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## **A Complexity-based Approach to Climate Change**

I appreciate the opportunity as a British Columbian to offer my thoughts on global climate change. My input is primarily directed to the Climate Leadership Team to help them think through paper submissions and formulating recommendations.

**"I think the next century will be the century of complexity."**

Stephen Hawking January 2000

In 1971 I attained a Bachelor's degree from UBC. It wasn't a degree in Engineering but in Applied Science. It constantly reminds me that my role as a professional engineer is to apply the laws of science to make the world a better place. In 1984 I attained a MBA from SFU. What I learned once again how to apply the laws of science but this time in social and formal sciences.

Two decades later I became aware how insufficiently my two university degrees had prepared me understand the 21st century. That's when I discovered another science called Complexity Science. It has emerged because the laws of science I learned at UBC and SFU could not explain how Nature and humans really behaved.

I look at the current university curriculums being taught and still see a huge vacuum. Newtonian physics, reductionism, convergence, cause & effect, linearity are the main lessons while concepts such as emergence, holism, diversity, biomimicry, correlation, non-linearity thinking remain on the sidelines. Yet these

phenomena of complexity are spoken in everyday language: going viral, butterfly effect, wisdom of crowds, tipping point, Black Swans.

We are taught how to think critically and value being competent at arguing to defend our position. We apply deductive and inductive reasoning to win our case. Sadly, little time is invested learning how to apply abductive reasoning and explore adaptation and exaptation to evolve a complex issue.

We are 15 years into the century of complexity. To what degree has complexity science been applied to today's climate change issues?

**"You teach how to think and not what to think. Teach curiosity; teach skepticism."**

Richard Dawkins 2015

While learning to be an applied scientist, I also learned how to be a skeptic. This is much different than being a cynic. Cynics push back because an cast-iron view they hold is being threatened. Skeptics push back because they want to really understand the issue by asking deep questions. Positive skepticism means accepting new information as it arrives and the willingness to alter/grow opinions as more is learned. As a skeptic, I believe Ignorance and Nonsense are just as valuable as Knowledge and Common Sense.

Thomas Kuhn enlightened us in his book *The Structure of Scientific Revolutions* how scientists (viz., astronomers) only observed data to support or continue to validate the paradigms dominating the period in time. We now know data can be missed due to internal cognitive biases or deliberately manipulated bordering on fraudulent behaviour.

History is full of examples when reliable facts later were proven wrong. Galileo was a skeptic who proved Aristotle was wrong. In 1931 Heinrich's Law stated in a workplace, for every accident that causes a major injury, there are 29 accidents that cause minor injuries and 300 accidents that cause no injuries. It is now deemed a myth. <http://bit.ly/1Qc4sUC>

Research has shown the left brain vs. right brain model which many personality assessment tests, self-motivation books and team-building exercises are based upon is all bunk. <http://bit.ly/1Qc4goe>

Recently it was announced that a new species of extinct human found in cave may rewrite history. <https://www.newscientist.com/?p=2056879>.

Regarding climate change, it shouldn't be a surprise that skeptics believe the Science is NOT settled. Last year Hans von Storch of the Institute of Coastal

Sciences in Germany stated: "We're facing a puzzle. Recent CO<sub>2</sub> emissions have actually risen even more steeply than we feared. As a result, according to most climate models, we should have seen temperatures rise by around 0.25 degrees Celsius over the past 10 years. That hasn't happened. In fact, the increase over the last 15 years was just 0.06 degrees Celsius – a value very close to zero."

I accept that both global warming and cooling are occurring. I remain skeptical about implications and predictions made by both experts and lay people especially when it comes to forecasting models.

***"Essentially, all models are wrong, but some are useful."***

George Box 1976

In addition, Hans von Storch said: "If things continue as they have been, in five years, at the latest, we will need to acknowledge that something is fundamentally wrong with our climate models. A 20-year pause in global warming does not occur in a single modelled scenario."

It's prudent to be skeptical and not take sides because the climate scientists might be both wrong or conceivably both right. My role as a skeptic is asking naive questions to open up new areas of ignorance (good questions rather than bad answers).

When gauging climate change arguments that use models, graphs, and maps to draw conclusions, the litmus test questions are:

1. Are the data reliable?
2. Is the model reliable?
3. Are the calculations reliable?
4. Are the people reliable?

Models and maps are just representations and somebody's interpretation of reality. Nobel Prize winner in physics Murray Gell-mann says: ""The only valid model of a complex system is the system itself."

All skeptics need to start somewhere. My starting point is global warming causes climate change. I act as if AGW is real while we all learn more about the dynamics of climate science.

**“Climate change is a complex environmental, cultural and political phenomenon that is reshaping the way we think about ourselves, our societies, relationships between socio- political and biophysical systems, and humanity’s place on Earth.”**

Mike Hulme 2009

I think I’m safe to say that Climate Leadership Team members like myself were schooled in a Newtonian environment. We are reductionists who can break apart complicated systems and analyze each part separately; the whole is equal to the sum of its parts. Using traditional problem-solving methods we search for cause & effect relationships. By applying constraints on system knowns, we can proclaim best practices. We resonate with Systems Thinking and can work with technology augmented by humans. We craft an idealistic future state and then apply more constraints like PMBOK® to force us there. All great stuff. But unfortunately not sufficient to deal with climate change. We are seeing the world with one eye open.

Opening the other eye reveals a different perspective where the whole is greater than the sum of its parts. New states of order emerge. Besides knowns and unknowns, there are unknowables and unimaginables. In systems thinking, it’s about identifying the parts, linear behaviour. In complexity thinking, it’s about the relationships and non-linear interactions between agents. An agent could be a human, a machine, an event (protest, war, vulcanism, Arctic methane expulsion, sun spots), an idea (pricing policy, rule, regulation, incentive). With so many uncontrollable variables, creating a measurable Future state based on predictions and assumptions is foolish. However, I do acknowledge that the exercise satisfies a need to control certainty, something that people like politicians crave. What makes more sense is to monitor the evolutionary potential of the Present.

**Cynefin**  
a sense-making framework

There are three basic types of system: ordered, complex and chaotic

Complex systems have propensities and dispositions but no linear material cause & effect

In Cynefin order is divided into ‘obvious’ & complicated and the fifth *domain* disorder

In a complex world we focus on direction & multiple parallel *safe-to-fail* experiments; not one *fail-safe* design

Management by vector .....

The diagram illustrates the Cynefin Framework with four domains:
 

- Complex:** Enabling constraints, probe-sense-respond, Emergent Practice
- Complicated:** Governing constraints, sense-analyse-respond, Good Practice
- Chaotic:** Absence of constraints, act-sense-respond, Novel Practice
- Obvious:** Rigid constraints, sense-categorise-respond, Best Practice

 A blue loop connects the Complex and Complicated domains, indicating a key area of focus for the Climate Leadership Team.

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Dave Snowden developed the Cynefin Framework that enables one to see the world with both eyes open.

See <https://youtu.be/N7oz366X0-8> for a video introduction. One note: the Simple domain has since be renamed the Obvious domain.

The blue loop indicates where the Climate Leadership Team should be operating. When reviewing paper

submissions, you are in the Complicated domain as a team of experts analyzing and discussing. When confusion and uncertainty arises, you move into the Complex domain to make sense of the situation. You open your mind by leaving

your existing beliefs and paradigms behind. You listen to stories to understand the meaning behind statements. Stories are a powerful way to collect and monitor climate change behaviour. Leverage the fact that humans are natural storytellers. Stories can reveal behavioural patterns that traditional surveys and interviews are unable to do. If a member of the Climate Leadership Team has an Organizational Development (OD) background, s/he will recognize we are practising the emerging field of Dialogic OD. <http://www.dialogicod.net>

Patterns show where to explore serendipitous opportunities as well as Black Swan possibilities. It's "connecting the dots" using the team's human intelligence (aka "distribution cognition"), not big data analytics.

Using abductive reasoning, you test hunches by probing with small safe-to-fail experiments. No business case necessary; just do it. If your hunch is wrong, no one gets seriously hurt. What hopefully crops up are newly found cause & effect solutions offering net positive benefits. You now move back into the Complicated domain to document, communicate, and implement recommendations and actions.

What follows are my bulleted comments and concerns applying a sense-making approach.

"In 2007, we set our greenhouse gas reduction targets based on the findings of the Intergovernmental Panel on Climate Change, the world's foremost authority on the subject, drawing on the expertise of more than 2,500 scientists." [BC Climate Leadership Plan]

- As a skeptic, I remain unconvinced the IPCC is the end and be all authority.
- I like to listen and give space to "outliers" who don't sing from the same hymn book. There are plenty of ongoing debates on YouTube such as "Is 97% or 0.3% that agree", Guy McPherson v. John L. Casey <https://youtu.be/ozC6ZrKYzco>, "Hiding the Decline", Prof. Judith Curry and Pacific Decadal Oscillation.

"Our focus remains firmly on our commitment to reach our legislated emission reduction targets for 2020 and 2050." [BC Climate Leadership Plan]

- This is a Complicated domain action for a Complex domain issue.
- Setting targets for an unpredictable future only fulfills a command & control edict: "If you can't measure it, you can't manage it."
- Being committed to political legislation is one thing. Trusting legislators is another. Since we live in a societal world, we can't ignore politics and the dynamics of "If you scratch my back, I'll scratch yours." Examples:
  - Australia has repealed its carbon tax, which PM Tony Abbott said was "useless and destructive [and] damaged jobs -- which hurt families' cost of living and which didn't actually help the environment."

- The governor of Florida, Rick Scott, has reportedly disallowed his employees to use the phrase, "climate change" and "global warming" when speaking in public.
- I was reminded of the term "political engineering" popularized by Chuck Spinney where the bureaucracies get their budgets, the contractors & consultants get their deals, the politicians keep their offices and get jobs in their constituencies, and no one who's not part of the system bothers to find out what is going on.
- I have no doubts that if emission reduction targets are set, success will be declared using gaming or rationalizing techniques.

"Need for action: By incorporating natural features such as green roofs, permeable paving and natural shorelines, we add to our communities' ability to adapt to a changing climate." [BC Climate Leadership Plan]

- I am pleased to see "adapt" in the plan. This recognizes that our communities form a complex adaptive system (CAS).
- More important than the ability to adapt is the speed to adapt. If flora and fauna cannot change as quickly as humans, our accustomed food supply may vanish and we die of starvation.
- I'm not so sure why a man-made green roof or paving is deemed natural but I am pleased to see the word "natural". Complexity is ubiquitous in Nature and why biomimicry is a huge innovative approach.

"B.C. established a revenue-neutral carbon tax in 2008 to encourage individuals and organizations to reduce fossil fuel use... The policy has been successful and continues to be a world-leading example of how to build a strong economy in a carbon-constrained world... Organizations such as the World Bank, Organisation for Economic Co-operation and Development and the United Nations identify B.C.'s revenue-neutral carbon tax as a model to follow." [BC Climate Leadership Plan]

- I support the idea of reducing our carbon footprint.
- As noted in the Glossary, carbon prices are used as a proxy to represent the level of effort in mitigation policies. We really don't know how much actual CO<sub>2</sub> is being removed by our green activities. Giving credit to solutions with questionable "If-then" relationships can be a slippery slope. It may be correlation, not causation.
- I am cautious about banging our drum too loudly. While we lead in climbing the ladder, we may later discover the ladder is leaning against the wrong wall and our carbon tax model is wrong. In my mind a world leader means having the courage to admit you're wrong and shifting direction.

“Putting a price on carbon is vital in addressing its impact on climate and future climate change costs. The price encourages companies and consumers to choose cleaner and more efficient ways to operate, and creates opportunities for low-carbon innovation.” [BC Climate Leadership Plan]

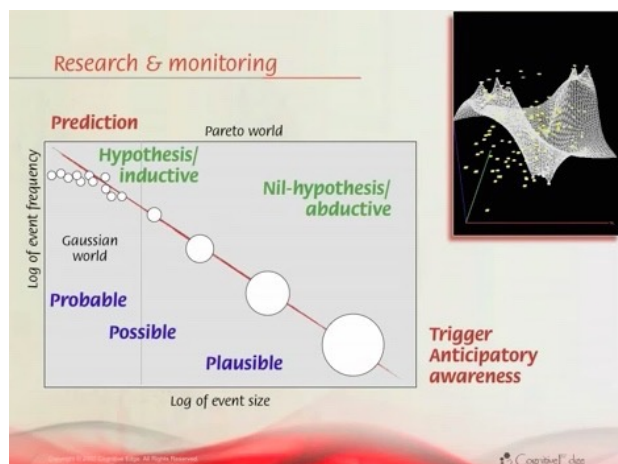
- I must be honest. I don't know what \$30 per tonne of carbon dioxide equivalent emissions (CO<sub>2</sub>e) means to me as a consumer. I receive no immediate feedback when I do something green. How about working on an app for my Apple Watch...

“... the province is preparing to develop a liquefied natural gas industry over the next decade. LNG could reduce global emissions by replacing the use of coal in fast growing economies such as China and India.” [BC Climate Leadership Plan]

- I understand that methane is a far more powerful greenhouse gas than CO<sub>2</sub>.
- LNG typically contains more than 90% methane and can be purified to give almost 100%. Should we be leaving LNG in the ground?
- The industry economy is a heat engine. We use LNG to replace coal and reduce global emissions but still contribute to global warming. Are we resolving a *wicked problem* with a *wicked problem*?

“Communities are thriving and resilient in the face of climate change... Governments need to invest more in building resilience to extreme weather events and provide stronger direction regarding appropriate places to build.” [Goal 1]

- Most people know that resilience is the ability to resist damage and recover quickly. This is the border between the Obvious and Chaotic domains in the Cynefin Framework. We pull back to resist damage and if we fall over the edge, we try to recover quickly.
- What most people don't know is that man-made disasters, natural wildfires, extreme flooding, avalanches and landslides will happen more frequently because everyday the world becomes more complex. For an explanation, see Dave Snowden's Risk and Resilience video at <https://youtu.be/2Hhu0ihG3kY>.



- C-suite executives are captivated by Big Data Analytics and the promise of better, more accurate forecasts, the premise being we can use data from the past to linearly predict the future. Yes in the Complicated domain but not in the Complex domain nor in a complex adaptive system.
- The key to building resilience is the capability to trigger anticipatory awareness and harnessing human intelligence. In complexity thinking, humans are augmented by technology.

“Governments, businesses, universities and colleges need to accelerate development of a workforce that excels in a low-carbon economy.” [Goal 3]

- If you believe the 21st century is the century of complexity, then excelling in a low-carbon economy means understanding the new science of complexity.
- Educational curriculums should include a primer in complexity thinking.
- I sense Gen Xers and Millennials appreciate complexity more than Boomers (the command & control generation) give them credit for. Uncertainty doesn’t faze them and they live in the Present.
- We Boomers were conditioned to live a linear life with a future-oriented focus. Fortunately there is still time to change and adapt. While we are no longer the primary workforce, we can still be healthy contributors to a low-carbon economy.

“Consumers should use their purchasing power to encourage organizations to reduce their emissions.” [Goal 3]

- Refer to the next topic.

“Government should expand the use of carbon pricing to stimulate business and consumer decisions that reduce emissions.” [Goal 4]

- From a timing standpoint, the current carbon tax model where revenues are returned to British Columbians through personal and business tax reductions is extremely weak. To shape behaviour, effective consequences must be given immediately (BF Skinner, Psych 101).
- Retailers know this by offering discounts at the check-out counter. As consumers we are attracted to daily and weekly flyers and store ads.
- I’d like to envision a consumer checking out receive a price discount for buying a product from a low-carbon manufacturer.
- It sends the clear pricing signal and one that’s not tied to the convoluted tax system.



“Government should set targets for types of emissions (e.g. transportation, industry, buildings, etc.) to get reductions.” [Goal 4]

- Setting targets (especially measures) is a Complicated domain solution with governing constraints. Not good.
- A bureaucracy will be required to administer the process, people to conduct compliance inspections and issue penalties, and an appeal board to deal with penalties. Not much value-add here.
- Skeptics may challenge the types of emissions being monitored and the measures used. I might be one of them.

“Government should use regulations and incentives to drive organizations and people to consider costs of adapting to climate change in important decisions.”

- Using regulations is an Obvious domain solution where rigid constraints are implemented to drive decision behaviour. While it can work in a closed system, we have a complex adaptive system and unintended negative consequences (civil protests, political riots, business non-cooperation, etc.) can emerge. We depict this in the Cynefin Framework as plunging from the Obvious domain into the Chaotic domain.
- Incentives can work if initially launched as safe-to-fail experiments. Try it out. See how it works. Observe who is attracted. If you get positive behaviour, do more incentivizing in that fashion. If you get bad or unsafe behaviour, dampen or extinguish the incentive.

In summary,

1. Climate change is a complex issue, not a complicated one. The many years of training has steered us to analyze parts as reductionists. Think of mayonnaise. You can't break it down to analyze the ingredients. So spread holistically.
2. Stay open-minded. Delay the desire to converge and stop new information from entering. Don't lock into some idealistic future state strategic plan. Remember, once you think you have the answer, you're in trouble.
3. Don't be outcome-based and establish destination targets. Be direction-oriented and deliberately ambiguous to enable new possibilities to emerge.
4. Adopt a sense-making approach - make sense of the situation in order to act upon it.

