choices and actions with the future reference point. It may also create challenges for strategies where pivoting is required. The more vivid the future reference point, the greater the anticipated effects of most of these biases.

Some normative projects involve steps for reconciling or bridging the two anchor points. As in exploratory projects, this objective may require repeated cycles to incrementally adjust from and reset anchors to create conditions that support creative problem solving in the horizon between the two anchors.

Embedded in normative projects, then, are all of the considerations and recommendations for both predictive and exploratory scenarios.

## 8.2 Six-Step Framework

Additional considerations emerged for improving the standard six-step framework outlined in Section 5 (see Figure 3). Most important to these is the recognition that individuals factor into the process at all stages and that, regardless of their expertise, level of experience, or role in the project, these individuals will be influenced by heuristics, including those outlined above.

Facilitators, researchers and core team members will be impacted by cognitive biases that influence what they notice and/or dismiss throughout the process. For example, affect (especially dread associations) and availability biases will impact what individuals identify – what signals they see – in horizon scans. Similarly, environment scans, SWOT analyses and other background or preparation materials provided by clients or commissioning agents will have affect and availability biases embedded in them. Events or elements that have occurred recently, are easily recalled, are vivid, or associated with strong positive or negative emotions will typically be over-represented in such materials.

In project steps that generate alternatives and consider known elements and uncertainties, individuals engaged in the process will assign personal probabilities and interpretations of risk in their assessments of the information. Particular attention should be given to the role of the affect heuristic at this phase, including: 1) the tendency to over-represent dread risks and under-represent associated benefits, 2) the tendency to under-represent events that don't evoke dread, and 3) the tendency to downplay risks and over estimate benefits of events with positive affect.

## 8.3 Compressing the Process

In a compressed foresight process, or one that is conducted rapidly to accommodate short project timelines, efficiencies may emerge from taking shortcuts by tapping into existing frameworks and content. This is inconsistent with foresight projects that require exploratory approaches for two reasons.

While quick and intuitive thinking is not inherently problematic, it can contribute to systematic errors in judgment and assessments of probability, risk and uncertainty. As highlighted in this research, many of these effects are predictable; however, such predictability only has value if the insights are applied in a real life setting. The value of knowing and predicting cognitive biases lies in accounting and compensating for them.

> **How do we apply reason to temper the strong emotions engendered by some risk events? On the other hand, how do we infuse needed "doses of feeling" into circumstances where lack of experience may otherwise leave us too "coldly rational"?**
>
> - (Slovic et al., 2004, p. 311)

A compressed project may not allocate appropriate resources (both time and human resources) toward compensating for these known effects.

The second challenge is that exploratory models rely on expansive thought to achieve stated project goals. As outlined above, achieving this expansive effect may require repeated touch points, cycles, or iterations to continually reestablish new anchors and ultimately achieve an end state that is far enough from the starting reference point to be of value. Anchoring and adjusting is a tenacious heuristic that impacts experts and non-experts, alike, with no established mitigation strategies. A strategic foresight process of multiple cycles may offer a convincing work-around for this constraint, while a compressed process may not.

Foresight projects with normative (preserving or transforming) objectives, and three-horizons models, insofar as they rely on an exploratory phase to surface options or criteria from which a desired future can be articulated, are similarly bound by these constraints.

Predictive projects may be more amenable to a compressed process since they tend to be less exploratory. The objectives of such projects may be better aligned with incremental shifts from an anchor, which can be either a reference point in the present or in an imaginary future.

## *Narrative 5 - The Futures of Radioactive Material in Ontario: An Imagined Foresight Project*

*A foresight project around nuclear waste disposal with implications for Kincardine might unfold something like the following imagined process. Only a few of the many touch points in the process are highlighted here, leaving room for the reader to explore the scenario and implications of this research through his or her own experience and lens.*

*Imagine that to help focus and direct current policy decisions in Ontario's nuclear energy sector, a branch or agency of the provincial government commissions a strategic foresight project exploring long-term implications of and strategies for managing the non-energy outputs (currently known as "waste") of Ontario's nuclear energy generation industries. If it were triggered specifically by discord and impasse over proposed strategies for storing the current reserves of nuclear waste, the project might be designed to test outcomes of one or more policy decisions – a "what if..." style study. A project designed to generate rather than test policy options, however, would be more exploratory in nature, with a likely focus on facilitating strategic thinking and dialogue around what might or could unfold that would have implications for the domain. Such a project might be designed to surface both risks and opportunities over a long timeline, and would look beyond the currently defined nuclear energy sector.*

*Background materials produce by various technical experts prior to commencement of the project would be largely analytical, and presented as assessments of "real" or empirical risks and probabilities devoid of affective or experiential influences. Direct risks and probabilities (mortality and morbidity, or jobs and taxes lost or generated, for example) would predominate. These materials would form an anchor for future discussions, with initial explorations clustering around the concepts introduced by these materials (adjusting from an anchor heuristic).*

*In a horizon scan or STEEPV[23] survey, what researchers notice or overlook will be influenced by the availability and affect heuristics. Dread, in particular, will contribute toward perceptions of risks that are far higher than statistical probabilities of such occurrences. Rare events generate particularly*

[23] *STEEPV is an acronym for Social, Technological, Economic, Environmental, Political, and Values, and is a common framework for structuring horizon scanning activities*

*strong signals in this regard. Accordingly, the recent story and images of the Fukushima Daiichi nuclear plant meltdown and radiation leak, which are likely to be available in the recall of most researchers on the foresight team as well as any participants or informants in the project, will introduce a distracting signal. Awareness of this catastrophe (availability heuristic) and the vivid, negative, and anxiety-triggering emotional coding of the event (affect heuristic, and dread) will tend to skew risk perceptions, and may distract from equally- or more likely possibilities and signals that generate lower recall or a neutral emotional response.*

*While knowledge of the Fukushima disaster may introduce to the information gathering and analysis phases of this project an exaggerated perception of risks or probabilities from natural disasters (and systemic human errors in planning for such possibilities), lack of recall or dread associated with other elements may result in an under-representation of other possibilities. In other words, less dramatic events may be overlooked by researchers and informants. Mundane possibilities, such as a broken door mechanism, or a small fire may not be noticed as possible factors in an environmental or horizon scan or systems mapping exercise. Such oversights of quotidian elements can have dramatic implications, however; both a malfunctioning door awaiting repairs, and a fire onboard a truck below ground were factors in two separate high-risk incidents (including a radiation leak that has temporarily disabled operations) at the nuclear Waste Isolation Pilot Plant in New Mexico in February of this year.*

*Similarly, a lack of drama – or dread – may influence strategy and policy decisions. While we may attempt to assess such risks and probabilities rationally and analytically, we are fundamentally designed to act on more affective, experiential information. It is easy to imagine grasping critical uncertainties related to potential radioactive air leaks or watershed contamination from a deep geologic repository, for example. It may be more difficult to get a strategy team equally excited about chronic low-level exposure to background radiation from radon naturally released from soil and well water. While a nuclear waste accident triggers a predictable visceral response in most readers, a colourless, odourless gas released by decomposing soil may not. The latter may also be less compelling for project team members to render visually or in narrative scenarios. Yet radon exposure is the second leading cause of lung cancer in North America, with a relatively high probability for most residents of Ontario. Should it be ignored in an exploration of risks and opportunities related to radioactive*

*materials? If something triggers dread, it is more likely to get managed than something that is emotionally neutral.*

*Radiation exposure stemming from radon versus nuclear waste also provides an interesting example for noting some differences in risk perception frameworks of experts and non-experts in a domain. Statistically, the risk of mortality or morbidity from radon is much higher than that of an accident related to nuclear waste storage, since radon is a certainty in the environment across the continent, while a nuclear accident is a high-impact but low-probability event. To put this in perspective, radon exposure in the United States accounts for approximately 21,000 lung cancer deaths[24] per year (US EPA), while the Fukushima meltdown has so far resulted in one known death, with future deaths from related cancers for those living in the region predicted as low to none (Brumfiel, 2013). A Health Canada report on household radon exposure reports over 11% of homes in the Grey-Bruce region of Ontario, where the town of Kincardine and the Bruce nuclear plant are located, have household levels of radon above safe levels established by the Environmental Protection Agency (Health Canada, 2012). So a case could be made for including radon in such a discussion.*

*An expert perspective on such risks might focus on mortality impacts and (possibly) on cost-benefit analysis of potential interventions. From a lay perspective, risks from a nuclear accident are assessed as human-caused and therefore avoidable and unfair, as well as irreversible. These characteristics contribute to a high dread response that demands attention to reduce fear triggers (Slovic et al, 2004). Risks from radon, by contrast, are naturally occurring, ambient and, therefore, considered unavoidable. They are not irreversible in the sense that known and widely available mitigating strategies can reduce potential for harm. Radon, then, falls into a low-dread category of risk that can be ignored more easily than a nuclear accident. Such a scenario is likely to generate disconnects between expert and lay perspectives of risk and willingness to act.*

*Other phases of this imaginary foresight project may also be influenced by the impact of heuristics. Imagine a stage in the project involving small groups. In this scenario, it is possible such group sessions would be regional consultations held at different times across the province, with each session hosting*

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*[24] The US Environmental Protection Agency contrasts this figure with 17,400 preventable deaths per year associated with drunk driving, and 2,800 resulting from house fires*

*several tables of participants, each with a facilitator and note taker. The facilitation team may be aligned in terms of core objectives of the project and sessions, as well as what information to provide to the groups, but they likely vary in terms of managing the process within their own break-out groups.*

*When analyzing the information gathered at these sessions, the team might notice that one group or region appeared to be bold, ambitious and visionary in their contributions and discussion, while another seemed conservative, nostalgic and fearful of change. It is possible such differences could be cultural, regional, or specific to a culture of practice (for expert consultations). It is also possible the differences result from variations in the ways information was presented by facilitators (the framing heuristic). For example, presenting information with a positive or negative frame will influence risk-seeking and risk-avoiding behaviours in predictable directions. In decision-making, people tend to avoid risks when information is presented with a positive frame (e.g. when presented with survival rates of a surgical intervention) and seek risks when the same information is presented with a negative frame (e.g. presented with rates of adverse outcomes of the same operation). So the effect noted by the foresight team may be natural variation, or it may be a predictable result of information framing. The significance of this effect will vary with project aims. In this scenario, one community may appear eager to host a storage facility for nuclear waste and another more reluctant; however, these perceptions may actually be artefacts of choices made by the core team. Analysis, and policy or strategy decisions based on this information could be misdirected.*

*Each of the priority heuristics outlined in the paper and those in Appendix B carry their own implications. This narrative provides just a sample of implications of heuristics and cognitive biases in a foresight project as a starting point for further thinking and strategic discussion.*

*So how can such behavioural insights help improve foresight frameworks?*

# 9. Recommendations

Part of the promise of strategic foresight is an inherent capacity of the approach to overcome individual biases and limits to expansive thinking. In order to manifest this promise, practitioners must be aware of the impacts of cognitive biases in strategic foresight frameworks. Applying a lens based in heuristics and cognitive biases, for example, raises the possibility that, instead of *liberating* thinking, a foresight process will introduce different but equally tenacious anchors that may limit subsequent expansive thinking. Similarly, decisions made throughout the foresight process establish frames that determine and have embedded within them how individuals will tend to react when applying information in subsequent steps. As foresight practitioners, we need to consider such effects and align them with project objectives, approaches and methods. The following are additional recommendations that emerged from this research and analysis for applying behavioural insights to improve foresight frameworks.

## 9.1 The Project Team

Cognitive biases will shape the judgments of technical, subject-matter and process experts and non-experts, alike, in assessing potential impact of events as well as the likelihood of their occurring. These biases will also influence what individuals notice and highlight in environment and horizon scans. One step toward improving foresight frameworks, then, lies in factoring these insights into assembling the project team. It is worth identifying strategies that can mitigate or compensate for the effects of heuristics and associated biases among core team members, facilitators, researchers, and contributors (authors, artists,

graphic designers) throughout the project.

For those steps in the process where reference points are introduced by the project team, process facilitators should be aware of the biases they are introducing with the aim of crafting these with intention. This is true in particular of establishing anchors and frames when developing and presenting materials, preparing interview questions, facilitating groups sessions, and facilitating other information gathering and processing steps. For example, in project stages that involve multiple small groups for input or information processing, the project team may want to determine in advance whether there is value to having facilitators frame small group sessions consistently across all groups, or intentionally introduce different frames and anchors across the groups. The first strategy would support comparison across groups, while the latter might establish a type of diversity by introducing different starting points for small group discussions.

## 9.2 Desired Futures

When working with frameworks that articulate a desired future, it is valuable to note that establishing a desired future can generate a strong pull toward that reference point regardless of new information or emerging options. The more vividly this desired future scenario is rendered, the greater the effect of many heuristics and associated biases. A vivid desired future, for example, may establish a tenacious reference point against which any changes will be experienced as losses. For projects where nimble strategies are desired, practitioners may consider lessoning the vividness of the future scenario to mitigate this

effect, and to support pivoting as new information or options emerge.

## 9.3 Repeated Cycles

One finding that emerged from the research is the probability that, instead of liberating thinking, a foresight process introduces different but equally tenacious anchors that may constrain subsequent expansive thinking. Using multiple or repeated cycles in a foresight project may allow for repeatedly establishing anchors, shifting or adjusting as far as possible from them, setting new anchors, and repeating the process to ultimately achieve expansive thought or a similar effect. Building on this insight, there may be value in testing the hypotheses that 1) repeated cycles in a foresight project can shift anchors to simulate expansive thinking, and 2) this may be a best-available alternative given that anchoring is tenacious and otherwise limits expansive thinking.

## 9.4 Under- and Over-representation

Judgments of the anticipated impact and likelihood of events, including risks, probabilities, and uncertainties, are affected by cognitive biases. This occurs even when we are aware of the impact of heuristics on our decision-making. For foresight practitioners, then, it may be important to scan specifically for various types of events to counteract the impact of these cognitive biases. For example, knowing that events or elements that do not evoke a strong affective response (especially a dread reaction) tend be ignored or under-represented in scans and analyses, project teams can introduce strategies to look specifically for these elements.

Similarly, steps should be taken to ensure that elements with high-probability but low-dread affect are factored into strategy considerations, since these will otherwise be under-represented. By contrast, risk(s) of events that are statistically rare but that have occurred recently in the domain of inquiry will tend to be exaggerated. It may be worth calculating and applying statistical probabilities to uncertain risks to support and complement the assessments of project participants.

## 9.5 New Scanning Frameworks

To further strategic foresight practices by applying behavioural insights, a suggested next step is the development and testing of new or modified tools and strategies to identify, assess and account for heuristic biases in a project domain. Such tools would be designed to highlight elements that can cause friction in the project domain through their availability, affect and dread associations that contribute to strong, unstated biases. Friction in this sense is associated with:

1) Elements that distract individuals from noticing higher impact/probability events
2) Elements that act as a reference point for loss aversion
3) Elements that define a sense of status quo, and
4) Those that are highly/commonly available in the domain and among experts, key stakeholders, and informants. These may be hegemonic (a paradigm, formula, set of assumptions) or more visible and consciously identifiable (a news item or recent event).

# 10. Conclusions

This investigation was designed as a transdisciplinary exploration of human decision-making in risk and uncertainty with the aim of applying these behavioural insights to improving strategic foresight and scenario planning frameworks. To fulfill this objective, the research responded to three questions:

1) What informs and influences individual human decision-making in situations of uncertainty and risk?
2) How do these decision-making frameworks interact with strategic foresight approaches to problem solving?
3) How might foresight approaches be improved by incorporating these insights into individual human decision-making?

An extensive literature review began to address the first research question. This secondary research component incorporated literature from standard economics, behavioural economics, cognitive psychology and other psychology disciplines, negotiations theory, and decision-making theory. Drawing on the literature from these diverse fields of study on human perceptions of risk and decision-making under uncertainty, this investigation highlighted heuristics and related cognitive biases that influence individual human behaviours. From this review and synthesis of the literature, themes in mental shortcuts, heuristics and biases that influence decision-making and perceptions of probabilities were generated and organized for further exploration through a concept mapping approach.

Since strategic foresight project design varies by practitioner and project in level of engagement, stakeholder-centredness, methods for processing information, vividness of communication tools, and other factors, a highly recognizable and time-tested six-step strategic foresight method was outlined as a framework for this inquiry. Behavioural insights surfaced throughout this research were then applied to this strategic foresight framework, and implications were explored and discussed. Recommended improvements to existing models were presented and discussed as a starting point for further dialogue in the field.

The research material was further investigated by applying narrative as a thinking tool to explore and surface additional implications. The narrative component complements the traditional version of the paper, and provides for a dual reading. One is analytical and reflective – the academic reading of the research, which is consistent with the ways standard economics and decision-making theory suggest make good decisions should be made. The other – the narrative – provides an experiential application of the material using a contemporary complex problem where foresight might be of benefit. Using narrative, findings were applied to and illuminated through a contemporary case study of proposed nuclear waste storage in an Ontario community.

Part of the promise of a strategic foresight approach is its capacity to overcome individual biases and limits to expansive thinking, with the aim of facilitating strategic discussions about possible futures to improve decision-making in the present. This paper concluded that, to fully manifest this promise, practitioners must be aware of the impacts of cognitive

biases at all stages of a strategic foresight process, and apply such behavioural insights to improve foresight tools and frameworks.

## 10.1 Further Research

This paper argues that strategic foresight frameworks can be further aligned with their implicit and explicit promise through a concerted application of behavioural insights into human decision-making in risk and uncertainty. Further research and new or modified tools may clarify and support such improvements.

### 10.1.1 New Scanning Frameworks and Tools

To further strategic foresight practices by applying behavioural insights, one recommendation proposed earlier is the development and testing of new or modified tools and strategies for identifying, assessing and accounting for heuristic biases in a project domain. Effective tools would be designed to highlight elements that can cause friction in the project domain through their availability, affect and dread associations that contribute to strong, unstated biases. Such a friction scan would identify:

1) Elements that distract individuals from noticing higher impact/probability events
2) Elements that act as a reference point for loss aversion
3) Elements that define a sense of status quo, and
4) Those that are highly/commonly available in the domain and among experts, key stakeholders, and informants.

One possibility is to add Friction or some similar concept to the current STEEPV framework. Testing and iterating on a STEEPV+F tool, and sharing results across the field could speed and improve this process through further application, iteration and dialogue.

Comparative analysis of how having such information on heuristic friction could impact and/or improve outcomes of a foresight project is an area for further research.

### 10.1.2 Repeated Cycles

One finding that emerged from the research is the possibility that a foresight process, in contrast with its promise of liberating thinking, introduces its own anchors that constrain subsequent expansive thought. As previously noted, using multiple or repeated cycles in a foresight project may counter this effect by allowing for repeatedly establishing anchors, shifting or adjusting as far as possible from them, setting new anchors, and repeating the process to ultimately achieve expansive thought or a similar effect.

Building on this insight, there may be value in testing the hypotheses that 1) multiple or repeated cycles in a foresight project can shift anchors to simulate expansive thinking, and 2) this may be a best-available alternative given that anchoring is tenacious and otherwise limits expansive thinking. Additionally, if it seems viable that repeated cycles of anchoring and adjusting can achieve or at least approximate improved expansive thinking, the field might benefit from further exploration of how to move through such cycles at a faster cadence without losing quality.

### 10.1.3 Public Policy

In public domains, vivid emotional responses to some risks may lead to calls for regulation or policy to mitigate perceived (usually dread-associated) risk. Additionally, situations may arise where there may be public resistance to regulation when a risk triggers little or no emotional response. There is an opportunity to explore ways a heuristic-informed foresight framework could complement current technical risk assessments and policy decision-making frameworks (including cost-benefit analyses) to ensure evaluations includes both analytic and experiential frameworks. Any robust process would account for and embrace the different ways technical experts and non-experts in a domain perceive risks, including probabilities of individual factors, uncertainty over long time horizons, and the concepts of burden of risk and irreversibility.

### 10.1.4 Diversity Considerations

One question that remains is: does any of this matter? Does diversity across and among individuals in a strategic foresight project counteract any or all of the effects outlined above? This paper argues that a concerted application of the outlined behavioural insights to strategic foresight practice can produce results that more consistently align with the stated aims and promise of the foresight field than current frameworks allow. It is possible, however, that foresight as it is commonly practiced may produce similar ends accidentally. This possibility is raised by the example of multiple of repeated cycles producing a simulation of expansive thinking by shifting anchors through time or across project participants. Is a simulation of the promised effect enough?

In projects where the aim and focus question concentrate on stimulating liberated thinking and facilitating strategic discussions about possible futures, the diversity issue may be accounted for within current frameworks. In other projects, however, the stated aim is to produce good decisions, and avoid bad ones. This is evident in the nuclear domain case example outlined in the narrative of this paper. In such a problem domain, rich and expansive exploration is not sufficient. There is pressure to get things right – or at least to not get them wrong – since some choices could have catastrophic and irreversible impacts. These need to be identified and avoided, at least in terms of keeping options open until more information or better alternatives emerge. In such a case, being aware of and controlling for the impact of information framing on subsequent risk-seeking and avoiding behaviours, for example, could be critical to producing good strategy decisions. Simply having diversity in input may not suffice if the systemic and unintended impacts of heuristics are not controlled for where plausible in the process.

By contrast, in an exploratory project where unfettered thinking about a domain is a key project objective, this research raises the possibility that the greatest diversity can be achieved not through methods that recruit for the broadest significant representation from across a domain, but from among those *with no previous contact* with the stated problem or focus question. Based on this research, it is possible to speculate that recruiting team members, informants and participants naïve to the domain in question may diversify the reference points of various heuristics (affect, anchoring, and availability heuristics, in particular) and produce the most expansive, and un- or diversely-fettered exploration. This

may be one of the mechanisms underpinning innovation and radical breakthroughs in a field frequently generated by those who are new to it, or who come from an outside discipline.

**We were new to the field. We didn't know it was impossible.**

- Amir Safari-Naeini and Oskar Painter on measuring quantum motions 100,000th the radius of an atom in microscale objects using light

In this research, the predictability of shifts and references points related to heuristics and related biases were coded subjectively and explored briefly. This may provide a starting point for more robust investigation of these effects and their relationship with diversity considerations. Further research into the interactions and implications of diversity and heuristics and cognitive biases in strategic foresight could produce valuable insights for the field.

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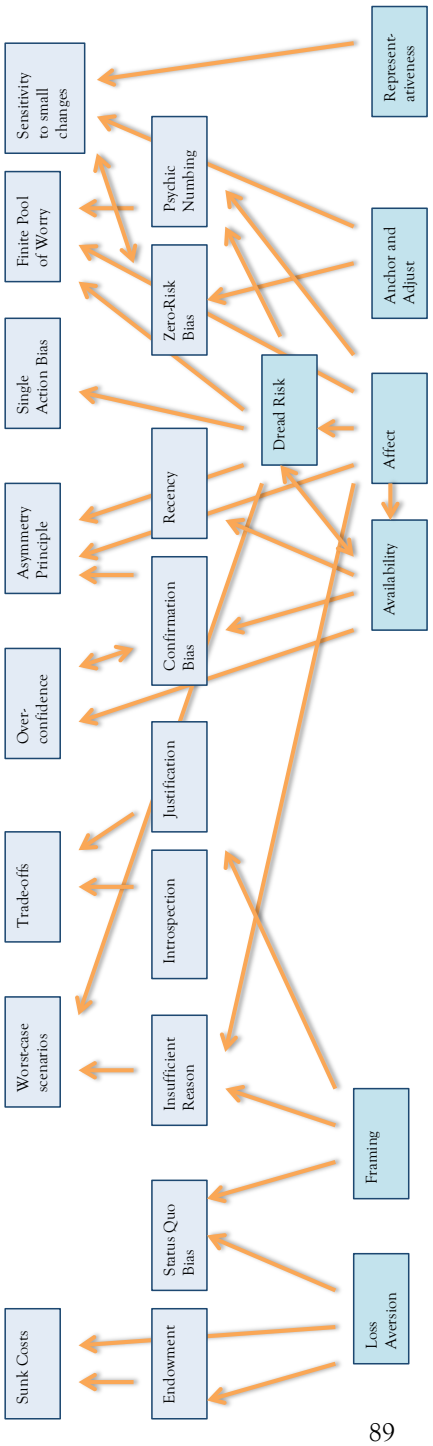
# Appendix A: Cascade Diagram of Heuristics, Biases and Effects




To prioritize them for further investigation, the heuristics, biases and other phenomena were:

1) Clustered by association (including different terms for similar phenomena)
2) Ordered hierarchically when a phenomenon was attributed/able in the literature to a higher order phenomenon (noted by the arrows), it was considered a lower (more specific) order

The most general phenomena appear at the bottom of the diagram. Arrows indicate some of their contributions toward other, more specific biases.

From this process emerged six heuristics (the highest order) to which the other biases, effects and fallacies could be attributed (see Table 2 for details).

# Appendix B: Additional Heuristics, Biases and Effects

**Asymmetry principle**

It is easier to lose or destroy trust than to build it. Slovic (1997) outlines that incidents that damage trust are usually clearly defined. They are events or moments that are noticeable and noted, while the types of things that build trust are not. Slovic gives this example: "How many positive events are represented by the safe operation of a nuclear power plant for one day? Dozens of events? Hundreds? When events are invisible or poorly defined, they carry little or no weight in shaping our attitudes and opinions" (1997, p. 302). Additionally, when either type of incident is visible, Slovic's research suggests trust-destroying events have a disproportionate impact.

**Burden of Risk**

While cost-benefit analysis and other assessment methods tend to examine hazards or interventions individually (Fischhoff et al., 1979), people include in their perceptions of risk a sense of equity – the concept of *burden* of risk. Is there a disproportionate cumulative risk? Is it unfair? Individuals tend to weigh risks, threats, interventions in combination.

**Finite Pool of Worry**

It has been suggested (Linville & Fischer, 1991; Marx & Weber, 2012) that people have a limited capacity to worry, what Linville and Fischer refer to as the **Finite Pool of Worry**, so that as worry about one hazard increases, worry about other hazards decreases.

**Introspection / Justification**

Thinking about the reasons for a decision in advance of making a choice can interfere with decision making and lead to poor choices or undesired outcomes. Multiple studies have found that research subjects asked to think about the reasons for their decisions before deciding made poorer quality decisions measured against expert insights than those who did not think about or justify their choices (McMackin & Slovic, 2000; Wilson & Schooler, 1991). The researchers concluded that thinking about pros and cons of decisions created distractions in the choice process by focusing attention on "non-optimal criteria" to the extent that individuals based their decisions at least in part on those criteria (Wilson & Schooler, 1991).

### Overconfidence

Most people are overconfident in the accuracy of their judgments almost all the time – especially when the accuracy is near the same level as pure chance. Not correlated to intelligence, and occurs among both laypeople and experts in a domain. Interestingly, Marx and Weber (2012, p. 107) highlight the broad literature that suggests some people are likely to exhibit little overconfidence – these include professions that receive immediate and constant feedback, including bookies and weather forecasters. Overconfidence may be partially an outcome of **Confirmation Bias** in which we are prone to seeking and synthesizing information – including from our own experienced memory searches – that reinforces our existing beliefs while avoiding challenges to such beliefs. Marx and Weber (2012) point out the downside to overconfidence is it reduces the inclination to seek additional information that might support consideration of alternatives.

### Principle of Insufficient Reason

Sunstein (2007) refers to the **Principle of Insufficient Reason**, that states when people lack info about probabilities they act as if all probabilities are equally likely.

### Single Action Bias

This is the tendency to take a single action to mitigate threats. Even when a multi-pronged response would have clear advantages, people are inclined to engage in only a single action because that one step removes the "hazard flag" (Marx & Weber, 2012) that provokes a response.

### Trades-Offs

Schwartz's (B. Schwartz, 2004) research into trade offs between or among options suggests that when faced with a single compelling option, we freely grasp it; however, when a second attractive option is introduced, it introduces trade offs that paralyze many decision makers. Trade offs introduce conflict, and Schwartz's research suggests such a conflict induces people to avoid choosing, altogether, even when the stakes are trivial (B. Schwartz, 2004, pp. 126–7). The phenomenon lies partly in the inclination to justify our decisions – to seek grounds for rejecting or selecting an option. This is more challenging when we consider multiple options, each of which might have features that are desirable.

### Worst-Case Scenarios

People perceive and treat situations as safe or unsafe based on emotional reactions (affect) to them and without looking at the likelihood of harm (Sunstein, 2007). Frequently ignore low-probability, high-impact events and round the perceived risk down to zero. Unless they have access (availability) to a negative outcome, in which case they exaggerate the risk. We react to worst-case scenarios with either / both indifference and overreaction.

**Zero-risk bias**

The tendency to prefer the complete elimination of a risk even when alternative options produce a greater reduction in risk overall. Research has demonstrated that people were willing to pay a disproportionately high price to completely eliminate a small risk (Baron, Gowda, & Kunreuther, 1993).