

Risk Management in the Arctic Offshore: Wicked Problems Require New Paradigms

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Abstract

Recent project-management literature and high-profile disasters—the financial crisis, the BP *Deepwater Horizon* oil spill, and the Fukushima nuclear accident—illustrate the flaws of traditional risk models for complex projects. This research examines how various groups with interests in the Arctic offshore define risks. The findings link the wicked problem framework and the emerging paradigm of Project Management of the Second Order (PM-2). Wicked problems are problems that are unstructured, complex, irregular, interactive, adaptive, and novel. The authors synthesize literature on the topic to offer strategies for navigating wicked problems, provide new variables to deconstruct traditional risk models, and integrate objective and subjective schools of risk analysis.

Keywords

Risk management; complexity, wicked problem; Arctic offshore.

Introduction

The public's trust in the effectiveness of traditional risk management practices has been shattered through recent disasters such as the financial crisis in 2008, the BP Deepwater Horizon oil spill in 2010 and the Fukushima radiation release in 2011. Although these disasters come from very different risk management contexts – finance, oil and gas and the nuclear power industry – with unique organizational risk profiles, all of them underestimated the degree of systems complexity and relied on traditional risk models. Traditional risk models perceive risk as primarily objective and identifiable, and utilize primarily reductionist, linear processes such as mathematical and statistical models. Pollack's (2007) research confirms this trend in the PM literature by surveying books, conference papers and research papers from 1992 to 2007. Empirical realism pervades the body of project management knowledge and the project management profession. Zhang (2011) finds that the majority of project management literature characterizes project risk as objective rather than subjective, and he calls for a framework that integrates both schools of risk analysis. Hancock (2010) echoes this criticism by using King's typology of four problem types:

Type I: Known outcomes + fixed sequences = deterministic

Types II: Known outcomes + known probabilities = statistical or stochastic

Type III: Known outcomes + unknown probabilities = uncertainty

Type IV: Unknown outcomes + debatable issues = emergence

Most conventional project management literature and techniques assume Type I and Type II problems while only a small portion of literature (Loch, DeMeyer, Pich, 2006) deals with Type III and Type IV problems. Using Charles Perrow's concept of 'normal accidents,' Hancock (2010) points out that type III and IV problems are the result of failures in complex, tightly coupled systems: The likelihood of disaster increases with a "higher degree of interactive complexity" and "tighter coupling" between systems components (cited in Hancock, 2010, p.40). Human operator error often takes the blame for system failures but it is merely the "trigger" rather than the root cause (Hancock, 2010). While the traditional, linear risk management practices are adequate for conventional projects, today's projects operate in increasingly complex system environments which require new education, processes and tools. In 2008, Bredillet—the editor of PMI's academic journal *Project Management Journal*—called for a new perspective and approach in project management research to meet the challenges of an unpredictable, discontinuous, unstable and nonlinear project environment: "I could argue that we are moving from an old paradigm—positivist—to a new one, or to a more balanced one, combining positivism, constructivism, and subjectivism, enabling us to address complexity, uncertainty, and ambiguity, because the old one is not working anymore." (Bredillet, 2008, p.3) Project Management of the Second Order (PM-2, hereafter) is a new project management paradigm that, according to Saynisch (2010), addresses Bredillet's call. As an extension of traditional project management, it advocates for an evolutionary, dynamic approach that uses simultaneously multiple techniques and tools to manage complex projects. Although the PM-2 concept is still in a "draft state," it won the IPMA Research Award 2007 and International Centre for Complex Project Management Research Prize 2010, and "will be the leading concept for the next decades" (Saynisch, 2010).

This paper contributes to risk management knowledge of complex project environments by linking the PM-2 to the wicked problem framework and applying it to the case study of the Arctic offshore as an example of a complex project environment. It synthesizes different

strategies from the wicked problem framework to navigate wicked problems, including new variables to deconstruct traditional risk management processes, which leads to reducing biases and integrating both, objective and subjective, schools of risk analysis. Supporting this theoretical extension of risk management knowledge and practice is an empirical analysis at the macro level, does the Arctic offshore as a project environment fit the definition of a wicked problem? Then, at the micro level, how do various stakeholders perceive, define, and identify risk? The data come from 22 presentations in a risk seminar series that the University of Alaska North by 2020 Forum and the International Arctic Research Center, organized during the fall of 2010 to spring of 2011. Scholars and practitioners from a range of disciplines discussed their definitions and assessments of risks in the context of offshore development projects in the Arctic.

Wicked Problems in the Project Management Literature

Wicked problems are problems that are unstructured, complex, irregular, interactive, adaptive and novel. They exist in any aspect of societal life—technological, cultural, economic, environmental, political, or legal—marked by complexity and interdependencies of stakeholders with differing views and values (Rittel & Weber, 1973). Wicked problems are found in different societal spheres, ranging from terrorism and AIDS to conflicts within project management teams over requirements, resources and competing interests. (The use of the terms—wicked problem and wicked projects—occur interchangeably in this paper employing Shurville and William’s (2005) definition of a wicked project as one displaying components of a wicked problem (cited in Finegan, 2010).

While wicked problems are still widely unknown in the project management literature in the U.S., international project management communities have a young but rich history of using the wicked problem concept in its literature such as academic journals, working papers and conference presentations. In Australia, Pollack advocates for a project management paradigm shift by combining soft and hard approaches. Finegan (2010) and Checkland (2000) have developed soft system theories as research methods and applied them in a variety of wicked problem case studies, ranging from systems engineering to resource management to climate change and disaster recovery to Australian space industry. In the U.K., theorists such as Checkland (2000) and Pidd (2004) at the University of Lancaster have played the leading role in developing wicked problem theory. British scholars, Hancock and Holt (2003), applied the wicked problem concept to the risk management case study of the Heathrow’s Terminal Five, illustrating the flaws of risk management processes which focused primarily on technical, linear solutions and neglected behavioral and systems complexity. Hancock’s book (November, 2010) *Tame, Messy and Wicked Risk Leadership* is one of the first publications of wicked problems in project management. In the U.S, project management literature started recently to pay attention to wicked problems. For example, Whelton & Ballard (2002) focused on the effects on the definition phase and Jeff Conklin’s research (2008) addressed wicked problems in organizations and project teams.

The wicked problem framework fits into the PM-2 reference model because both share elements from traditional project management, complexity theory, chaos theory, cybernetics, systems thinking theories and cognition theories. The concept of a wicked problem also underlies, as seen in Appendix A, Saynisch’s types of project complexity (2010): structural, technical, directional and temporal. Both concepts offer a systems view in dealing with complex projects which conventional, linear techniques do not provide.

Wicked Problem Characteristics Applied to the Arctic Offshore

This paper applies three characteristics of wicked problems from the wicked problem literature through Rittel and Weber (1973) and Conklin (2006): (1) uniqueness, social and technical complexity; (2) changing requirements and constraints to solutions and (3) multiple stakeholders with different views and values—to show that identifying and managing risks in the Arctic offshore environment is a wicked problem. Within these three characteristics, we provide few examples to illustrate how they apply to the Arctic offshore project environment.

Uniqueness, Technical and Social Complexity

As onshore resources decrease and global warming change the landscape of multi-year sea ice, there have been efforts worldwide to explore the options of offshore oil development in the Arctic. Some Arctic countries such as the U.S. and Canada have plans for exploratory offshore drilling projects in the Arctic while other countries like Russia and Greenland move closer to implementing development drilling there. Some previous oil and gas projects are in some sense arctic, such as the Northstar project in Alaska, the Snøhvit project in Norway and Sakhalin I and II in Russia's Far East. However, exploration and development in the Chukchi and Beaufort are unique with their own design challenges and solutions. It is thus novel and unique which is, according to Rittel & Weber (1973) and Conklin (2006), a characteristic of a wicked problem.

Offshore Arctic projects have a high degree of technical and social complexity. Conventional or “tame” projects, according to Rittel and Weber (1973), can be “very technically complex,” but they have overall less systems interfaces, social and behavioral complexity and uncertainty than wicked problems (Conklin, 2006). Technically, the Arctic offshore project environment poses risks from an engineering and response and rescue perspective. Offshore structures need to withstand multiple year ice, strong winds and ocean currents. With accelerating climate change, it is not certain if materials and engineering specifications are sufficiently defined and designed. Designing and operating infrastructure in this extremely harsh and remote environment poses unique project risks, as reflected in Fisher's (2006) risk analysis of oil and gas capital projects (OGP, hereafter) in Alaska. By comparing these risks to OGP in other parts of the U.S., Fisher's survey of Alaskan project professionals concludes that Alaskan OGP are unique. This is particularly true for their External and Technical risk factors which constitute 91 percent of the all the identified risks in OGP in Alaska (p.49). Fisher's analysis shows that OGP in Alaska is inherently complex and unique by nature; operating offshore projects in one of the most vulnerable, unique ecosystems in the world will add to this complexity. The same finding is true for technical capabilities of government and industry to respond and contain major oil spills adequately and quickly (see more detailed discussion later).

The social-ecological impacts of Arctic offshore resource development on the fragile and unique Arctic ecosystem are unknown. Prince William Sound still hasn't fully recovered from the Exxon Valdez oil spill in 1989. A similar oil spill in the Arctic Ocean has potentially even more severe and long lasting ecological consequences. In addition to the oil spill risks, preliminary studies show that industry noise affects the migration of whales (Richardson, 1999). Any impacts on the environment will have complex social effects on the local Iñupiat population and their ten-thousand-year-old subsistence culture. While Iñupiat's own most of the threats to their local environment, they have relatively little to gain by offshore development in federal waters. Competing views and identities among Iñupiat's increase the social complexity: while some

groups support offshore development, others oppose it (see the ‘Multiple Stakeholders with different views and values’ section for a more detailed discussion).

Economic and energy security further increase the social complexity of this project environment. The State of Alaska depends on oil and gas exploration as it makes up 80 percent of its economy, collecting a total of \$141 billion in taxes and royalties (Goldsmith, 2009, p.26). The state of Alaska already started an offshore oil production venture with BP through its North Star field which is connected to shore by a causeway. The world’s first offshore oil producing site in the Arctic is mostly located on state territory about 6 miles northwest of Prudhoe in the Beaufort Sea, and has produced oil since 2001 (Rosen, 2007). As oil production through the Trans Alaska Pipeline (TAPS) declines to 1/3 of its capacity and the existing policies continue, the State will keep encouraging the oil industry to explore and develop oil fields in the Arctic.

The Federal government, as the biggest national owner of Arctic waters, also balances conflicting missions: the stewardship of marine resources, mineral leasing and revenues, the special legal relationship with indigenous peoples, maritime navigation and safety, and energy and national security. In the *Arctic Region Policy*, the Obama administration states its contradictory policy that the United States has "broad and fundamental national security interests in the Arctic region," including "boundary issues, scientific research, transportation, energy and environmental protection" (Lundestad, 2009). The federal agency of the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE, former MMS) is at the forefront of negotiating these federal policies. From 2005 until 2008, BOEMRE had revenues of \$2.75 billion through leases in the Chukchi and Beaufort Sea, including Shell’s Chukchi lease of \$2.1 billion (Joling, 2011). Geo-politically, countries like Russia have made territorial claims to the Arctic, putting pressure on other Arctic and non-Arctic countries to substantiate any claims in the contested area of the Outer Continental Shelf (OCS, hereafter). Seven Arctic countries (U.S. Canada, Norway, Russia, Greenland, Sweden and Norway) and non-Arctic Countries represent different stakeholders whose interests often conflict. The Law of the Sea—which the U.S. has not yet ratified—is currently the only international applicable policy, and legitimizes territorial claims based on a country’s portion of its continental shelf. According to the USGS report (2008), the Arctic has a total of 90 billion barrels of undiscovered, technically recoverable oil (13 percent share world-wide), 1,670 trillion cubic feet of technically recoverable natural gas (30 percent share world-wide), and 44 billion barrels of technically recoverable natural gas liquids (20 percent share world-wide) in 25 geologically defined areas located north of the Arctic Circle. Eighty four percent of these resources are offshore (USGS, 2008). These shares are between 20.5 percent and 27.6 percent of the total global resources which the industry perceives as the “last frontier of substantial resources” (SDWG report on Arctic Energy, 2009, p.7). In addition to hydrocarbon resources, other globally important resources such as marine mammals, shipping rights, renewable energy, fishing, tourism and water reserves also create conflicts between national and international stakeholders.

Changing Requirements and Constraints to Solutions

The Arctic is at the forefront of global climate change which occurs there at an accelerated pace. Jane Lubchenco, Under Secretary of Commerce for Oceans and Atmosphere and Administrator, National Oceanic and Atmospheric Administration (NOAA) put it succinctly “No single region better exemplifies the complex interdependence of communities and changing ecosystem conditions than the Arctic” (Leggiere, 2011). Environmental changes affect requirements for scientific research, regulation, engineering, operations and emergency response.

Due to insufficient baseline and monitoring data, limited understanding of system dynamics, and correspondingly unreliable forecasting models, it is difficult to predict the rate of climate change and its consequences on the marine environment. For example, baseline data for seismic activity, ice loads and currents are available for certain parts of the Arctic Ocean, but they are not always conclusive, complete and accessible. The Arctic Ocean Research and Science Policy Review Act of 2009 requires agencies to collect scientific baseline data in the Arctic (Metzger, 2010), but it will depend on Congress's willingness to approve funds to address these science gaps. The current preparedness level of the Coast Guard, as the first responder in Arctic emergencies, also illustrates new requirements for safe Arctic operations. A recent government report to congress indicates that the Coast Guard "doesn't currently have Arctic maritime domain awareness – a full understanding of variables that could affect the security, safety, economy and environment in the Arctic" (GAO, 10-870, 2010). One important factor is the lack of Coast Guard infrastructure in the Arctic. The nearest Coast Guard base is located 1000 miles away on Kodiak Island; the "tyranny of distance" in Alaska limits the Coast Guard's ability to engage in effective oil spill prevention, containment and cleanup (Montoya, 2010). The Coast Guard currently has three icebreakers of which only one is operational, limiting its Arctic response capabilities (*Witness the Arctic*, 2011).

As Arctic ice cover decreases, there might be less need for icebreakers in the long-term and higher demand for commercial ship models. For example, Hyundai Heavy Industries just completed testing of a new ice-breaking iron ore carrier, the 190,000 DWT, at the Institute for Ocean Technology in Canada (MarineLink, 2011). If these requirements are safe for Arctic operations, new sailing routes could cut the distance between Europe and Asia by 40 percent and with that, transportation cost and emissions. A higher level of Arctic activities through vessel traffic and drilling operations require the need for consistent regulation standards and safety and rescue infrastructure across the Arctic countries. Limited political support to fund research, to build capacities of agencies such as the Coast Guard and of Arctic infrastructure are constraints to solutions of operating safely in the Arctic, which is another aspect of the wicked problem (Conklin and Weill, cited in Pidd, 2004, p.203).

Multiple Stakeholders with different views and values

Project stakeholders in the Arctic have conflicting views and values about the risks of resource development. Internationally, some Arctic countries such as Russia "embrace" offshore development while others such as Norway take a more careful approach. In 2008, Russia passed a law that permits the "transfer offshore blocks to state-controlled oil companies in a no-bid process that does not involve detailed environmental reviews" (Kramer and Kraus, 2011). In August 2011, Rosneft and Exxon Mobil signed a deal for offshore drilling in the Kara Sea. Many Russians perceive this place as "icy dump" because of nuclear waste disposal from nuclear submarines and testing (Kramer and Kraus, 2011). In contrast, Norway recently rejected drilling around the Lofoten and Vesteraalen islands off northern Norway which is an important spawning ground for cod (Amland, 2011). Canada's discourse about drilling safety in the Arctic offshore shows conflicting views between regulators and industry. While regulators and environmental groups favor 'expensive' relief wells as a mandatory requirement, the industry rejects the idea and focuses on improving technology to prevent and stop blowouts (McCarthy, 2011). Regulatory systems among major Arctic countries, as Baker's research (2011) shows, differ substantially. While some countries favor prescription-based regulation (i.e. USA) others rely on performance-based regulation (i.e. Norway, UK), resulting in varying environmental and

response planning standards. Another regulatory issue is that the existing guidelines by the Arctic Council are “non-binding” and lack their own wording, but heavily rely on the UN Declarations such as the FPIC (Free Prior Informed Consent) principles for indigenous rights (Baker, 2011).

The position of Alaska’s North Slope Borough Mayor Itta shows that stakeholder opinions also vary at a regional level and over time: In 2007, Mayor Itta opposed offshore development, stating that “It’s a way of life against an opposing value. This way of life has value; nobody can put it in dollars and cents (Mouawad, 2007).” In fall 2010, he declined to legally challenge Shell’s recently approved permits for offshore exploration in the Beaufort Sea. The North Slope Borough and the Arctic Slope Regional Corp (ASRC) now support offshore development with best practice environmental protection by arguing that modern Native identity depends on economic development through resource extraction (Itta, 2011; Glenn, 2011). In contrast, the Native Village of Point Hope, the Inupiat community of the Arctic Slope, community leaders in Nuiqsut (Napageak, 2011) and tribal-environmental groups like Resisting Environmental Destruction on Indigenous Lands (REDOIL) oppose offshore development because of the risks to the environment and subsistence culture (Burke, 2010).

Stakeholders also differ in evaluating the capacity to clean-up major oil spills in the Arctic. Shell claims “We already took into account worst-case discharge when we built a world-class Arctic oil spill response fleet for Alaska, so it’s hard to imagine raising the bar even higher than we already have in that arena” (Joling, 2011). Leah Donahey of the Alaska Wilderness League refers to a spill study in Norwegian Arctic, showing that “There is no known way to clean up a spill in the Arctic’s icy, extreme conditions” (Joling, 2011). Although discussing the same topic, both stakeholders have completely opposing views and perception of the risk and capability to clean-up a major oil spill. Discussion at the seminar questioned whether cleanup crews would be even deployed under hazardous weather conditions.

This macro-structural analysis of this case study shows that resource development in the Arctic offshore is a wicked project environment because it is unique and socially and technically complex; has changing requirements and constraints to solutions; and involves multiple stakeholders with different views and values. The next section examines risk complexity at the micro level to explain why and how stakeholders perceive these risks differently.

Analysis: Risk Complexity at the Micro-Level

Research Methods and Approach to Analysis

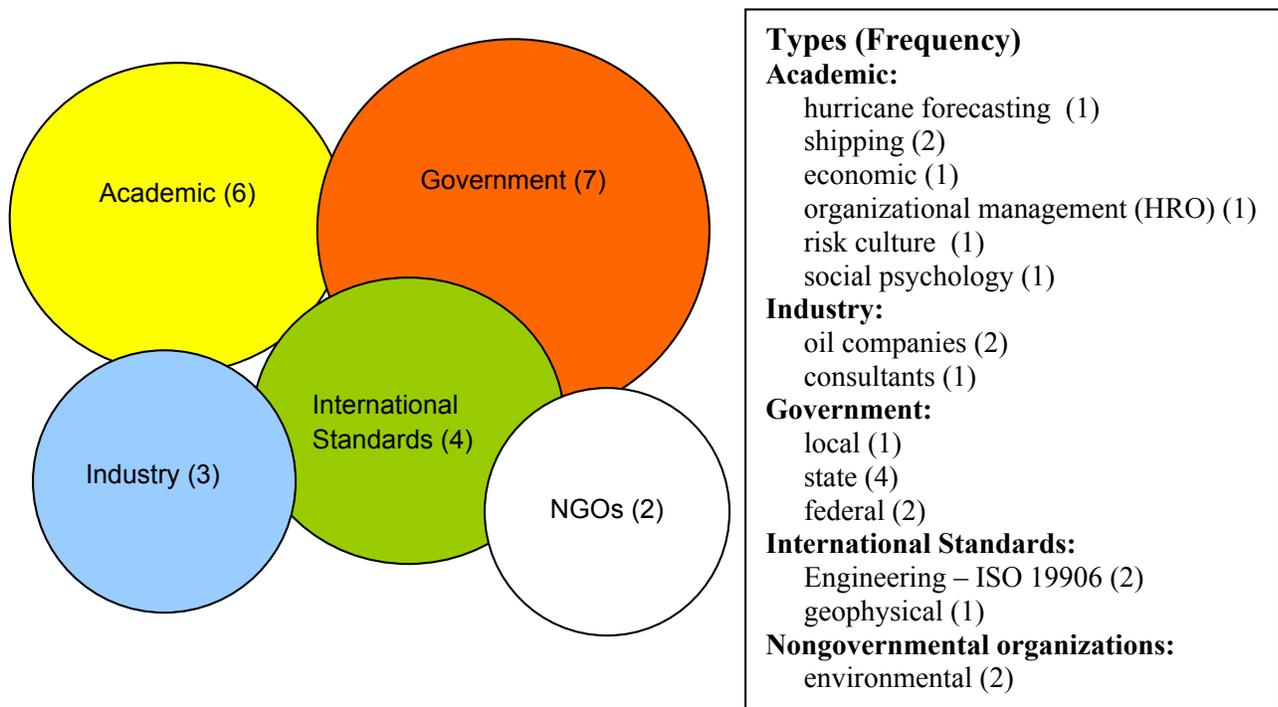
Content analysis is the methodology of choice; Appendix B shows the research protocol used for analyzing the presentation data from the seminar series “Defining Risk in Arctic Coastal and Offshore Resource Development: Perspectives and International Standards” that was organized by the University of Alaska North by 2020 Forum during the fall of 2010 to spring of 2011. This qualitative, non-statistical social science research method analyzes different types of communication. (Presentation data including video and Power Point slides are available on a website *North by 2020: Defining Risk in Arctic Coastal and Offshore Resource Development: Perspectives and International Standards*). Appendix C shows the seminar schedule with

presenter, date and title of the presentation.) After attending the presentations and reviewing the video recordings, we coded the presentations—according to the research protocol in Appendix D—to analyze the descriptive data. Additional information came from post-presentation Q&A sessions and the organizations’ webpages.

The Risk Seminar Series

The risk seminar series is a North by 2020 project which is part of the International Polar Year initiative that aims to increase understanding of Polar Regions globally. The risk seminar’s primary goal was to identify some of the major institutional players from the private, public and governmental sector of the Arctic offshore project environment and to learn about their perceptions of risks. Figure 1 illustrates the broad scope of the seminar series.

Figure 1: Overview of Risk Seminar Series, Fall 2010 to Spring 2011



Twenty two presentations introduced some of the key stakeholders of Arctic offshore projects and explored different types of project risks which affect Arctic safety, ranging from oil and gas projects to Arctic vessel traffic to disaster management projects, both to human-caused and natural disasters (i.e. geophysical hazards and hurricanes), to human error in the decision-making process. The seminar series focused on risk perspectives of, regulatory agencies, oil companies, consultants, local governments, environmental NGOs, and academics. Each stakeholder’s risk context depended on the project type and organizational mission. The sample is not random, and while it is intentionally diverse, it does not represent all key stakeholders of Arctic Offshore projects.

Research Variables

The application of three research variables—risk paradigms, risk attitudes, and data sources—explains how and why risk perceptions vary among different stakeholders and project types.

While most research focuses on distinguishing between objective and subjective risk analysis, the use of these variables applies to both schools of risk analysis and deconstructs the risk analysis process. Utilizing these variables helps project managers to negotiate complex project environments with diverse stakeholder groups and is a first step to reconcile both schools of risk analysis.

Risk Paradigms

We identified five categories of risk paradigms: probabilistic-deterministic, traditional risk assessment, holistic, precautionary and cognitive psychology of decision-making (CPoDM, hereafter). Although the use of these terms is common, they are unique in this context. Although each risk paradigm conceptualizes risk differently, presentations displayed a wide spectrum of characteristics from different risk paradigms. This resulted in the possibility of presentations belonging to more than one category. In such cases we identified the presentation according to the paradigm most prominent within the presentation. For each paradigm, we provide a short overview, offer examples from the presentations and assess its robustness to deal with systems complexity and biases.

Probabilistic-Deterministic Perspective

The probabilistic-deterministic risk paradigm describes risk from a technical engineering perspective. Examples from the seminar series were Walt Spring's and Andrew Metzger's presentations about the ISO 19906 standard. This international design standard provides engineering design parameters for oil and gas offshore structures which are located in waters of varying ice cover due to seasonal changes (Spring, 2010). Legally, the ISO 19906 standard is not enforceable and each country decides about its own implementation. It only requires engineers to develop their own designs within the given parameters of the normative. While Walt Spring's presentation focuses on the development of the normative, Andrew Metzger's describes its philosophy. This means that structures are engineered in such a way to withstand certain stresses of actions (i.e. ice, waves, currents, wind).

The robustness of an engineered system is based on the reliability principle. That is the capacity of the system has to be larger than the demand on the systems. If both of these variables are known, the problem is deterministic and no risk exists. If the variables are unknown, it is a non-deterministic problem that has increased uncertainty in its engineering design. The distance between these two reliability values—the resistance factor ϕ and the load factor γ —within their statistical distributions determines the degree of uncertainty in the engineering design. As the distance between the two means increases, reliability increases and uncertainty decreases for a certain design (Metzger, 2010). Although this methodology is based on a sound process involving mathematical, statistical models and reliability theory, engineers determine the reliability values and their distance to each other according to their organization's needs and desired level of reliability. To control for these uncertainties, engineers usually “over-design” the structure through a “robust” design and use materials which exceed specifications. These considerations, however, put economic strains on project costs and stakeholder organizations investing in these projects. Organizational culture and cognitive biases play a significant role in making these design and oversight decisions.

In a recent article “Why risk analysis fails,” Douglas A. Samuelson (2011) points out eight common mistakes in risk analysis. In this context, we apply three of these which are appropriate for analyzing the probabilistic-deterministic risk paradigm critically: The first mistake is “unduly

limiting assumptions in the analyses” which pertains to applying the same models, variables and values in different project environment; for example, BP used the same drilling procedure and risk assessment to operate in unprecedented water depth for its Deepwater Horizon well. Samuelson says that the relationships between variables change and “uncorrelated behaviors become correlated.” Also, global warming may change calculations and relationships between ‘actions’ variables (i.e. ice, currents, wind) affecting the offshore structures. A second mistake is, according to Samuelson, insufficient attention to availability and quality of data. A robust statistical sample is required to calculate important variables such as ice actions. While some scientific data exists for some points in the Arctic, comprehensive data is lacking. In addition, there isn’t sufficient baseline data to determine the rate of environmental change and its effects on the design reliability during a product’s lifecycle. Forecasting models are imperfect and demand more data during its development process. Samuelson points out that modelers often choose not to collect more data but to use already existing, easily accessible data. As experienced engineers start to retire, transferring their knowledge base to the next generation of engineers will be crucial to make safe decisions in uncertain project environments.

Traditional Risk Assessment

The traditional risk assessment is a managerial approach that is process and expert centered and uses qualitative and quantitative tools. This risk paradigm perceives risk as something identifiable and manageable. The majority of presentations in the seminar series used this risk paradigm across different project environments and organizations such as maritime traffic (MRA - Aleutian), disaster management (MRA – USCG and Hurricane Risk Methodology), oil and gas infrastructure (IRA – SOA), regulatory agencies (BOEMRE, ADNR), and internal risk management processes of companies (Shell, Conoco Phillips).

PMBOK Guide (2008) includes risk management processes which reflect this paradigm; they are used to determine project risks and their effects on project objectives such as costs, schedule and scope. A “good” process is, according to Hancock, the “dominant control mechanism” that provides an impression of control (2010, p.5). The premise of the traditional risk identification and assessment process is that data gaps can be filled by using an iterative process to collect “High-Quality Information” such as historic records, interviews, experts, and workshops (*Practice Standard for Project Risk Management*, 2009). In contrast, Hancock argues that a lack of information is only one reason for uncertainty, but behavioral, social, interactive complexities also cause uncertainty.

Another common characteristic of this paradigm is assessing known risk by multiplying the probability of the risk occurring with the severity of this risk on project objectives. According to Hancock (2010), rules of probability do not capture the “reality of risk” (p. 41) and imply the “illusion of control and understanding [...] and enables organizations to devise risk registers that quantify risks in terms of figures, adding credence and authority” (p.5). This probability model may also encourage identifying unknown risks as if they were known risks to make them more “manageable.” Although PMI’s *Practice Standard for Project Risk Management* (2009) acknowledges the existence of “unknown” risks, it advises not to “waste” resources on unmanageable risks (p.32). This is one of the reasons why traditional risk assessment has an “abysmal record” of predicting rare, high impact—Black Swans—events (Taleb, Goldstein and Spitznagel, 2009). Another critique is that the calculation is linear in probabilities and outcomes, whereas human risk preferences are decidedly nonlinear. Humans tend to be more risk averse for

low probability but high impact adverse outcomes. On the other end, many people are risk seeking for low probability but high impact beneficial outcomes, like lotteries (see further discussion under Risk Attitudes)

Samuelson (2011) cites “insufficient empiricism about assessing quantitative methods” as a common mistake in risk assessment. Samuelson cautions using single measurement variables such as confidence intervals and standard deviation to assess risks and their impacts on projects. Research studies show that experts often struggle with their computations and these measurement variables do not account for all sources and excesses of variation as they exist in the real world (Hubbard, 2009, cited in Samuelson, 2009). Some critics even argue against using standard deviations in risk management (Taleb, Goldstein and Spitznagel (2009). This means, Samuelson (2011) says, that popular techniques such as Analytic Hierarchy Process (AHP) have limited utility; they “increase comfort far more than they improve actual results.” When assessing risks, risk team management members need to be aware of the elusiveness of risks and use risk assessment tools cautiously.

Holistic Perspective

The holistic risk paradigm employs a systems approach to risk, which takes a broader and more inclusive view to risk. It includes multiple disciplines and puts more emphasis on integrating traditional indigenous knowledge. Classical examples from the risk seminar series were associated with two presentations of the Arctic Council—International Arctic EPPR Standards and Arctic Maritime Risk Assessment— which reflect the policies and missions of this intergovernmental body and its working groups. Each working group of the Arctic Council consists primarily of technical experts, but the Arctic Council’s founding mission, as stated in the Ottawa Declaration of 1996, requires working groups to incorporate traditional indigenous knowledge (Arctic Council, 1996). In addition, the Arctic Council’s projects and their research scopes are complex, and require working across different working groups, stakeholders and disciplines. For example, International Arctic EPPR Standards uses a multi-disciplinary approach to identify emergency prevention, preparedness and response activities for different types of emergencies, whether human-induced or nature-induced. We also lumped in a group of academic studies such as Selkregg’s presentation about risk culture or Roberts’ research about High Reliability Organizations because they address dimensions of risk assessment which are unaddressed in the traditional risk paradigm. Another example of a holistic risk paradigm is the State agency’s Geological and Geophysical Survey; its organizational mission is to address Alaskan coastal communities’ geophysical risks by which 84 percent of these villages face the risk of flooding and erosion (Wolken, 2010). Traditional indigenous knowledge provides “anecdotal” information and supplements scientific geophysical data from baseline studies, mapping and fieldwork studies (Wolken, 2010; Eicken 2011). Although the holistic risk paradigm can include elements from other risk paradigms, it facilitates more than the other paradigms a project environment that sees risk identification and assessment from a systems view and fosters collective knowledge from different disciplines and cultures.

Precautionary Perspective

Environmental law differentiates between the precautionary approach and precautionary principle. This paper focuses on the precautionary risk paradigm as conveyed in the combination of these two quotes by British mathematician Peter Saunderson and the Wingspread Statement:

“[I]f one is embarking on something new, one should think very carefully about whether it is safe or not [for human health and the environment], ... [even if some cause and effect relationships are not fully established scientifically] and should not go ahead until reasonably convinced it is.” (cited in Bell, 2009, p.232)

The precautionary risk paradigm opposes traditional risk assessment, arguing that it is not possible to fully understand and manage risk. The precautionary risk paradigm is in essence risk averse by which no risk is tolerated if there is a chance of significant harm. In the risk seminar series, examples of this paradigm were environmental NGOs such as Pacific Environment and local government perspectives. Holley (2010) used two opposing questions to explain the precautionary perspective: The traditional risk assessment asks “How much harm is allowable” while the precautionary perspective states “How little harm is possible.” Its premise is that all projects are harmful and people make mistakes (Holley, 2010). The precautionary perspective also takes a critical view of the probabilistic-deterministic one by challenging the reliability of these engineering structures and the ability of the oil and gas industry and regulatory state and federal agencies to control the risks. The local North Slope Borough government, as another presentation, also identifies with the precautionary perspective but with a much ‘milder form.’ The NSB favors “Best Management Technology” (BMT) and “Best Management Practices” (BMP) which invites biases as to who determines this selection and how is “best” defined. Holley, in contrast, defines the precautionary principle in its most conservative form, appealing to moral and ethical standards to see it as “duty to take action to prevent harm” (Holley, 2010). As an environmental NGO, the precautionary approach is part of its organizational culture of environmental conservation. However, the presentation by Henry Huntington from the Pew Environment Group shows that environmental NGOs may vary within the conservation approach: The Pew Environment Group contributes to the “conversation” about offshore resource development by communicating its research results. Pew accepts the fact that a zero risk approach to offshore development is not realistic, and advocates for “raising the bar to the highest possible standards” and a more realistic practices of response strategies to oil spills such as controlled oil spills in Norway (Huntington, 2011).

Cognitive Psychology of Decision Making (CPoDM)

Project Management literature has focused on systematic biases in decision-making such as group think, overconfidence, sunk cost, organizational and project culture (Shore, 2008) while cognitive biases have been neglected. Biases represent common distortions in the human decision-making process, and “reflect a particular point of view that may be contrary to rational thought” (Shore, 2008, p.7). The cognitive psychology of decision-making (CPoDM) examines cognitive biases and their effects on risk perception in decision-making. Weber (2010) provides a succinct overview of the insights from psychological research on how humans perceive risk and how it affects decision making. She explains the common differences between expert and public perceptions of risk in terms of risk as an “objective” construct versus risk as a feeling. Perceptions of risk are affected by familiarity: unfamiliarity engenders fear (risk is

overestimated), while familiarity engenders complacency (risk is underestimated). Perceptions are affected by the perceived degree of individual control (e.g. driving a car versus flying in an airplane); the salience of recent events (e.g. Deepwater Horizon spill); by beliefs, expectation, values and culture; by unrelated issues competing for our limited capacity for attention; and by context cues, such as the social setting or the words used to describe the possible outcomes. There are also framing effects that weight gains differently than losses relative to some perceived status quo. Tolerance for risk tends to vary by age, gender, and affluence. Furthermore, individuals' risk taking and perception vary across different domains, physical, financial, moral, social or recreational. For example, they may be risk averse in recreational situations while seeking risks in business situations (Blais and Weber, 2006). Positive or negative experiences can change these perceptions. Therefore, decision-making under uncertainty is not a static and consistent concept but is rather fluid: emotions and cognitive evaluation affect how an individual or group perceives risks at a certain time, situation and place.

In her research about High Reliability Organizations (HRO, hereafter), Karlene Roberts (2010) uses the CPoDM framework with organizational theory to identify risk perception—what knowledge exists and to what extent it is acknowledged and mitigated—as one of five components organizations must possess to be considered highly reliable. The other four components are process auditing, reward system, quality degradation and command and control. From studying other high risk project environments such as the nuclear power industry, the chemical industry and naval carriers, Roberts points out the significance of repetitive safety training procedures in management and operations. The reward system encourages low power agents to actively participate in identifying and communicating risks. Applying the CPoDM framework contributes to deconstruct risk management processes, to create awareness of biases and to counteract complacency within project teams and organizations.

Primary Data for Risk Identification

Figure 2 shows the presentations grouped by risk paradigms (except the Cognitive Psychology of Decision Making) and primary data sources they use to identify risks. (Appendix E shows the detailed analysis, illustrating what data sources are utilized by different stakeholders.) Shading shows to what degree stakeholders utilize various data sources: dark means high use, light means low use, while white means no use at all.

Figure 2: Primary Data Sources for Risk Identification Process by Risk Paradigm

	Quantitative - hard	Qualitative - soft					Complementary
Data Sources	Geophysical, metocean and technical	Expert judgment	Lessons Learned	local knowledge	public testimony	social science research - interviews,	Systems modelling
Probabilistic-Deterministic							
Traditional Risk Assessmt.							
Holistic							
Precautionary							

Across all the risk paradigms, quantitative data in the form of geophysical, metocean and technical data and expert judgment are the most frequently used data source. However, the risk seminar series features a variety of qualitative data, ranging from expert judgment to specific social science research methods, which as a data category make up most of the data being utilized in the risk seminar series. Systems modeling can include quantitative and qualitative aspects depending on the type of model such as maps and forecasting models, and represent a simulation of the real world.

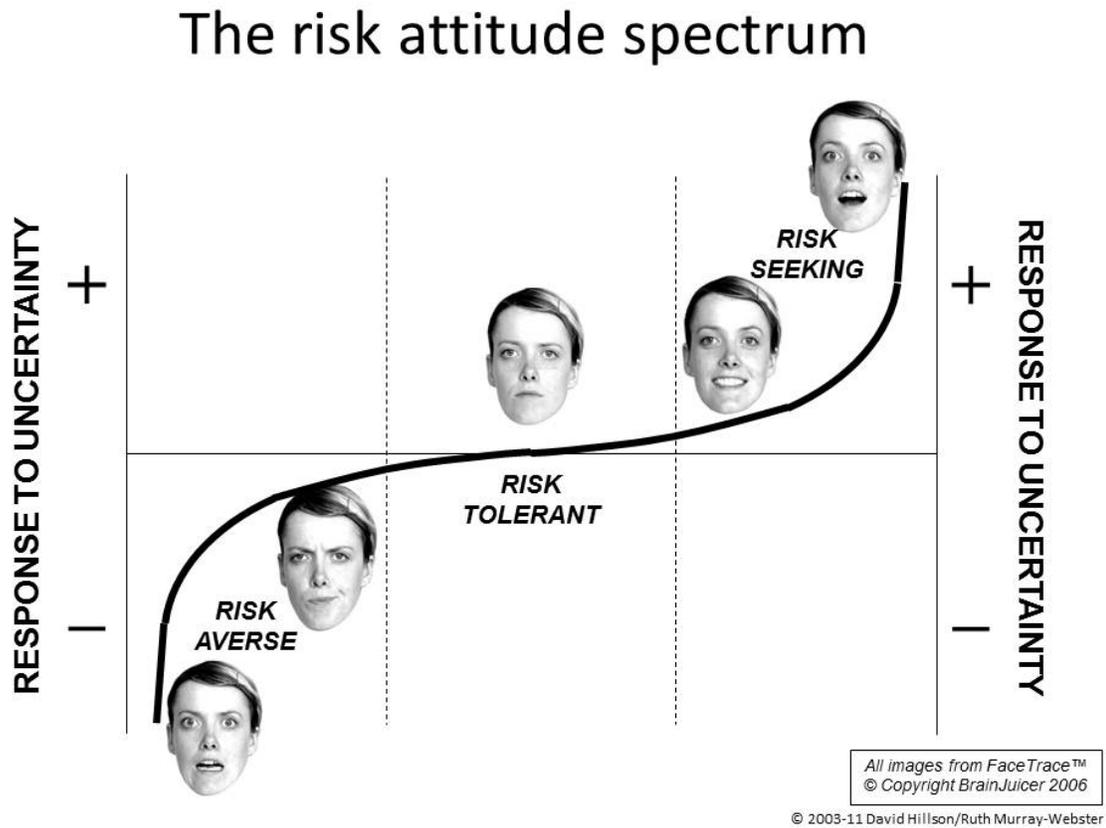
While some paradigms utilize a wide range of different data sources, others use only few. The probabilistic-deterministic employs more quantitative data while other types of data are either not utilized or not mentioned in these presentations. The traditional risk assessment paradigm uses six out of the seven types of data to identify risks, including qualitative data such as Expert judgment, Lessons Learned and complementary approaches. The holistic risk paradigm and precautionary principle use most of their data from qualitative and complementary data sources, and utilize all of the seven data types available.

Each risk paradigm uses quantitative data to identify risks but differs in their variety of data sources: The traditional risk assessment and the holistic risk paradigm have the most significant range of data sources and use more local knowledge than the other paradigms. The holistic and precautionary risk paradigms emphasize a wider range of stakeholder involvement, including local knowledge and public testimony.

Risk Attitude

The last research variable of this micro-analysis is risk attitude; the PMI's *Practice Standard for Project Risk Management* (2009) defines it as a "chosen mental disposition towards uncertainty, adopted explicitly or implicitly by individuals and groups, driven by perception and evidenced by observable behavior" (p.111). Although risk attitudes can occur on a continuous scale, PMI identifies four main categories as illustrated in Figure 3.

Figure 3. Risk Attitude Spectrum (from Hillson D. A. & Murray-Webster R., 2007)



- Risk-averse stakeholders are not comfortable with risks and are willing to avoid the risks. Examples from the seminar series are the North Slope Borough as local government, the Coast Guard as the incident commander and environmental NGOs.
- Risk-tolerant stakeholders are indifferent about risks. The majority of presentations had a tolerant risk attitude, including presentations from state agencies, the Arctic Council and academic entities. There is also a political interest from a government agency perspective to frame their risk position as neutral rather than tolerant or seeking. Organizations' risk attitude reflects also its mission and organizational culture. For example, State agencies that conduct risk assessments to protect public and environmental well-being balance this against other objectives such as State's revenues, employment or costs of moving villages away from coastal areas.

- Risk-neutral stakeholders manage risks based on their expected value. Two presentations reflecting this risk attitude come from the engineering-industry perspective. The engineering design process gives a sense of control and familiarity with the risk of design failure. Spring's presentation also reflects corporate interests of Shell, which potentially has the most to gain from Arctic oil development. Another presentation describes the economic risks of not developing resources in the Arctic offshore (Goldsmith, 2011).
- Risk-seeking stakeholders see risks as challenges and feel excited dealing with them. There weren't any stakeholders who had a risk seeking attitude.

Appendix F lists each presentation with its corresponding risk category.

Psychology research confirms this distribution of risk attitudes: People tend to experience level of discomfort to risks by being risk averse rather than being comfortable to risks and being risk seeking. In addition, there is a correlation of stakeholder's risk attitude and whether stakeholders will benefit or lose from risks. Those who have little to gain and are directly impacted by negative risks tend to be risk averse while those who potentially gain from it, tend to be more risk neutral or tolerant. As familiarity levels with project risks changes during the project, stakeholders may adopt a different risk attitude at different phases of the project.

Summary of Wicked Problem Discourse Analysis in the Arctic offshore

The foregoing analysis consists of two main sections. With the premise that existing linear risk management processes are inadequate to address complex project environments, the first section defined a wicked problem and applied three characteristics of a wicked problem. Arctic offshore is a wicked project environment because it is unique, socially and technically complex, has changing requirements and constraints to solutions and involves multiple stakeholders who have different views and values about project risks related to resource development. According to Conklin, there is "neither right nor wrong" when dealing with wicked problems, because different perspectives represent "independent values and goals" from their ideological or cultural point of reference (Conklin, page 7).

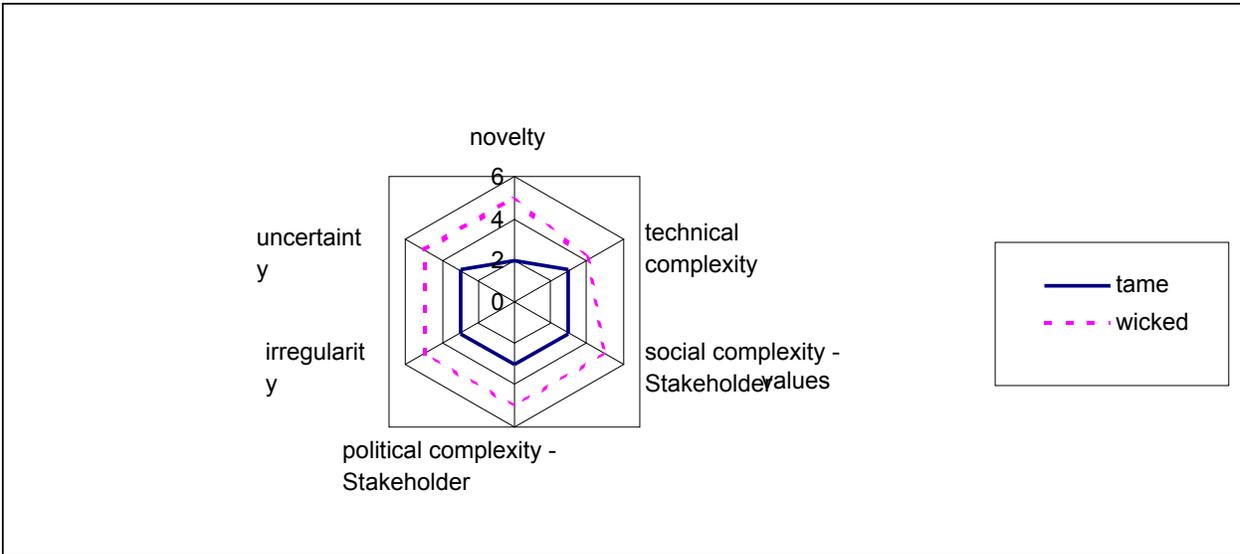
Examining risk complexity at the micro level through a unique set of presentation data explains the reasons why stakeholders perceive and define risks differently: each stakeholder group employs a distinct combination of risk paradigm, risk attitude and data for risk identification which individuals -- based on project type, disciplinary conventions and individual cognitive biases -- use and interpret differently. Some stakeholders defined risk as something identifiable and manageable through risk management processes and tools as illustrated by the traditional risk assessment approach, others defined risk as a social construct and feeling which perceives risk as less tangible and not manageable. Each risk paradigm used a distinct set of data sources depending on the project and its purpose. The holistic risk paradigm utilized, though to varying degree, most of the available data sources available and put most emphasis on involving diverse groups of stakeholders and local knowledge. The majority of presentations used a neutral risk attitude while others were risk averse or risk tolerant. Risk attitude depends on various factors such as organizational culture, proximity to risks and potential outcome for the stakeholder, from either positive or negative risks.

How can risk managers navigate wicked problems?

Strategies for Navigating Wicked Problems

Risk managers have several emerging tools and theories to tackle wicked problems. Some are under development in project management theory and practice, while others are rooted in other fields of social science and professional practice. The risk identification phase is most critical. The risk manager must identify the problem as wicked, not tame, and recognize the shortcomings of traditional, linear risk management techniques. Figure 4 synthesizes different wicked problem literature: it conceptually shows the difference between wicked and tame problems in terms of their dimensions and degrees of complexity (Rittel and Weber, 1973; Conklin, 2010).

Figure 4. Wicked versus Tame Complexity



Synthesizing some of the literature and our research findings, here are some strategies of the wicked problem framework:

Systems thinking theories are tools to identify and understand different aspects of wicked problems (Checkland & Winter, 2003). Andrew Finegan (2010) recommends a multi-technique approach of different system thinking theories—Soft Systems Methodology (SSM) and System Dynamics Modelling (SDM) and Grounded Theory (GT)—because each technique has its own strengths to understand the wicked problem. Appendix G describes each theory in detail.

After identifying that the problem is wicked, a participatory, deliberative process, such as a risk workshop, can facilitate diverse stakeholder representation to assess and mitigate risks collectively. This participatory, deliberative process relies on four key principles:

Integrate collective intelligence. Complex problems are beyond the scope of knowledge of any one individual or group. Therefore, decision-making situations must employ collective intelligence to transfer, receive and integrate knowledge about wicked problem complexities (Weber and Khademian, 2008). Diverse representation integrates and harnesses collective intelligence. Research indicates that for complex problems, utilizing collective intelligence leads to better decisions over the long run. If stakeholders with a range of different risk paradigms are at the table, the risk analysis would be more complete, democratic and effective.

Employ local knowledge. Local stakeholders have unique knowledge, vantage point, observations, interests and perspectives. The risk management process should fully engage local stakeholders and utilize the resources they bring to the table.

Distribution of risks and benefits. Risks and benefits are not evenly distributed in space, time, or social landscape. Stakeholders who bear a disproportionate share of the adverse risks need to be engaged and represented in the risk management process. This is not only a question of environmental justice, but of managing political risk, decreasing the likelihood of legal, political or extra-legal opposition. At-risk stakeholders are likely to promote and improve strategies for risk reduction, impact mitigation and response, as well as strategies for sharing benefits to promote buy-in.

Equitable solutions. Recent scholarship on the politics of ecosystem management demonstrates the benefits of participatory and deliberative methods of decision-making for finding equitable solutions to conflicts over natural resources. Theories of participatory and deliberative democracy suggest that the trust and “buy-in” that are the foundation of institutional sustainability can be best achieved when decision-making processes account for the individual calculations of interest of stakeholders and where shared values are developed within flexible arrangements for making and implementing policies (Ager, et al, 2005; Lipschutz 1996; Janicke 1996). Discussion on design principles for effective participation can be found at Haley et al. (2011).

How can risk managers implement this participatory, deliberative process to approach wicked problems more effectively? Risk leadership competency will encourage risk managers to use an adaptive management approach, and problem-structuring tools aid in the conduct of multi-stakeholder processes to conceptualize risk.

Risk Leadership competency. Hancock’s concept of risk leadership (2010) is the management competency that risk managers need in order to approach wicked problems. In contrast to traditional process-based risk management, it encourages risk practitioners to take a “reflective, situational approach to project management” by acknowledging and even, embracing risk management’s imperfect, dynamic and complex nature (Hancock, p.86). Appendix H compares risk leadership to regular risk management characteristics. Risk leadership emphasizes a behavioral approach in risk management by taking into account different beliefs, risk perceptions, motivations and needs. According to risk leadership, the risk process adapts to overcome other project risks such as politics, bureaucracy and resources and to facilitate “satisfactory” solutions for the “common good” rather than optimal solutions for few stakeholders (Hancock, 2010). This concept of risk leadership is congruent with the literature on adaptive management. For application to the Arctic offshore project environment, see Rosenberg and Powell (2011) and Hazlett (2011).

Problem Structuring Tools. Risk managers can use problem-structuring tools such as Mind maps/ Rich picture, risk variables (i.e. paradigms, data sources and risk attitudes) and their definitions to assist stakeholders with conceptualizing the problem collectively.

- Mind-Maps/Rich Pictures are graphic models of “the insights of people” that “make them accessible to others” (Pidd, p.6). Rich Picture from Checkland’s soft system methodology (SSM) is the most common application, but there are other models. For example, Conklin’s Dialog Mapping is an iteration of Rittel and Weber’s issue-based information system (IBIS) that focuses on recording group decisions while Eden and Ackermann’s cognitive mapping model assists individuals and groups in strategic situations (cited in Pidd, 2004).
- Variables and their Definitions: Stakeholders can use risk variables —risk paradigms, data sources and risk attitudes—to deconstruct existing risk management processes and mitigate their own and other stakeholders’ biases. Ideally, stakeholders are aware of their own and other stakeholders’ risk paradigms, of the biases from data sources and invite perspectives from other paradigms to aim for a complementary approach. In addition, the classical SSM approach, the CATWOE analysis, can stakeholders’ definitions of **C**ustomer, **A**ctors, **T**ransformation process, **W**orld view or perspective, **O**wners and **E**nvironmental forces. Clarifying definitions of these concepts contributes to common understanding among stakeholders about the problem and each other’s perceptions.

Why should risk managers and upper management support this wicked problem framework as a methodology to approach risks in complex projects? Key benefits include mitigating biases, conflict reduction and building trust and relationships.

Mitigate bias. Traditional risk management, grounded in the linear, reductionist paradigm, brings that particular bias to the conceptualization of risk. If the project or risk management team consists of primarily experts from the same organization or industry perspective and with a similar familiarity level, the risk assessment is more homogenous and biased. The wicked problem framework creates awareness of cognitive biases among team members and experts and encourages participation from team members and stakeholders who have diverse backgrounds (i.e. experience level, functional areas, organizations and industries). Although *PMBOK Guide* (2008) calls for a broad stakeholder input and quality data to mitigate cognitive and motivational biases, concrete steps on what and how to facilitate this process are lacking. Elke Weber’s research (2011) offers insights about creating an effective group setting, such as a risk workshop or extended stakeholder dialog, to promote convergence in risk perceptions, favour collective over individual goals and concerns, and foster a longer time horizon.

Conflict reduction. Conflicts among stakeholder groups are ubiquitous. When addressed early, disagreements can be valuable catalysts to creative solutions that are supported by the group, particularly if there is active communication and a shared interest in problem-solving. The end result can be greater support for, and therefore more durable, solutions and their implementation. In multi-party processes, the design of the process can determine how conflict is prevented as well as addressed when it emerges. The field of collaboration and conflict resolution offers several principles for effectively engaging parties in a process: see the 2005 OMB-CEQ memorandum to federal agencies engaging in collaborative problem solving and environmental conflict resolution, and from draft principles the US Institute developed for stakeholder engagement in marine spatial planning. (Palmer, 2011

<http://www.iarc.uaf.edu/en/NX2020/SI/program/panel2-palmer>)

Relationships and trust. Face-to-face dialog over time builds cross-stakeholder relationships, understanding and trust. Communication and trust is prerequisite to collaborative problem solving, including conflict resolution, adaptive management and rapid response to unprecedented events. New information, unanticipated change, and unprecedented events are hallmarks of dynamic, complex systems and require this kind of continuous learning, innovation and adaptation in risk management processes.

In short, for wicked problems, better solutions are reached through extended, face-to-face, facilitated dialog involving diverse stakeholders.

Conclusion: What Next?

Risk assessment and management will never be perfect or solvable. Traditional, linear risk management paradigm has implied that it can be done, but this is no longer true for complex—wicked—problems.

This paper offers the Arctic offshore as a practical application of a wicked project environment and analyzes how its stakeholders define risk. Different variables of risk analysis show how and why risk varies among stakeholders. Drawing from a range of literature, this paper suggests strategies to create adaptive, participatory risk workshops involving diverse stakeholders. Even if the wicked problem can not be solved, this analytical framework offers a better and long-term approach to engage and manage stakeholders and utilize collective knowledge about project risks in complex projects.

As society and projects become more complex with multiple layers of interactive complexity, the project management profession requires a systems view to risk management and collaborative strategies and institutions to address today's increasingly wicked projects with their unique and complex risks.

APPENDIX A

Four dimensions of Project Complexity (Saynisch, 2010)

Structural complexity - numerous individual structural elements; often described as “complicated”

Technical complexity - Complexity in project-product, among others, from technical or design problems

Directional complexity - Unshared goals and goal paths, unclear meanings and hidden agendas

Temporal complexity - Results from unanticipated environmental impacts, such as legislative changes or civil unrest

APPENDIX B

Rubric for Content Analysis

Presentation Title:

Date:

Time:

Presenter:

Place:

Duration:

Content Analysis Question	Answer Categories
What type of organization is represented in this presentation?	academic engineer, academic social science, engineering firm, management consulting, regulatory agency, leasing agency, local government
What is the purpose, context or application for this definition of risk?	i.e. international engineering code document, leasing and permitting, academic theory, applied case study
What dimension of risk is represented?	i.e. Engineering, operations, occupational health & safety, management, financial, economic, socio-economic, ecological - direct, ecological - indirect (dynamic system) community perception/human feeling, political
What risk paradigm is reflected in the presentation?	i.e. probabilistic-deterministic, risk as a feeling, holistic, precautionary
What is the primary data source for risk assessment?	i.e. Best available geophysical, metocean and technical data, Expert judgments, local knowledge, systems modeling, public testimony,
What risk attitude in the PM context is reflected in the presentation?	i.e. risk averse, risk tolerant, risk neutral and risk seeking
How much does this presentation incorporate diverse stakeholder perspectives, including local (Native) knowledge?	i.e. scale from 1-5

APPENDIX C

Seminar Schedule Fall 2010 to Spring 2011

- Thursday September 16, 3.00pm:

Introduction to the seminar series (H. Eicken, UAF) - @UAF

Walt Spring (Bear Ice Technology/Shell): The international standard on Offshore Arctic Structures ISO 19906 - What is it? When is it to be used? How does it incorporate risk? - @UAF

- Friday September 24, 3.00pm:

Laura Tesch (Environmental Resources Management): Aleutians Risk Assessment Program - @UAA

- Thursday October 14, 3.00pm:

Ben Greene & Robert Suydam (North Slope Borough) NSB perspectives on risk: Where to draw the line? Are we willing to gamble our Maktak to attract Big-Oil? - @BARC

- Thursday October 21, 3.00pm:

Elke Weber (Center for Research on Environmental Decisions, Columbia University):

Understanding, communicating, and managing risks across stakeholders and cultures - @UAF

- Friday October 22, 3.00pm:

David Barnes (UAF): Brief update on the Arctic Council's Emergency Prevention, Preparedness and Response Program - @UAF

Elke Weber (Center for Research on Environmental Decisions, Columbia University):

Understanding, communicating, and managing risks across stakeholders and cultures - @UAA

- Friday November 5, 3.00pm:

Gabriel Wolken (State of Alaska, DNR-DGGS): Assessing natural hazards in Alaska's coastal communities in a changing climate - @UAF

Cdr. Shane Montoya (USCG): R=SP2 (Risk = Severity, Probability, Preparedness) - @UAA

- Thursday November 11, 3.00pm:

Andrew Metzger (UAF): Engineering aspects of ice-related risks to offshore structures - @UAF

Seong-dae Kim (UAA): Hurricane risk analysis - @UAA

- Thursday November 18, 3.00pm:

Ira Rosen (Alaska Dept. Environmental Conservation) and Tim Robertson (Nuka Research): The Alaska Risk Assessment Project: How Does the State Assess and Manage Risks from Oil and Gas Development Activities? - @UAA

Lawson Brigham (UAF) - Risk assessment in the context of the Arctic Marine Shipping Assessment and evolving International Maritime Organization Standards - @UAF

- Thursday December 2, 3.00pm:

Carol Holley (Pacific Environment): Risk Assessment and the Precautionary Principle: At Odds in the Arctic? - @UAA

Sheila Selkregg (UAA): Cultural dissociation and risk exposure: Insights into critical decision making and loss of risk management commitment - @UAA

- Thursday December 9, 3.00pm:

Summary discussion - @UAF with participation by all sites

Schedule / Spring Semester 2011 (as of April 11, 2011)

- Friday, April 15th, 2011, 3:30pm:

Scott Goldsmith (UAA; ISER): "The Economic Risks of Not Developing in the Arctic Offshore"

Kevin Banks (Division of Oil and Gas, ADNR): "Incorporating Risk-Based Decisionmaking into Government Actions"

- Thursday, April 21st, 2011, 3:30pm:

Henry Huntington (Pew Environment Group): "Risks, Responses, Consequences: Why We Worry about an Arctic Oil Spill"

Alice Bullington (Conoco-Phillips): "Capital Project Risk Management in the Arctic Environment"

- Thursday, April 28th, 2011, 3:30pm:

Jeffery Loman (BOEMRE): "Preventing Success from Breeding Complacency"

Susan Childs (Shell): "The Safety Case: Implementing a System for Identifying and Addressing Risks in Offshore Operations"

- Tuesday, May 3rd, 2011, 7pm: Panel Discussion: "Managing Oil and Gas Risks in the Arctic Offshore: Emerging Perspectives." Panel speakers include:

Fran Ulmer, Fran Ulmer, Chair, US Arctic Research Commission

Catherine Foerster, Alaska Oil and Gas Conservation Commission, "Ensuring mechanical integrity from exploration to abandonment in Alaska."

Jeffrey Loman, Bureau of Ocean Energy Management, Regulation and Enforcement, "Risk Management – The NASA Experience"

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Karlene Roberts, Center for Catastrophic Risk Management, UC Berkeley, "High Reliability Organizations (HROs) and High Performance."

- Thursday, May 5th, 2011, 3:30pm:

Karlene Roberts (UC Berkeley; Center for Catastrophic Risk Management)

- Friday, May 6th, 2011, 3:30pm:

Karlene Roberts (UC Berkeley; Center for Catastrophic Risk Management)

- Thursday, May 12th, 2011, 3:30pm:

Hajo Eicken (UAF; IARC/Geophysical Institute): "Assessing Environmental Hazards in Arctic Coastal and Offshore Resource Development"

Mandy Kaempf (UAA): "Risk Complexity: The Arctic Offshore as a Case Study" Discussion

APPENDIX D: Coding of Presentations

Presentation #	Presenter – Background	Type of organization - Role	Presentation Title	Short Descriptions	Topical Keywords for references in tables
1	Walter Spring – academic engineer	Private – engineering consulting	The international standard on Offshore Arctic Structures ISO 19906 - What is it? When is it to be used? How does it incorporate risk?	Walt Spring, an engineer, works for Shell, and discusses the development of the ISO 19906 which is a international engineering design specifications standard for offshore structures in the Arctic.	Arctic engineering risk methodology - ISO - Spring
2	Laura Tesch – practitioner	Private – risk consulting	Aleutians Risk Assessment Program	Laura Tesch, a private consultant , presents the methodology for a risk assessment about maritime vessel traffic for the Aleutian islands which was conducted by a partnership between the state of Alaska and a consulting company.	Aleutian - Maritime Risk Assessment - Consulting
3	Ben Greene & Robert Suydam – academic natural scientist	State management agency – local government	NSB (North Slope Borough) perspectives on risk: Where to draw the line? Are we willing to gamble our Maktak to attract Big-Oil?	Ben Greene and Robert Suydam, two natural scientists, present the NSB perspective of a precautionary risk approach, including historical context of oil and gas development and scientific studies about its impacts on water and air quality.	Local Government Risk Perspective - NSB
4	Elke Weber – academic social scientist	Public – university	Understanding, communicating, and managing risks across stakeholders and cultures	Elke Weber, an academic psychologist from Columbia University, discusses psychological and cognitive biases in decision making under uncertainty.	Psychology of Risk Perception - academic

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5	David Barnes – academic engineer	Intergovernmental – international – Arctic Council	Brief update on the Arctic Council's Emergency Prevention, Preparedness and Response Program (EPPR activities)	David Barnes, an academic engineer and member of the EPPR working group at the Arctic Council, presents the vision, projects and current status of this working group.	International Arctic EPPR Standards - AC
6	Gabriel Wolken – academic social scientist	State management and regulatory agency	Assessing natural hazards in Alaska's coastal communities in a changing climate	Gabriel Wolken, a geoscientist, describes how the state of Alaska defines and assesses geological risks to Alaskan coastal communities.	Infrastructure Risk Assessment - SOA
7	Shane Montoya – practitioner	Federal – multi mission (regulation, enforcement, safety)	The Emerging Arctic R=S*P	Shane Montoya, a Coast Guard commander, presents challenges and risks the Coast Guard may face for future operations in the Arctic.	Maritime risk assessment - USCG
8	Andrew Metzger – academic engineer	Public – university	Engineering aspects of ice-related risks to offshore structures	Andrew Metzger, an academic engineer from UAF, discusses the philosophy of the international engineering standard for offshore structures -- ISO 19906.	Arctic engineering risk methodology - ISO Metzger
9	Seong Dae Kim – academic engineer	Public – university	Hurricane Risk Analysis	Dr. Seong Dae Kim, an academic engineer from UAA, discusses the relationship between improved forecasting models and response strategies in hurricane risk analysis.	Hurricane Risk Methodology - academic
10	Ira Rosen/ Tim Robertson – practitioner	State agency	The Alaska Risk Assessment Project: How Does the State Assess and Manage Risks from Oil and Gas Development Activities?	Ira Rosen and Tim Robertson, a project manager of the Alaska Department of Environmental Conservation, present the risk assessment methodology utilized by the state of Alaska and a consulting company to evaluate risks in operating oil and gas infrastructure at the North Slope in Alaska.	TAPS - Oil Infrastructure Risk Assessment - SOA

11	Lawson Brigham – academic social scientist	Intergovernmental – international – Arctic Council	Risk assessment in context of Arctic Marine Shipping Assessment and evolving Intl. Maritime Organization Standards	Lawson Brigham, an academic social scientist and a member of the Arctic Marine Shipping assessment working group at the Arctic Council, presents challenges, risks and current project status from an international intergovernmental organization perspective.	Arctic - Maritime Risk Assessment - AC
12	Carole Holley – practitioner	Non-profit – environmental	Risk Assessment and the Precautionary Principle: At Odds in the Arctic?	Carole Holley, program co-director of Pacific Environment, represents the environmental NGO perspective of a precautionary risk perspective. She discusses the historical context, its characteristics and differences to the traditional risk assessment approach.	Environmental risk perspective - NGO
13	Sheilla Selkregg – academic social scientist	Public – university	Cultural Dissociation and Risk Exposure: Insights into Critical Decision Making and Loss of Risk Management Commitment	Sheilla Selkregg, an academic social scientist, discusses the culture of risk as it relates to policy decision making about rebuilding infrastructure in high-risk earthquake areas.	Risk Culture - academic
14	Scott Goldsmith – academic economist	Public – research institute	The Economic Risks of Not Developing in the Arctic Offshore	Scott Goldsmith, an academic economist at ISER, uses forecasting models to state the long-term threats to the Alaskan economy (i.e. employment, tax structure) and its residents if resource development in the Arctic Offshore doesn't occur.	Economic Risks - academic
15	Kevin Banks – practitioner	State agency – regulatory	Incorporating Risk-Based Decisionmaking into Government Actions	Kevin Banks, regulatory administrator with the Division of oil and gas, discusses weaknesses and strengths of regulatory systems—the prescriptive (U.S.) versus the performance-based (European) system.	Regulatory risks -- ADNR

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16	Henry Huntington – practitioner	Non-profit – research	Risks, Responses, Consequences: Why We Worry about an Arctic Oil Spill"	Henry Huntington from the Pew Environment group, an environmental research NGO, summarizes the results of a research study about the capability of cleaning up an Arctic oil spill.	Environmental Risk – Pew NGO
17	Alice Bullington – practitioner	Private – industry	Capital Project Risk Management in the Arctic Environment	Alice Bullington, a risk manager of Conoco Phillips’s capital projects, discusses the internal risk management process to manage schedule, cost and scope risks.	Project risks – Conoco Phillips
18	Jeffrey Loman – practitioner (retired)	Federal – regulatory	Preventing Success from Breeding Complacency	Jeffrey Loman, a former federal regulator, compares his personal experiences of different safety cultures at BOEMRE and the NAVY	Regulatory risks: Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE)
19	Susan Childs – practitioner	Private – industry	The Safety Case: Implementing a System for Identifying and Addressing Risks in Offshore Operations"	Susan Childs of Shell explains the safety case as a risk methodology to identify and address oil spill risk in the Alaskan Arctic offshore. The bow tie reflects the process to prevent and respond to oil spill risks.	Process risks – Shell
20	Catherine Foerster – practitioner	State – regulatory	Panel: Ensuring mechanical integrity from exploration to abandonment in Alaska.	Catherine Foerster, a state regulator, describes the regulatory challenges of maintaining the mechanical integrity of oil and gas infrastructure.	Regulatory risks – Alaska Oil and Gas Conservation Commission (AOGCC)
21	Karlene Roberts – academic psychologist	Public - university	High Reliability Organizations (HROs) and High Performance	Karlene Roberts, an academic psychologist, discusses her research results about studying different types of high reliability organizations such as nuclear power industry, chemical industry and aircraft carriers.	Organizational management risks - academic

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22	Hajo Eicken – academic geophysist	Public – university	Assessing Environmental Hazards in Arctic Coastal and Offshore Resource Development	Hajo Eicken, an academic geophysicist, explains his research about changes in multi-year sea ice and their effects on the environment and infrastructure.	Geophysical risks – academic
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APPENDIX E

Risk Identification Data Used by each Stakeholder

			Primary data source - risk assessment						
			Quantitative - hard	Qualitative - soft					Complementary
# presentation	Topical Key words	risk source	Geophysical, metocean and technical	Expert judgment	Lessons Learned	Local knowledge	Public testimony	Social science research - interviews, experimental studies	Systems modeling
1	Arctic engineering risk methodology - ISO-Spring	oil & gas infrastructure	X	X					
2	Aleutian - Maritime Risk Assessment - Consulting	maritime transportation	X	X			X		X
3	Local Government Risk Perspective - NSB	oil & gas infrastructure	X			X	X		
4	Psychology of Risk Perception - academic	risky decision-making				X		X	

5	International Arctic EPPR Standards - AC	oil & gas infrastructure, maritime transportation	X	X					X
	Psychology of Risk Perception - academic	risky decision-making				X		X	
6	Infrastructure Risk Assessment - SOA	geophysical hazards	X			X			X
7	Maritime risk assessment - USCG	maritime transportation	X		X				
8	Arctic engineering risk methodology-ISO-Metzger	oil & gas infrastructure	X	X					
9	Hurricane Risk Methodology - academic	hurricanes	X						X

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10	TAPS - Oil Infrastructure Risk Assessment - SOA	oil infrastructure		X	X		X		
11	Arctic - Maritime Risk Assessment - AC	maritime transportation	X						X
12	Environmental risk perspective - NGO	human induced - oil & gas infrastructure & operation				X	X	X	
13	Risk Culture - Academic	natural hazard induced - earthquakes		X		X	X	X	
14	Economic Risks - academic	Oil & gas development		X				X	X
15	Regulatory risks -- ADNR	Oil & gas development	X	X	X		X	X	

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16	Environmental Risk – Pew NGO	Oil & gas development			X			X	
17	Project risks – Conoco Phillips	Oil & gas capital projects	X	X	X				X
18	Regulatory risks – BOEMRE	Oil & gas development	X	X	X		X	X	
19	Process risks – Shell	Oil & gas development	X	X	X				X
20	Regulatory risks - AOGCC	Oil & gas infrastructure	X	X	X				
21	Organizational management risks (HRO) - academic	Project management risks		X	X	X		X	
22	Geophysical risks – academic	Environmental - geophysical	X			X			X

APPENDIX F

Risk Attitudes

Risk Seeking	Risk Tolerant	Risk Neutral	Risk Averse
	<p>Arctic Engineering risk methodology – ISO - Spring</p> <p>Arctic Engineering risk methodology – ISO - Metzger</p> <p>Economic Risks - academic</p>	<p>Aleutian - Maritime Risk Assessment – consulting</p> <p>Hurricane risk methodology – modeling</p> <p>Infrastructure Risk Assessment – SOA</p> <p>International Arctic EPPR Standards – AC</p> <p>Arctic - Maritime Risk Assessment – AC</p> <p>Infrastructure risk assessment – academic</p> <p>TAPS – Oil Infrastructure Risk assessment – SOA</p> <p>Psychology of Risk – academic</p> <p>Regulatory risks -- ADNR</p> <p>Project risks – Conoco Phillips</p> <p>Regulatory risks - BOEMRE</p> <p>Process risks – Shell</p> <p>Regulatory risks – Alaska Oil and Gas Conservation Commission</p> <p>Geophysical risks – academic</p>	<p>Local government risk perspective – NSB</p> <p>Environmental risk perspective – NGO</p> <p>Maritime risk assessment – USCG</p> <p>Environmental Risk – Pew NGO</p> <p>Organizational management risks - academic</p>

APPENDIX G

Summary of techniques and their contribution to understanding wicked projects (adapted from Andrew Finegan, 2010, p.3)

Theory	Contribution to Wicked Projects
SSM – Soft Systems Methodology	Good at helping to better understand what to do about “the mess”. It can be incorporated into stakeholder and requirements analysis.
AR/AL – Action Research/ Action Learning	Assess in a better understanding of dynamic processes, and assist the management of innovation and change.
SDM – System Dynamics Modelling	The resultant models can provide an improved understanding by mapping the dynamic complexity of the project. It is useful to define cause-effect relationships. SDM can also be used to produce a post-mortem analysis of the project.
ANT – Actor Network Theory	Assist in tracing the relations in actor-networks, and encourage active participation and communication between different stakeholders and key players.
GT – Grounded Theory	Assist in the analysis of organizational contexts, and the analysis of issues in complex projects.

APPENDIX H

Traditional Risk Management vs. Risk Leadership (adapted from Hancock, 2010, p.87)

Risk Management	Risk Leadership
Works to a defined scope, budget, quality and programme.	Recognizes the possibility of different outcomes and tries to ensure that risk activities are directed towards making an acceptable set of outcomes more likely.
Uses the instrumental lifecycle image of risk management as a linear sequence of tasks to be performed on an objective entity using codified knowledge, procedures and techniques, and based on an image of projects as apolitical production processes.	Uses concepts and images which focus on social interaction among people, understanding the flux of events and human interaction, and the framing of projects within an array of social agenda, practices, stakeholder relations, politics and power.
Manages process to ensure complicated projects of people and technology are kept running smoothly.	Develops behaviors and confidence in team through scenario-planning and team-building to identify and respond to risks and opportunities.
Establishes detailed steps, processes and timetables for risk management.	Understands the ‘many acceptable futures’ proposition and manages risk to produce the changes needed to achieve the acceptable outcomes.
Practitioners as implementers of the risk process. Training and development which produces practitioners who can follow detailed procedures and techniques that are prescribed by project management methods and tools.	Practitioners as reflective listeners. Learning and development facilitates the development of reflective practitioners who can learn, operate and adapt effectively in complex project environments, through experience, intuition and the pragmatic application of theory in practice.
Applies concepts and methodologies which focus on risk management for product creation or improvement of a physical product, system or facility, etc., and monitored and controlled against specification (quality), cost and time.	Applies concepts and frameworks which focus on risk management as value creation, whilst aware that ‘value’ and ‘benefit’ will have multiple meanings linked to different purposes for the organization, project and individual.
Attempts to control risk by monitoring results, identifying deviations from the plan and developing mitigation actions to return to plan.	Adapts the risk process to overcome major political, bureaucratic and resource barriers to develop change in behaviors through trust and managing expectations.
Based on the assumptions that the risk model is (assumed to be) the actual terrain (i.e. the actual reality out there in the world).	Based on the development of new risk models and theories which recognize and take cognizance of the complexity of projects and project management at all levels and that the model is only part of the complex terrain.
Seeks predictability and order.	Has learnt to live with chaos, complexity and uncertainty, and leads through example to a successful conclusion.

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