MS Thesis

Environment and Natural Resources

Strategy Under Uncertainty:

Open Innovation and Strategic Learning for the Iceland Ocean Cluster

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Graduating June 2014

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Final Thesis for MS-Degree in Environment and Natural Resources

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This is a 60 credit thesis to obtain a MS degree in Environment and Natural Resources linked with the Faculty of Business Administration, from the School of Social Sciences, at the University of Iceland.

Printed by: Háskólaprent ehf.

Reykjavik, 2014

Preface & Acknowledgements

The impetus for this research began with a simple but intriguing observation: the chasm between cause and effect. This becomes a veritable “can of worms” when it is observed that the attempt to establish cause and effect, necessarily stemming from the desire to understand change in a historical context, quite often does more harm than good, inviting influence through cognitive bias, missing information and false inference. This is pervasive in the political and economic process, typified by its fallacious blame casting and one-upmanship

Uncertainty is, well, uncertain. For many, this makes it a daunting prospect. As a conjecture, this may be what makes it so susceptible to the errors mentioned above. Yet despite being the defining factor of our collective future existence, it is until recently relatively explored, and all but absent from the public lexicon, barring notion of the “butterfly effect” in the engagement of socioeconomic ideas. The nascent literature base pertaining to uncertainty is now shedding considerable insight into it by revealing the true, that is to say unpredictable, and sometimes radical nature of the relationship between cause and effect. The underlying fundamentals seem relatively straightforward, but at the same time are mind boggling; it is the power of “stochastic disturbances” to punctuate the prevailing order with unlikely and unpredictable effects, often only loosely related to their causes, often showing scaling impact far and above “what was supposed to happen”.

Fortunately, recent contributions in the uncertainty literature, particularly the writings of Nassim Nicholas Taleb, have put forward ways in which uncertainty can be domesticated rather than placed into misconceived, harm-causing frameworks. This analysis is very much based on an engagement with those ideas (and the many others form which they stem), along with a practical means by which to meaningfully articulate these possible outcomes. This is made possible and afforded by developments in global internet-based collaboration. Whilst these approaches could never (nor do they purport or seek to) solve the strains of uncertainty fully, they can go some way towards making the positive side of this uncertainty useful, even beneficial. This at once solves problem that are often brought about in some (read: many) instances by centralised decision-making processes both in

government and within corporate hierarchies.

From an environmental perspective, the relationship between technology and the environment is a hotly debated topic, and addressing the challenge of uncertainty is an important issue. Whilst nature can never be replaced through technological means, and whilst many environmental problems are not technological in nature, technological solution can still be brought into existence to reduce waste and creative value. This directly implicates the activities Iceland Ocean Cluster, around which part of this research is based. Moreover, the approaches put forward here, in line with the vast number of innovative technological solution to environmental that have been allowed to come into existence through crowdsourcing and crowdfunding, may find general application in unleashing scientific creativity to solve environmental problems.

No work is completed in isolation, and the researcher is only as good as the individuals in front of whom he stands, supported by them along the way. From the academic establishment at the University of Iceland, very special mention goes to our academic coordinator Brynhildur Davidsdóttir and our programme coordinator Bjargey Anna Guðbrandsdóttir, without whom none of this work would have been possible. Special thanks also goes to my kind and diligent supervisor Dr. Sveinn Agnarsson, Gylfi Magnusson from the Business School for putting up with my conjectures, and to Runólfur Smári Steinþórsson for coming in as a second supervisor with some extremely helpful feedback and comments. I am also very grateful for the time and attention of Thor Sigfusson and Haukur Gestsson, founder and economist at the Iceland Ocean Cluster, for our initial interview in December 2013 and subsequent interactions and for giving me the chance to be involved.

On a personal note, special mention goes to David Cook and the long hours spent debating the intricacies of uncertainty and indulging in some critical cross-examination; he has certainly been a candle in the dark. I would also like to thank my fellow Environment and Natural Resources (ENR) colleagues; the debates and conundrums explored with them have been a continuing source of inspiration. Finally, I thank my father, Professor Anthony

Hall for his loving support, helping me to stay on the beaten academic track and to my sister, Dr. Julie Hall and my partner Rannvá Danielsen for her love, support and care along the way.

Dedicated to the memory of my mother,

Rejane Mattos-Hall

Abstract

Uncertainty is the principle challenge of the future. Strategy attempts to relate organisations to their respective environments and thereby deal with uncertainty better. The present analysis accepts and recognises uncertainty as an intractable facet of the order under which our affairs are conducted, and shows that a considerable amount of work in the field of strategy fails to do this. The analysis begins by outlining the tenets of some of these contributions to strategy that fall under the "planning" and "positioning" schools, demonstrating that they are methodologically biased. The analysis then turns to critique these schools from the "learning" school approach. In doing this, the analysis argues that strategy is an emergent process that is considerably vulnerable to environment-related volatility. This hopes to create a "realised" strategy; a confluence of "intended" and "emergent". The analysis seeks instead to domesticate uncertainty, to harness it for the better, arguing that knowledge is best harnessed when it comes from diffuse, disaggregated inputs, leading to large spillover effects. By feeding these inputs into not only into the innovation but also the market process, this analysis puts forward a new a kind of emergent strategy based learning, Open Innovation (OI) and "convex" principles that benefit from volatility, arguing for crowdsourcing and crowdfunding. This is then applied to the case study of the Iceland Ocean Cluster (IOC), and the analysis argues that the benefits of clustering can be combined with O principles to bring together the benefits of co-location and disaggregation for a positive innovative effect. To this end, the present analysis has tied together a range of disciplines from uncertainty theory, history, economics, economic geography; the philosophy of science; naturalistic cognitive psychology; social network theory; the history of technology; competition and policy interwoven with practical examples.

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List of Abbreviations

Crowdsourcing Strategy	CSS
Cluster Initiative	CI
Closed Innovation	CI
Cluster-Based Open Innovation	CBOI
Cosmic Microwave Background	CMB
Commonwealth Scientific and Industrial Research Organisation	CSIRO
Compounding Annual Growth Rate	CAGR
Crowdfunding	CF
Crowd funding Platform	CFP
Crowdfunding Venture	CFV
Crowdsourcing	CS
Electronic Numerical Integrator and Computer	ENIAC
Environment Serving Organisation	ESO
External Innovation Partners	EIP
Extended Field Anomaly Relaxation	EFAR
Field Anomaly Relaxation	FAR
Foreign Direct Investment	FDI
Friends and Family	FF
Iceland Ocean Cluster	IOC
Intellectual Property	IP
Intuitive Logic	IL
Institute of Electrical and Electronic Engineers	IEEE
Innovation Investment Fund	IIF
New York University	NYU
North Atlantic Ocean Cluster Alliance	NAOCA
Nordic Crowdfunding Alliance	NCA
Open Innovation	OI
Open Innovation Strategy	OIS

Pre Seed Fund	PSF
Public Private Partnership	PPP
Special Economic Zones	SEZ
User Interface	UI
Venture Capital	VC
World Economic Forum	WEF
World Bank Group	WBG
World War Two	WWII

Introduction

The central aim of the disciplines of corporate and competitive strategy, strategic management and corporate planning purport to help organisations relate to the external environment. There has been a robust treatment of the shortcoming of the "planning" and "positioning" school in the strategy literature, outlining alternative views based on the "learning" and "entrepreneurial" schools. This marks the transition away from strategy as a formal, analytical process and towards and emergent, visionary process; the demarcation between "prescriptive" and "descriptive" schools.[1] Encapsulating the prescriptive approach, Hussey describes the "strategists dream" as follows:

> […] to have at his command a dynamic model of his total company which correctly represents every function of that company and its relationship with every other function, and which may be used to explore the full financial effect of alternative strategies and "what if?" questions […] a model of backwards iteration, able to search backward from an output (or objective) to establish what inputs would have been necessary to cause them[2]

Behind this approach lies the attempt to achieve the following:

1. The conflation of analysis *ex post* with synthesis *ex ante*
2. That is it possible to deliberately "choose" a strategic position
3. That is possible to protect firms occupying a particular strategic position from competition
4. Establishing historical causality as a basis upon which to understand past strategic approaches and the present business environment.
5. Use pre-existing strategic techniques to extrapolate and predict causality into the future.
6. Understand and compartmentalise change into tautological frameworks so that it can be more easily dealt with and related to.

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[1] Mintzberg, H, Ahlstrand, B, & Lampel, J., 1998, *Strategy Safari: the Complete Guide Trough the Wilds of Strategic Management*. London: Financial Times Prentice Hall.

[2] Hussey, D, E., 1974, *Cor orate lanning Theory and ractice,* Pergamon Press: Oxford and New York, 310

The prescriptive approach, based in large measure on the five points outlined above, seeks to plan, analyse, protect and position target organisations in response to competition. The present seeks argues that not only is this approach incorrect, but it is damaging primarily because it battles against uncertainty rather than attempt to benefit from the volatility that it inevitably brings.

This approach towards competition and the external environment necessarily implicates innovation, and a strong epistemological argument can be made against such an approach. This is because the growth of human knowledge, embodied in technological innovation, is the primary way in which the external environment evolves. Within this appreciation lies the epistemological impossibility of predicting the future business environment based on the fact that it is impossible to predict the future of technological innovation via *a priori* or scientific means. The failure to recognise this fact is the primary flaw of prescriptive strategy.[3]

Rather, an emergent and visionary strategy, based on "strategic learning" instead of "strategic planning" and "strategic management" seeks to learn and adapt in relation to the external environment. In order to do this, the emphasis on causality, backward and forward iteration must be abandoned in favour an approach that is based on trial and error, generating option visibility for organisations that can implement such a strategy, as opposed to option-blindness. Recognising also that such a seemingly wanton process can have no direction, it is equally important to have a general yet adaptable view looking forward. For this reason, what emerges is a "realised" strategy, a confluence of "intended" and "emergent" strategy.[4]

The case study of the IOC shows that its very existence, state of development and current trajectory are the result of the vision of its founder and CEO Thor

[3] Popper, K, 1960 (1957) *The Poverty of Historicism,* London: Kegan Paul
[4] Mintzberg, H, Ahlstrand, B, & Lampel, J., 1998, *op. cit.*

Sigfusson. This is important for an emergent strategy because ti shows that, in this particular case, that understanding from the "entrepreneurial" school, that sees strategy as a visionary process can, in some context such as this, have an important role to play. As such, it is important to recognise that a realised strategy in this case stems from an intended strategy that is entrepreneurial and adaptable in nature, and is consistent with the analysis.

The IOC is a progressive organisation that is building upon Iceland's historical strengths in the ocean industry by creating entirely new sources of value out of what were once waste products. In doing this, the Icelandic ocean industry has raised the raw material utilisation rate to 80%. A nascent marine biotechnology and pharmaceutical industry has risen around these developments, a variety of small entrepreneurial ventures (supported by the main fishing companies) with an array of promising products and enormous global potential from no additional raw materials, raising the catch value substantially.

Given the case study and the insights outlined above, the present analysis seeks thus to set forth an emergent, realised strategy that can help forward and beneficial but unpredictable ways. To this end, five research questions are proposed:

1. To what extent have the prescriptive strategy schools addressed the concepts of uncertainty, innovation and prediction?
2. Have the prescriptive been successful in engendering an appropriate response to the dynamics of uncertainty, and why?
3. What aspects of the ecological realities of innovation and technological development have been missing from the prescriptive schools and how do the descriptive schools address these concerns?
4. What is the current state of development of the IOC and how can a new strategy fit with the strategic agenda currently in place?
5. Which practical steps and possibilities steps can be taken to build these missing elements into a new strategy for uncertainty?

In answering the first research question, chapter one will outline some of major contributions of the prescriptive school. This will mostly revolve around the writings of Michael E. Porter, who has created a large theoretical architecture to support a body of concepts that purport to help businesses cope with competition. This culminates in the idea that competiveness is supported by the national “diamond” model with cluster as the micro basis for national competitiveness and as a predictor of future competitive industries based on factor endowments. This chapter also discusses other prescriptive offering to environmental “turbulence” and scenario modelling as a method to sensitise firm to future perturbations in the business environment

Chapter two debunks the collective prescriptive school approach put forward by Porter by showing that it serves only as a framework within which to understand previous and current manifestations of the competitive landscape in doing this however it does not serve as a method to understand future competitive changes. Chapter two also discusses critiques scenario planning and the standard understanding of “turbulence” showing this to be a methodologically false conception. This chapter also shows how the attempt to place change, invariably past change, within a map, framework or tautology as attempt to understand the future is too false. This enquiry also reveals a paradox where the prescriptive schools recognises that dealing with the challenge of the future is problematic, but continues to use standard methods to deal with uncertainty. This chapter lays bare a host of methodological flaws and biases that make this approach further problematic. This chapter argues that the prevailing order is one of uncertainty and, as such, these prescriptive tools ineffectual in dealing with future environments

Chapter three escapes the tautologies of traditional approaches by showing it is not necessary to construe causality, showing instead that this need results from the vulnerability to changes in the external environment, necessitating a predictive view typified by the prescriptive schools. This chapter argues instead that emergence is a fundamental tenet of the intractable uncertainty that is the principle challenge of the future. As such, this chapter argues that this appreciation of emergence has been

missing and instead puts forward an emergent, adaptable, “learning” approach to strategy, based on a non-predictive view. This chapter argues that it is instead necessary to implement a “convex” approach whereby the upside, or potential positive benefits are unlimited and where, conversely, the downside or negative benefits are limited. This is a clear way in which to deal with the volatility and uncertainty of the future. The convex approach is instrumentalised through trial and error, an important tenet of the learning school; this yields options, bringing about option-awareness or options visibility as opposed to option-blindness. Moreover, this chapter, attempts a non-theoretical approach to understanding technological innovation, showing that knowledge and understanding is fundamentally disaggregated and technologically uncertain. Only an emergent strategy can respond to these ecological realities. This chapter also deals with some of the realities of technological innovation by showing that the constant diffusion of proprietary technology is an inevitable consequence and that to respond to this, it is necessary to keep innovating.

In answering the fourth research question, chapter four attempts to make some important reconciliations between the limitations of emergent strategy, the “entrepreneurial” school which sees strategy as a visionary process, OI principles and clusters. Chapter four argues that entrepreneurial strategy can address the weaknesses that emergent strategy bring forth such as lack of coherence and direction; entrepreneurial strategy offers a malleable strategy with vision. Equally, whilst OI is a separate field of research altogether, the analysis draws insights from OI and attempts to show they can be reconciled with a learning approach to produce a strategy that can benefit from uncertainty. Chapter four then locates these arguments in the context of clusters, arguing that clusters are in a good position to benefit emergent and entrepreneurial strategy as well OI by virtue of the fact that cluster are in the position to benefit strongly both from the benefits of co-location as well the clear benefits of disaggregated, tacit knowledge inputs. This takes take clusters out of Porter’s positioning frame and relocates them.

This chapter then goes into the details of crowdsourcing (CS) and crowdfunding (CF) and discusses the nascent literature in these field, ultimately showing that CS that yield

solutions to known problems from unknown places and that CF solves an about knowledge problem that has afflicted traditional sources of entrepreneurial finance; namely, whether or not a project will succeed or fail. The success of CF is in giving nascent ventures a wider reach, a better chance and exposure to traditional funding sources. This chapter also explores aspects of the current operations of the IOC, focusing on biotechnology and ocean technology.

In answering the fifth research question, chapter five considers three main sets of recommendations based on the insights gleaned from the whole analysis. Here, the analysis advocates the creation of a CS platform and a crowdfunding platform under various configurations. The first set of configuration pertains to the openness of CS strategy, and the second set considers different configurations of CF strategy. Both sets offer possibilities ranging from limited to open in nature as well as easier and perhaps more difficult to implement. The third set considers different funding configurations relating to the CF strategy and allocates roles ranging from purely crowdfunded, supported by Venture Capital (VC), supported by Public Research and Development (R&D) and then finally a combination of all three. Finally, the analysis recommends the establish a speculative research fund. This could act as a key enabler for knowledge growth, and by consequence of this function as a preliminary commercialisation strategy may identify new useful compounds and/or a diversified use of existing raw materials. This seeks to continue pushing forward the highly developed Icelandic expertise in raw material utilisation of aquatic resources and continue pushing resource efficiency for value creation further, in unpredictable ways.

Combined, these three strategies accept uncertainty as an immutable facet of the environment and place the IOC in a position to benefit whilst taking into account how such a strategy can be integrated into its existing activities.

Methodology

The present analysis has established the conceptual and practical groundwork for justifying and implementing a learning-based strategy that integrates clusters with the open innovation principles. The reasons for undertaking this research have been twofold: to understand the dynamics of uncertainty and apply these understandings meaningfully The primary understanding from the uncertainty side is that it is largely random and unpredictable. On the other more practical side, there is a perceived gap between the capabilities of the IOC as case study cluster which, though extensive, could be greatly bolstered through marshalling OI principles to bring in a greater range of exogenous inputs and a more diverse and diffuse range of sources. The implications of the arguments and the conclusions drawn out in this research are such that there is considerable room for expansion in this area, and despite path dependent socio-economic and other contextual differences, the strategic learning based approach may be replicable in other regions and nations. The only recommendation, in keeping with the research, can be to try, expect to fail and try again. These conclusions are reliable to the extent that they are drawn out of a diverse literature base from a range of fields. Not only this, but the evidence from the CS and CF literature shows that these activities/industries are growing extremely quickly at the time of writing. Their growing popularity is surely a partial indicator of their success at giving entrepreneurial ventures a chance.

Chapter I: Competition, Prescriptive Strategy and the Role of Uncertainty

Introduction to Chapter I

Chapter one is a descriptive chapter in which the prescriptive schools of "strategic planning" and "strategic management", as exemplified by Porter's contribution. There is a particular focus on how strategy is conceptualised and dealt with uncertainty. Here, the focus is mainly on the Michael Porter; this is so because Porter's contribution to strategy and competition is the strongest and partly because of the emphasis Porter on clusters as means to compete. This is done with a view to locating clusters within the positioning school, as stemming from the theory of national competition, itself stemming from Porter's work on the forces of competition. The chapter shows that strategic planning and strategic management attempt to predict future environments theoretically via the conceptual isolation of "industry forces" as well as through scenario analysis and through other frameworks that attempt to understand the "fundamentals" of change.

Competitive Strategy and Industry Evolution

In 1979, Porter published *How Competitive Forces Shape Strategy*, the main thesis of which was that the strategic aim within a given industry sector was excess profits.[1] In perfectly competitive markets, competitive forces are strong, and this negatively impacts the sustainability of the profit potential within an industry sector. Only where competitive forces are weak is it possible to maintain "superior performance".[2] Porter sets out a framework of five competitive forces that can determine the competitiveness of an industry; (1) the bargaining power of buyers, (2) the bargaining power of suppliers, (3) rivalry among existing firms, (4) the threat of new entrants and (5) the threat of substitute products. As such "the corporate strategist's goal is to find a position in the industry where his or her company can best defend itself against

[1] Porter, M, E., 1979, "How Competitive Forces Shape Strategy", *Harvard Business Review*, March-April: 137-145.
[2] *Ibid*, 138

[competitive] forces or influence them its favour".[3] To achieve this strategic position of superior performance is to achieve *sustainable competitive advantage*, and the five forces are "Perhaps the single most influential model in the field of strategic management**".**[4]

In, *Competitive Strategy,* Porter outlines how the three ´´generic´´ strategies for sustainable competitive advantage of (1) "overall cost leadership (2) "differentiation" and (3) "focus" are affected by "industry evolution", eroding their effectiveness. [5] For this reason, understanding "the process of industry evolution and being able to predict change [is] important".[6] This is because industry evolution affects the underlying sources of the five competitive forces. Porter also outlines 14 general evolutionary processes in addition to their strategic implications. Of these, the six most relevant to the present analysis are considered. The desired result in each case is to establish mobility barriers to competition that can sustain strategic positions and thus establish or maintain a sustainable competitive advantage.[7]

First, "reduction of uncertainty" is brought about as firms mature; this in turn attracts new market entrants through imitation of best practices, since risk is perceived to be lower. The incumbent firm must defend its position against imitators and/or adjust quickly to cope with new competition.[8] Second, "diffusion of proprietary knowledge" lends itself to imitators and imitation. Here, patent protection, economies of scale in research and development (R&D) and the creation of new proprietary technology prevents the erosion of competitive advantage. Third, "product innovation" widens the market, promotes industry growth and enhances differentiation. Here, it is necessary to "[forecast] product innovations [by] examining potential sources".[9]

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[3] *Loc. cit*.
[4] The Oxford Handbook Of Strategy Volume 1: A Strategy Overview And Competitive Strategy, Oxford: Oxford University Press, 250
[5] Porter, M, E., 1985, Competitive Strategy: Techniques for Analysing Industries and Sectors, New York: The Free Press
[6] *Ibid.*
[7] *Ibid*
[8] *Ibid.*
[9] *Ibid*, 178

Fourth, "marketing innovation", through new and different themes and channels, can increase differentiation. Fifth, "process innovation" influences capital intensiveness and economies of scale, whether from inside or outside the firm. This can greatly reduce barriers to entry, facilitate new market entrants and reduce profitability. In response, firms must broaden their "views of technological change beyond industry boundaries".[10] Finally, "structural changes in related industries" can sometimes force a strategic rethink. Since the bargaining power between sellers and buyers may shift, firms must "diagnose and prepare for structural evolution".[11]

Competitive Strategy under Uncertainty: Scenario Planning

Building upon *Competitive Strategy*, *Competitive Advantage* presents scenario building as a way of identifying strategic uncertainties by diagnosing and preparing for industry evolution.[12] Each scenario "provide[s] a picture of the five forces representing the industry's structure in the event that the assumptions about the scenario come true".[13] Firms can then estimate when uncertainties will be resolved in order to predict competitor behaviour and set the firm's own strategy. In the period since *Competitive Strategy* was published, different scenario approaches have been developed by other thinkers, as outlined in this section.

Systematic judgement methodologies have been the most explored scenario building techniques, of which there are two main types. "Intuitive logic" (IL) tests "the ability of a strategic decision to 'fly' in the variety of circumstances an uncertain future might hold can be tested".[14] A scenario is "an internally consistent view of what the future might turn out to be".[15] A scenario attempts to analyse future industry structure, competitor behaviour and "the sources of competitive advantage under a

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[10] *Ibid*
[11] *Ibid*, 181
[12] *Ibid.*
[13] *Ibid*, 464
[14] Coyle, T, J., in Faulkner, D, O., Campbell, A, eds, 2000, *The Oxford Handbook Of Strategy Volume 1: A Strategy Overview And Competitive Strategy,* Oxford: Oxford University Press p 302-343.
[15] *Ibid*, 446. Porter's emphasis.

particular set of assumptions about the future".[16] Uncertainties fall into three categories: *constant* (unlikely to change), *predetermined* (foreseeable and variable) and *uncertain* (unresolvable). Causality must be traced back far enough to separate scenario variables, and each combination of variables requires different assumptions to be made, creating different scenarios. Uncertainty is bounded in the scenario approach both by the choice of assumptions and difficulty in generating strategic responses to a large numbers of scenarios.

In morphological forecasting such as Field Anomaly Relaxation (FAR), models of the entire business environment are visualised as a field of interactions of varying strengths between different components that accommodate all plausible possibilities by allowing "filling space" for these possibilities. Like IL, FAR is internally consistent, but unlike IL it is open, webbed and does not converge on a particular set of decisions. FAR is a four-part process led by a study team. Step one requires a formulation of a vision of the future, step two describes this vision, and step three tests for internal consistency. Step four leads to the formulation of different scenarios as possible outcomes of the interaction of different factors. This produces a factor array with elastic timeframes, uncertain developments, more and less plausible outcomes and "wild cards" as surprise events. This process ultimately hinges on plausibility and the critical question: "can I see this world leading to that one?"[17] Regarding the possibility that scenarios are likely incorrect, Coyle notes:

> "the [scenario's] purpose is to sensitise strategy formation to uncertainties of the future. Their value will lie in making decision-makers thinking about the robustness of their choices in the face of the future's vagaries, and not seek the illusion of an optimal decision".[18]

Porter outlines five strategic moves as responses to a particular scenario outcome. These are (1) bet on the most probable scenario; (2) best scenario, offering the best

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[16] *Ibid*, 470
[17] Coyle, T, J., in Faulkner, D, O., Campbell, A, eds., 2000, *op. cit.*, 326.
[18] *Ibid*, 324

prospects for "sustainable long-run competitive advantage";[19] (3) hedge, producing satisfactory results under all scenarios; (4) preserve flexibility (non-commitment) until it becomes more clear which scenario will transpire; and (5) influence, using its resources to bring about a desirable scenario. Ultimately, this approach informs "a conscious and complete understanding of the likely significance of uncertainty for competition".[20]

On National Competitive Advantage, and Clusters

The Competitive Advantage of Nations, arguably Porter's magnum opus, puts forwards a theory of local and national competitiveness within a global economy with practical outlines and places the "theory [of] the principles of competitive strategy in individual countries at its core".[21] This means that the five forces underpin national competition in Porter's framework.

Porter puts forward the "diamond model" in support of this framework, comprising four elements. First, *input or factor conditions* include tangible assets and endowments such as physical infrastructure, natural environment, resources, legal and research institutions. Second, *demand conditions* account for the nature of the local market. For integration in the global economy, it is the *quality* of local demand rather than the *size* that is key important, since the provision of higher quality goods and services provides a better basis for global competition. Third, the *context for firm strategy and rivalry* includes macroeconomic and political stability as well as the overarching investment climate, microeconomic policies, tax system, corporate governance, regulations and labour market. Finally, *related and supporting industries* connect with clusters by furnishing skills, resources and technological know-how. New entrants can be either established firms seeking to enter the cluster with transferable strengths and start-ups that could stand to benefit from accumulated knowledge.

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[19] *Ibid,* 473
[20] *Ibid*, 478
[21] Porter, M, E., 1990, *The Competitive Advantage of Nations*, Basingstoke and London: MacMillan Press, p *xii-xiii*

The striking feature of the model of national competitive advantage is that the "diamond" model is the same at the local level as it is at the global level. Porter states the important role of the 'local' within the 'global' context in terms of competitiveness, and the emphasis on *how* rather than *what* industries compete emerges as one of its most salient arguments. The idea of the cluster is at the heart of the "how" of national competitive advantage (on which, see Chapter Four). Figure 1 shows the full diamond model, including the aspects of "chance" and "government".

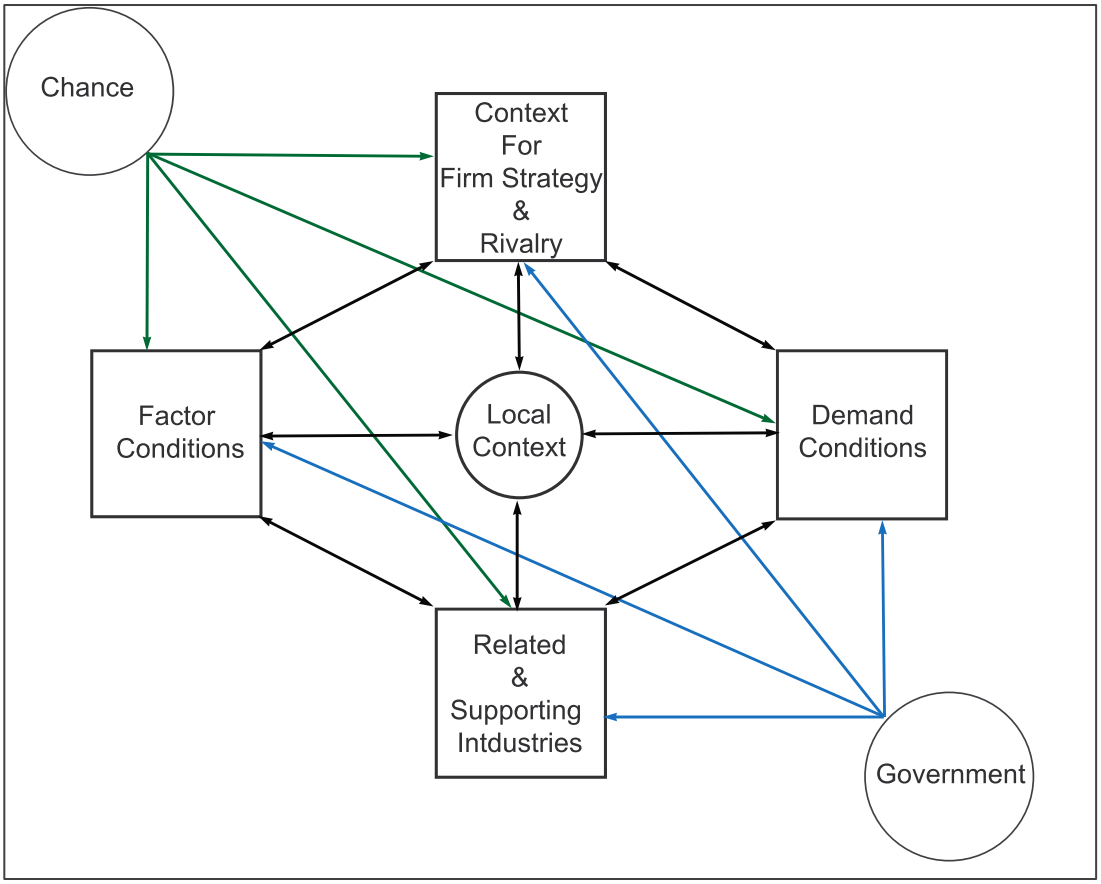

Figure 1: Porter "diamond" model.[22]

Porter on Innovation, Chance and Predictability

Innovation occurs in an incremental fashion, depending more on a critical mass of

[22] Porter, M, E, 1990, *op. cit.* 129

collected insights and less on radical 'leaps'. It often involves things that had not been actively pursued, and "always involve investment in skills and knowledge".[23] Innovation can shift competitive advantage if there is a lack of responses to new ways of competing. Porter writes: "It is hard for firms steeped in an old technological paradigm to perceive the significance of a new one. It is often harder for them to respond to it".[24] This affliction is rooted in complacency, conventional wisdom, organisational and technological inertia. Here, as in *Competitive Advantage*, the importance of the first-mover advantage is re-emphasised, because it can allow for the exploitation of structural change.

Porter argues that the occurrence of chance events is mostly outside of the influence of firms and governments. Acts of chance include pure invention, major technological discontinuities, factor and demand discontinuities, significant macroeconomic shifts, demand surges, political decisions, instability and wars.[25] Chance events precipitate discontinuities and can also neutralise the status quo, shifting advantage to where none existed previously, resulting in an upgrade from one national "diamond" to another. Whilst chance does, in Porter's view, have a role, "[t]he "diamond" has a more important influence on the ability to convert an invention or insight into a nationally competitive industry […] [i]f a nation has only the invention, other nation's firms will be likely to appropriate it".[26] This implicates the role of imitation and diffusion in competition (on which, see Chapter Three). Equally, the "diamond" model is purportedly able to predict future industry evolution. Porter writes:

> "While unpredictable chance events such as acts of invention are also important to industry development, the "diamond" influences their likelihood of occurring in a nation". The "diamond" allows predictions about whether chance events will result in a competitive industry."[27]

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[23] *Ibid*, 45
[24] *Ibid,* 46
[25] *Ibid.*
[26] *Ibid,* 126
[27] Porter, M, E., 1990, *op. cit,* 175

In Porter's view, this is about the way in which the national "diamond" lends sufficient critical mass to chance events and new ideas by supporting innovation and new business creation, increasing national competitiveness.

To conclude, a summary of the predictive powers of the entire framework as presently outlined; first, the fives forces that change through industry evolution can be understood and a strategy can be formulated to best position a given firm.[28] Second, scenario building can help to mitigate uncertainty and sensitise firms to future changes.[29] Lastly, the "diamond" model makes it possible to predict how competitive advantage will manifest based on the strength of the underlying "fundamental" determinants.[30] This will facilitate a sustainable competitive advantage through exploiting market imperfections through competitive barriers. Figure 2 shows how these concepts relate to one another diagrammatically.

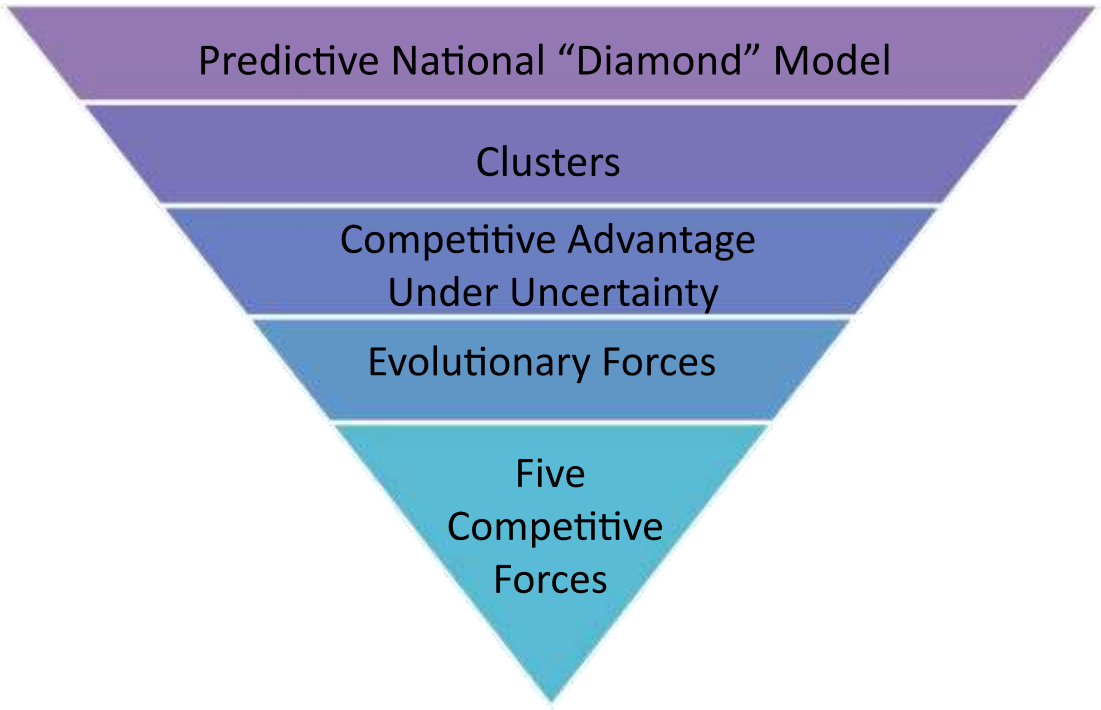

Figure 2: Representation of Porter's contribution with focus on uncertainty.

[28] Porter, M, E., 1980, *op. cit.*
[29] Porter, M, E., 1985, *op. cit.*
[30] Porter, M, E., 1990, *op. cit.*

Uncertainty, Change and Forecasting in Strategic Planning

Ansoff's 1965 offering *Corporate Strategy*, argues that the speed of technological change is increasing and that predictability is decreasing. This leads to rising levels of "turbulence" amidst the business environment. For Ansoff, turbulence exists at five levels ranging from ''Repetitive'' where there is no change; 'through to 'Surpriseful'' wherein change occurs without notice, visibility or predictability.[31] Increasing levels of 'surpriseful' turbulence mark the modern era. In 1979, *Strategic Management* explores the ways in which firms, as Environment-Serving Organisations (ESOs) relate to the turbulent business environment.[32] Building on arguments made in *Corporate Strategy,* the developments of the 20th century have brought increasing "novelty" of change, "complexity", environmental "intensity" and decreasing predictability. This makes environmental changes more "novel", costlier to deal with, faster and more difficult to anticipate.[33] Echoing Ansoff, Channon and Jalland argue along similar lines, stating that the period 1950-1970 was marked by large discontinuities, bringing heightened environmental turbulence.[34]

Strategy and planning scholars typically attempt to understand the turbulence of the business environmental through the construction of models, charts, diagrams, frameworks, and matrices. These forms of analysis attempt to assimilate the predictability of change; ESO and budgeting behaviour; response time in relation to novelty and "start of response"; the shifting relation between predictability and novelty and economic efficiency under turbulence.[35] Forecasting techniques help to deal with turbulence, but act as filters, and each method "[captures] different aspects of the potential future", and thus no method is complete, including scenario building.[36] Perception filters "restrict the

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[31] Ansoff, I, 1965, *Corporate Strategy: An Analytic Approach To Business Policy For Growth And Expansion*, McGrawHill: New York
[32] Ansoff, I, 1979, *Strategic Management,* The Macmillan Press: London and Basingstoke, 51.
[33] *Ibid*, 35
[34] Channon, D, F., Jalland, M, 1979, *Multinational Strategic Planning*, Macmillan Press: London and Basingstoke
[35] Ansoff, I, 1979, *op. cit.*
[36] *Ibid*, 147

perception of the environment by rejecting […] information which is inconsistent with previous experience".[37] The stated aim in constructing the related models of turbulence is to render uncertainty comprehensible, intelligible and strategically manageable, and to aid the perceived development of foresight.

A foresightful perception is beneficial according to Ansoff for two reasons: it helps ESOs to anticipate shifts in environmental turbulence and it enables ESOs to anticipate and to react to threats and opportunities "ahead of other ESOs in the industry."[38] It is important for a firm to able to do this for strategic and competitive reasons, similar to a first mover advantage. Hussey's 1974 offering, *Corporate Planning: Theory and Practice* also aims to identify the threats and opportunities that environmental change brings about.[39] Hussey recognises the extraordinary technological change of the 20th Century and discusses the managerial inertia and "roadblocks" that impede change and result in inflexibility, noting the refusal of companies "to see the opportunities produced by change".[40] Hussey suggests that this is because change brings risk, but good planning will "assist the company to develop those qualities which allow it to meet the challenge of the future".[41] To make long-range plans in this way, similar to scenario building, necessitates making accompanying assumptions, which provide a framework from which to take a general perception of the future environment of the firm, defined as "a statement of opinion about the occurrence of an event which is outside the control of the planner".[42] Assumptions then are built into environmental forecasts, which commit firm resources to a particular course of action. Throughout, Hussey warns both against the "corporate self-delusion", whereby the assumptions are taken as certainties, and the unnecessary temptation towards complexity where simplicity in methods will suffice. Assumptions in planning create a basis upon which to understand the nature of risks facing the company and for courses of action to reduce those risks and/or their impact.

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[37] *Loc. cit*
[38] *Ibid,* 146
[39] Hussey, D, E., 1979, *op. cit.*
[40] *Ibid,* 36
[41] *Ibid*, 38
[42] *Ibid,* 52

A number of other techniques are outlined, such as product lifecycles, S-curves, statistical projections, analytical forecasts and technological forecasts, which should be "interpreted not so much as a prediction of what will happen, but as an indication of what is possible and which can therefore be made to happen".[43] Contingency, hedging and scenario planning are consistently noted as the main techniques with which to deal with uncertainties and discontinuities.[44]

Conclusion to Chapter 1

This descriptive chapter has sought to answer the first research question by showing how the major works of the prescriptive school, as exemplified by strategic planning and Porter's strategic management, have dealt with change and uncertainty. This chapter shows that this collection of authors believe that their planning frameworks can help firms within various industry sectors to better deal with uncertainty by establishing a framework through which change can be understood, predicted and managed and anticipated, particularly under the "multiple future generation" of scenario planning, whatever the method. As chapter two will argue, these attempts have largely failed, and these approaches, whilst having made a meaningful contribution towards strategy as environmental relation, can be left behind as methodologically flawed approaches.

[43] *Ibid,* 66
[44] *Ibid,* Channon, D, F., Jalland, M, 1979, *op. cit.*

Chapter II: From the Managerial to the Methodological Problem

Introduction to Chapter II

This chapter answers the second research question will shows why the prescriptive schools have failed. To this end, this chapter makes a number of important arguments, which can be ordered as follows.

1. Uncertain, compounding outcomes stemming from "epistemic opacity" and "uncertainty"[1] makes the establishment causality impotent in dealing with past events and future outcomes
2. That this renders the strategic techniques of forecasting and scenario building moot.
3. That the prescriptive strategy discipline has inadvertently identified uncertainty as "turbulence", and fallaciously placed this in a contextual narrative of the past in relation to the "stability" of the past.
4. That these efforts, and the conflation of apparent determinism with stochastic[2] processes are compounded a series of methodological biases
5. That these bias filter through to Porter's strategic analysis
6. That it is easy to replicate this kind of analysis with the benefit of hindsight
7. That such foresight is epistemologically impossible leading to the grand fallacy, the conflation of analysis and synthesis, or strategy formation.

These arguments are undertaken in two sections. The first section introduces the concept of epistemic opacity as an unshakable, intractable uncertainty that stems of the interactions of distributions of possible outcomes. This leads to a critique of scenario planning, showing that it is close to impossible to predict possible futures, and that choosing between which of these futures to act upon raises further problems. This goes on to an analysis on strategic planning concept of "turbulence" and shows that turbulence is precisely a manifestation of epistemic opacity rather than a new fact of modern life. This leads to a discussion of related methodological biases including the

[1] These two terms are used interchangeably through the analysis
[2] "Stochastic" is used interchangeably with "random" throughout the analysis

influence of ideology, confirmation bias, the expert problem and simplifications known as “platonicity”.

Section two applies these insights to strategic planning and strategic management itself, showing that these processes occur exclusively in hindsight and is therefore a *retrodictive analysis*. Equally, the discipline is marked be axiomatic, non-falsified tautologies that are said to be extrapolative. Combined, this represents a reduction of past trends to fit a future that is objectively opaque in an effort to reduce or limit the effects that uncertainties and discontinuities may have on the competitive environment. The predictive abilities of Porter’s prediction are challenged and shown to be flawed, showing that the prescriptive school is a purely *ex post* exercise. The ultimate consequence is to reduce strategy to a non-opportunistic tautology, arguably making firms vulnerable to negative random disturbances and less able to benefit from positive random disturbances, less able to pursue the options that are necessary in order to innovate.

Importantly, this section also shows why, drawing on simple conundrums from statistics and theoretical physics to show that these analyses suffer from an acute information failure and an inability to trace causality would preclude a successful analysis even in the event of full information. This chapter attempts to show what strategy should not be and what it should move away from in a negative fashion.

Section I:

From Uncertainty to Epistemic Opacity

Decisions have effects that occur along *distributions of possible outcomes*.[3] The distribution is characterised by a range of outcomes. The outcomes are context-dependent, that is to say, the outcomes of a given decision or course of action will vary according to the different environments in which they occur. Figure 3 represents one

[3] Alchian, A, 1950, “Uncertainty, Evolution, and Economic Theory” *Journal of olitical Economy*, 58 (3) 211-221

attempt at demonstrating a distribution of possible outcomes diagrammatically.

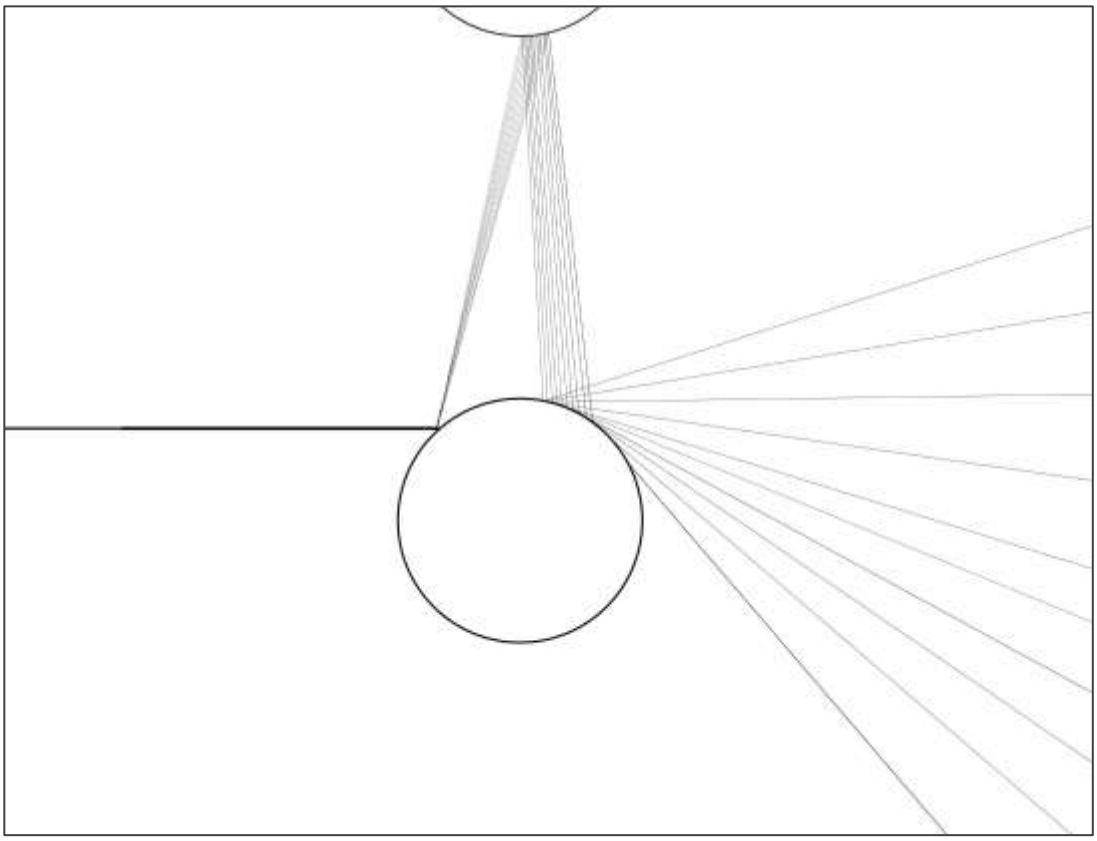

Figure 3: How decisions and outcomes disperse: first and second "bounce"[4]

Figure three shows the dispersal of ten 'outcomes' that disperse relatively minimally after the first iteration yet, subtle differences emerge. At the second iteration, variations in the initial conditions from the first 'bounce' become considerably amplified. This leads to a much wider dispersion of results thereafter. This diagram reflects outcome dispersals over time. Since many decisions are constantly being made, there are an "overlapping distributions of potential outcomes".[5] Figure four offers the next potential stage in the outcome dispersal problem, as well as other considerations:

[4] Based on and adapted from Taleb, N, N., 2007 (2010) *The Impact of the Highly Improbable,* London: Penguin Books

[5] *Ibid*, 212.

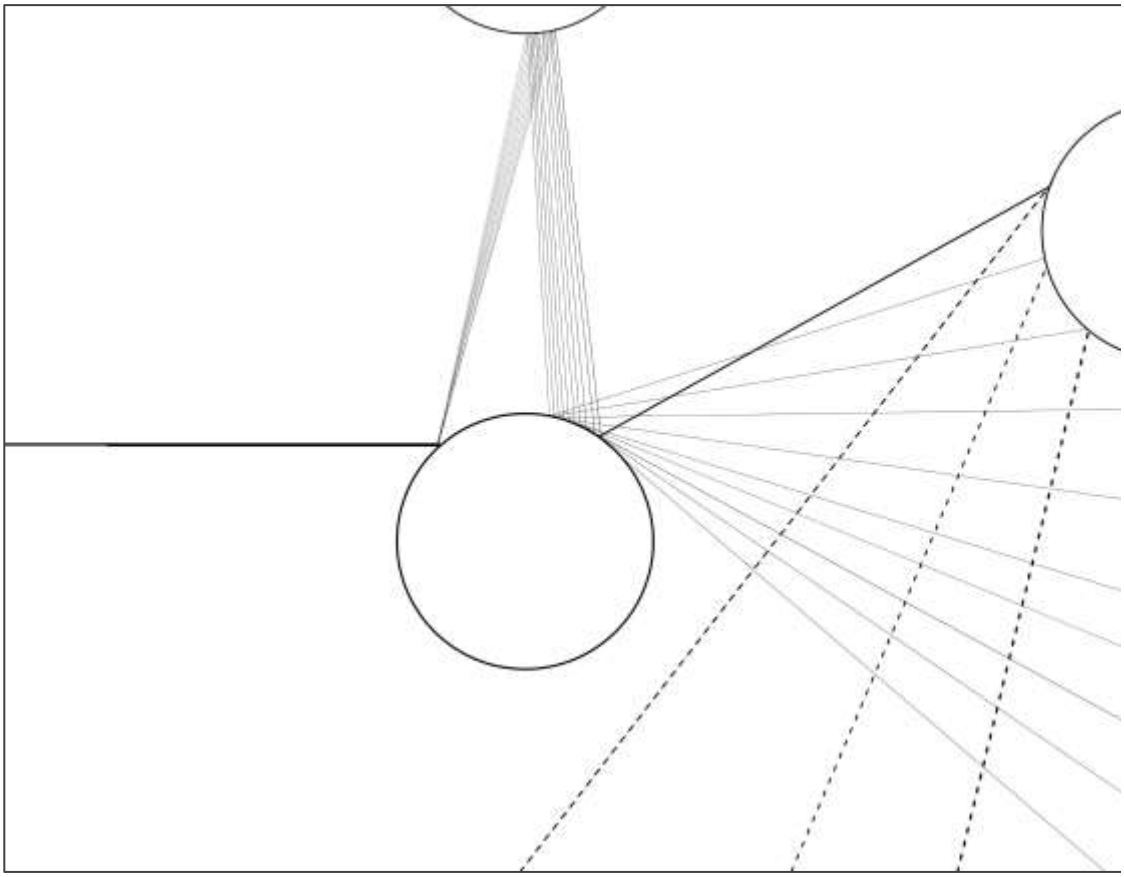

Figure 4: Dispersal at the third "bounce"[6]

Figure four builds on figure three in two ways. First, whereas in figure three, the ten lines represent a wide but relatively even dispersal, figure four alters the dispersal of the tenth dispersal (thicker line). Second, figure four shows the interaction of the tenth dispersal, along with two others, in relation to a third "bounce" (dashed lines). This shows how the outcomes disperse even further in relation to the starting point before the first "bounce". In reality, there is no clear starting point, and the outcome dispersal does not occur on a single continuum; there are many millions of overlapping outcomes dispersals or "distributions".

What can now be referred to as "opacity" emerges from "incomplete information at some layer, indeed any layer".[7] A "layer" (to speak of one such layer amongst a

[6] Author's creation elaborated upon from Taleb, N, N., 2007 (2010), *op. cit.*
[7] Taleb, N., N., 2010 (2007), *o cit*.

unknown number) can be understood as the interaction between one set of possible distribution of outcomes interacting with other distribution of outcomes, as exemplified by figures three and four. Due to the obscured nature of the interactions themselves, and because they evolve over time, epistemic opacity can be said to be "emergent". [8] Due to the epistemic opacity within which incomplete knowledge and information prevails, it is either enormously difficult or impossible to derive, conceive or understand possible outcomes. This has dramatic implications with respect to socio-economic causation, and by consequence the nature and understanding of our relationship to the past, present and future.[9]

The relationship with the past is generally understood in large part as the interaction of different causes and effects. In understanding the nature of causality, two approaches are outlined. First, the concept of epistemic opacity, a result of incomplete or failed knowledge, stems from Laplace's scientific determinism and has been recently explored in the writings of Nassim Nicholas Taleb.[10] This view of uncertainty results from not being able to identify causes. Second, and conversely, *ontological uncertainty* is where causality is completely unidentifiable as "the uncertainty [is] much more fundamental than the epistemic".[11] This means that, in the first instance, causality is unidentifiable because it is unclear, and in the second that causality is totally unfathomable. This means that there is no qualitative difference between each respective source of uncertainty.

Subsequent sections of this chapter will argue that epistemic opacity makes forecasting and scenario building much more likely to fail rather than succeed due to the compounding forecasting error as the time period progresses. This means that attempts to establish causality through the construction of an otherwise well-meaning narrative is a fallacious approach to understanding emergent, opaque events.

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[8] Emergent defined here as "an effect of complex causes and not analysable simply as the sum of effects". See glossary for other definitons

[9] Omerod, P, 2005, *Why Most Things Fail,* London: Faber and Faber

[10] *Ibid*,

[11] *Ibid,* 344.

There is (some) Order

The acknowledgment of epistemic opacity does not mean to say that "it's all random"; rather, that it is "more random than we think".[12] What economist George Shackle has termed "structural uncertainty" is necessarily circumscribed by Institutional frameworks, including the rule of law, contractual obligations, private property, and the political, fiscal and monetary systems.[13] Yet, there remains considerable room for stochastic disturbances; the idea of bounded uncertainty is not inconsistent with epistemic opacity: "we must suppose, perhaps, that any man's decision can set off a chain of reaction that will amount to a great effect."[14] Uncertainty being "bounded" by the limited number of consequences a particular decision can have, the random discontinuities produced by layers of decision-making in the social, legal, political and economic history is therefore punctuated with unforeseen, 'surprise' events that have serious ramifications.[15] Due to their emergent nature and stochastic attributes, the notion of causality remains highly tenuous.

Critique of Causality and Narrative-Dependent Scenario Planning

Recognising epistemic opacity has critical strategic implications. Chapter One showed that strategy attempts to relate firms to their respective environments, both by outlining the "fundamentals" of change and by attempting to sensitise firms to future competitive challenges. However, the scenario-building approach is ultimately circumscribed by "the extent to which human imagination and judgment can extend into the future", and also by the plausibility and comprehensibility of future changes. [16] This limitation permeates every aspect of the scenario approach to uncertainty due to

[12]Taleb, N., N., 2007 (2004), *Fooled by Randomness*, London: Penguin Books

[13]Harper, D, 2000 (1996), Entrepreneurship and the Market Process, London: Routledge; Ford, J. L., ed, 1990, G. L. S. Shackle: Time, Expectations and Uncertainty in Economics: Selected Essays of G. L. S. Shackle, Hants, Vermont: Edward Elgar

[14]Ford, J. L., ed, 1990, G. L. S. Shackle: Time, Expectations and Uncertainty in Economics: Selected Essays of G. L. S. Shackle, Hants, Vermont: Edward Elgar , 25

[15]Taleb, N., N., 2010 (2007), *op. cit.*

[16]Coyle, T, J., in Faulkner, D, O., Campbell, A, eds., 2000, *op. cit.*, 235.

the compounding forecast error. Compounding forecast error stems from the argument in the previous section regarding the dispersal of interactions; the further one departs from the present, the more inaccurate extrapolated causality tends to become. Figure five illustrates this point diagrammatically:

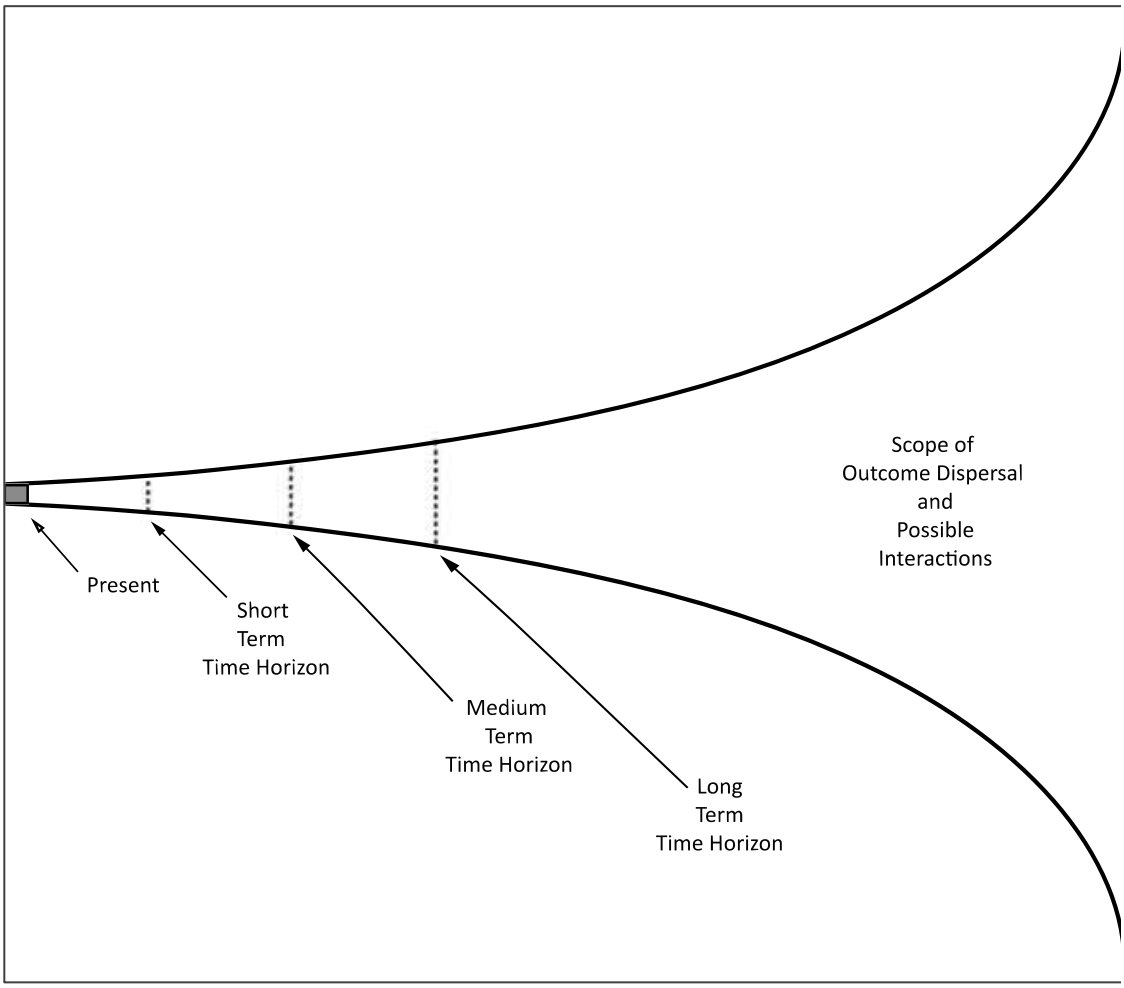

Figure 5: Compounding forecast error over time horizons.[17]

The increasing scope of the "cone" shows that this relationship is nonlinear, showing that the increasing numbers and possibilities for dispersals within and between different sets of factors accelerates. The nonlinearity means that the potential for error increases at an accelerating rate in relation to the time period. A possible amelioration of the

[17]Due to the emergent and opaque nature of future environments, short, medium and long term are respectively defined for the purposes of this discussion as between the present and three months; between three and six months and six to 12 months and beyond.

compounding error might involve a firm undertaking a continual recalibration of scenarios and forecasts, enabling better predictive abilities. However, such a strategic response would exclude the possibility of unforeseen, unlikely events, which frequently tend to have very large ramifications.[18] One of the primary consequences of the compounding forecast error, and of epistemic opacity, is the eventuality of "outliers", occurrences that lie outside of the forecaster's or scenario builder's imagination. [19] Derbyshire and Wright argue that the scenario planning approach fails because of its reliance on causality and plausibility.[20] This is problematic, since opaque causality precludes plausibility. Epistemic uncertainty introduces surprise events which do not seem plausible to strategists, but which occur nevertheless. This means that the plausibility of causality upon which the scenario approach depends is an inherent and fundamental weakness.

Derbyshire and Wright also go on to argue that this increases the susceptibility to surprise events in the particular IL technique that they study.[21] This implicates other techniques that also rely on causality, which suffer from similar problems and vulnerabilities to surprise events. A further problem arises out of the need to keep the task of scenario unfolding manageable. Scenarios methodologies are usually limited to four possible eventualities, and Wack argues that six is the greatest number that should be developed.[22] This is problematic because it *excludes* a far greater number of possible futures than it *includes*, therefore the likelihood of the scenario coming to fruition is miniscule. Compounding this problem is the fact that a miniscule likelihood must identify the sources of uncertainty, making them tractable *ex ante*. As this thesis has discussed, epistemic opacity ensures that the number of possible futures is potentially infinite, bringing about a nonlinear discord between changes and effects and a failure of mechanistic methodologies.[23] Complementing this is a predisposition towards pattern seeking, precipitating a bias towards causality.[24]

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[18] Taleb, N., N., 2010 (2007), *op. cit.*
[19] *Ibid.*
[20] Derbyshire, J, Wright, G, 2014, "Preparing For The Future: Development Of An 'Antifragile' Methodology That Complements Scenario Planning By Omitting Causation" *Technological Forecasting & Social Change* 82: 215–225
[21] *Ibid.*
[22] Mintzburg, H, 1994, *op. cit.*
[23] Omerod, P, 1998, *Butterfly Economics,* London: Faber and Faber
[24] Clegg, B, 2013, Dice World: Science And Life In A Random Universe, London: Icon Books

The bias towards causality and the impact of surprise events makes Porter's five possible strategic forces problematic. The most likely scenario may not come to pass, the best is not the most likely, hedging and flexibility may be too non-committal and influence depends on there being too many factors to control without recourse to uncompetitive, monopolistic behaviour.[25]

This places an incredible exigency on the firm; to be correct about the given causes should they occur. Management scholars such as Starbuck and Mintzburg have argued that apart from lending false certainty to the future, committing to a particular scenario outcome involves allocating resources towards a particular eventuality. This, by extension, entails a certain irreversibility of the process, in that it is harder to disengage and change course should circumstances change.[26] Further to this, Hussey warns that too often there is the danger that the plausibility of a constructed scenario can be taken as the *actual future*, warning that it must remain borne in mind that it is a projected reality.[27] Goodwin and Wright have referred to this as the *simulation heuristic*, which lends greater perceived plausibility to a possible chain of events and increased overconfidence.[28] Supporting this, Kahneman has shown that, in practice, humans have a psychological predisposition known as the conjunction fallacy that makes convincingly explained causality appear more plausible and inevitable.[29]

Predeterminations of this kind lead to formalisations that necessarily obscure the multiplicity of options that are available to decision-makers, in actual fact by fixing to a particular course in relation to a particular end.[30] Starbuck cites Chakravarthy and Lorange to show how predetermination is brought about by the formalisation of strategy, and it can only be broadly successful under two conditions; (1) where the firm

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[25]Starbuck, W, n.d, "Strategizing Realistically in Competitive Environments" available at http://pages.stern.nyu.edu/~wstarbuc/mob/strategizg.pdf, accessed on 03. 02. 2013

[26]*Ibid,* Mintzburg, H, 1994, *op. cit*.,

[27] Hussey, D, E., 1974, *op. cit.*

[28] Goodwin, P, Wright, G, 2010, "The Limits Of Forecasting Methods In Anticipating Rare Events", *Technological Forecasting & Social Change* 77: p 355–368.

[29]Tversky, A, Kahneman, D, 1983, "Extensional Versus Intuitive Reasoning: The Conjunctive Fallacy In Probability Judgement", *sychological Review* 90(4) p 293–315.

[30] Taleb, N, N., 2012, Antifragile: Things that Gain from Disorder, New York: Random House

faces a predictable environment and (2) where the firm has several distinct competencies upon which to draw.[31] However, "when [either of] these conditions do not hold, […] integrative [formal] strategizing is not only ineffective, it is counter-productive."[32] The predictability condition cannot hold under epistemic opacity due to the opportunity for discontinuity that it creates.

Strategy and Perpetual Turbulence

Categorising "environmental turbulence" is just another aspect of the above-mentioned point. Common in this line of thinking is the idea that the present age is the "age of turbulence", that now is far less predictable than previous "ages" that were seemingly more stable.[33] However, it is difficult to see how any historical timeframe was more or less turbulent, and nor is it helpful to forge a comparison with the timeframe that preceded it. It is more accurate to recognise that every "age" is turbulent and discontinuous in different, unpredictable ways. Ironically, the perpetual turbulence is, in fact, a roundabout and explicit recognition of the manifestation and effects of epistemic opacity.

Indeed, the feverish attempts to establish causality and understand the pathway of future changes perfectly exemplifies the utterly dysfunctional relationship that traditional strategic approaches have with the future. The many maps, frameworks, forces and tautologies that attempt to manage change stem from an attempt to achieve the strategist's dream outlined in Chapter One.[34] Stuart writes:

"In the context of complex decisions with uncertain outcomes and no obvious right answer, the managerial mind inevitably longs for some handrails to grasp […] Strategic planning offers that consolation – or illusion – of a sure path to the future".[35]

Strategic tautologies attempt to relegate the "winds" of change to mere "gusts",

[31] Starbuck, W, n.d, *op. cit.*
[32] *Ibid*, 3
[33] Ansoff, I, 1965, *op. cit.*, Ansoff, I, 1979, *op. cit.* Channon, D, F., Jalland, M, 1979, *op. cit.*
[34] Hussey, D, E., 1974, *op. cit.*
[35] Stewart, M, 2009, *The Management Myth*, London: W.W. Norton & Company

flying in the face of the "gales of creative destruction" that consistently punctuate both market economies and economic history.[36]

Platonicity, Naïve Empiricism and Ideology

Phillip Tetlock from New York University (NYU) critically examines "experts"[37] in three sets of studies, showing that there is a tendency towards "borderline tautological patterns of thinking"[38] about complex path dependent events; ideological beliefs were shown to heavily influence the perception of counterfactuals. The willingness to revise counterfactual beliefs depended on ideological outlook and the presence of asymmetrical standards of evidence in accordance with the consonance and dissonance of ideological counterfactuals. Critically, Tetlock notes: "[E]xperts whose most likely scenarios did materialize credited their accuracy to their sound reading of the "basic forces" at play"[39] This is as opposed to: "[E]xperts whose most likely scenarios did not materialize argued that […] the original forecasts had not been satisfied because a qualitatively new array of "fundamental forces" had come into play".[40] Whilst experts did perform better than undergraduates, Hartford notes that the experts "did not do well by any objective standard". [41] The marginal gains from extra knowledge of a broad contextual understanding are limited. [42]

In light of the evidence from economic history and psychology, the strategic approach to business uncertainty appears problematic indeed. Formal strategy is predicated on the "constraining" and "modelling" of selected events into frameworks, theories and "forces" (of competition, of industry evolution, national competitive advantage). The reduction of intractable, epistemic opacity into tractable intellectual forms is known as "platonification". Platonification focuses "on pure, well-defined and

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[36] Mintzburg, H, 1994, *op. cit.,* Schumpeter, J, 1942, *The Theory of Economic Develo ment,* Cambridge: Harvard University Press

[37] Experts defined here according to Tetlock as: "advanced graduate students and professors in universities, policy analysts in think-tanks, intelligence analysts in government service, or journalists".

[38] *Ibid,* 357.

[39] *Ibid*, 351.

[40] *Ibid,* 354.

[41] Harford, T, 2011, *Ada t: Why success always starts with failure*. London: Macmillan, 34

[42] *Loc. cit*.

easily discernible objects […] at the costs of […] seemingly messier and less tractable structures […] mistak[ing] the map for the territory".[43] Platonicity is a form of narrative-dependence, and is itself dependent on the establishment of causality, a tenuous possibility indeed.

Popper substantiates this argument with his critique of path independence. This is the idea that similar outcomes will necessarily arise out of similar circumstances. It is "a methodologically naïve view – the view that the method of generalisation can be taken over from physics by the social sciences – will produce a false and […] misleading sociological theory".[44] It represents a flawed attempt to reduce fundamentals and isolate causality from context, an effort to delineate path independent and replicable processes. However, causality can never be separated from its context. To suggest that this is intrinsically possible has the consequence of misrepresenting the true discontinuity and path dependence of occurrences.[45]

Hindsight, Confirmation, Survivorship Bias, and The Expert Problem

The section regarding turbulence is very important for understanding where the traditional approach falters. In identifying the "stability" of the past, the discipline of strategic management actually exemplifies to some degree the information failures that characterise the vantage point of hindsight, leading to the hindsight bias. [46] The emphasis on past "stability" can also partly be explained by a lack of awareness and acknowledgement of the clear historical record of the dramatic and indeed turbulent events of the past.

The previous section regarding Tetlock's study adds support to the confirmation bias, a well-known methodological bias also known as "cherry picking" where specific confirmatory (disconfirmatory) events from a succession are held to be true (rejected)

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[43] Taleb, N, N., 2010 (2007), *op. cit.*, 309.
[44] Popper, K, 1960 (1957), *op. cit.*
[45] *Ibid.*
[46] Taleb, N, N., 2010 (2007), *op. cit.*

relating to particular theories, frameworks and narratives.[47] Furthermore, It supports the "expert problem", in which "the expert knows a lot but less than he thinks he does".[48] In additional support of this understanding, Starbuck highlights the findings of Armstrong (1985): "expertise beyond a minimal level in the subject being forecast is of little value in forecasting change".[49] Together with the "expert problem", Tetlock's results replicated the well-established "overconfidence effect" whereby confidence limits of 80 percent or higher were correct in only 45 percent of cases.[50] Teigen and Jorgenson (2005) also show that research in overconfidence in forecasts finds that 90 percent confidence intervals given by participants are accurate only 30 to 50 percent of the time.[51]

In general, the overconfidence effect shows that having more data about past trends lends more certainty to the possible outcome of future events. A greater amount of data is believed to lead to more confident and reliable predictions and forecasts.[52] Sterman notes that the ability to fit historical data to standard logistic models of technological adoption and diffusion, economic models and forecasts, does not provide a sufficiently strong basis for establishing the nature of feedbacks that might be responsible for system dynamics. Different diffusion models with "wildly different predictions" can fit equally well.[53] This process does not identify the specific feedback processes in the system that have given rise to the dynamics in the first instance. Moreover, *gathering more data for* a sufficiently long-time series is necessary to provide stable parameter estimates. However, by the time that enough data is gathered, the usefulness of the data for forecasting purposes is rendered moot because the future time point has already arrived. In addition, obtaining stable

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[47] *Ibid.*

[48] Taleb, N, N., 2012, *Antifragile,* New York: Random House,

[49] Armstrong, J, S., in Starbuck, W. H., n.d, *op. cit.*

[50] Tetlock, E., 1999, "Theory-Driven Reasoning About Plausible Pasts and Probable Futures in World Politics: Are We Prisoners of Our Preconceptions?" *American Journal of olitical Science*, 43(2) p 335-366

[51] Teigen, K, and Jørgenson, M, 2005, "When 90% Confidence Intervals are 50% Certain: On the Credibility of Credible Intervals" *A lied Cognitive sychology* 19: 455–475

[52] Taleb, N., N., 2010 (2007), *op. cit.*

[53] Sterman, J, D., 2000, *Business Dynamics: Systems Thinking and Modeling for a Complex World,* McGraw Hill: Boston, 330.

parameter estimates does not mean that a future time series will respect the continuous nature of such estimates. [54] These insights are significant for data driven, quantitative strategies relating to the potential adoption of a new product, for it shows that it is possible to adopt until a given product is adopted, a manifestation of the signal to noise problem".[55]

This methodological conundrum is compounded by the survivorship bias. The survivorship bias distorts our understanding of success by obscuring failure. Indeed, a success is extremely rare in a world that is punctuated by failure.[56] Here, "survivors" generating *visible results* become over-represented in samples. The survivorship bias supports the narrative dependence that is used to justify or explain ex-post success by establishing clear and apparent causality between ostensibly stochastic, path-dependent events.[57] Alchian writes:

"Suppose that some business had been operating for one hundred years. Should one rule out luck and chance as the essence of the factors producing the long-term survival of the enterprise? *No inference whatever* can be drawn until the number of original participants is known; and even then one must know the size, risk, and frequency of each commitment [to draw a relevant conclusion]".[58]

"Losers" disappear as counterfactual possibilities, and the survivorship bias conceals the stochastic nature of events due to the difference between what is either remembered or recorded *ex post in relation to* what happened *as it happened*.

Section II:

Retrodictive Planning

By backward iterating and interpreting past actions down the "fundamentals" that are

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[54] *Loc. cit*.
[55] Taleb, N, N., 2007 (2004), *op. cit.,* Taleb, N., N., 2010 (2007), *op. cit.*
[56] Omerod, P, 2005, *op. cit.*
[57] Taleb, N, N., 2010 (2007), *op. cit.*
[58] Alchian, A, (Jun., 1950) "Uncertainty, Evolution, and Economic Theory" *Journal of olitical Economy*, Vol. 58, No. 3, 215.

said to have governed them, prescriptive strategy is fundamentally retrodictive by nature. Yet, the principles of prescriptive school lose a considerable amount of their purported utility when they do not work in terms of *prospects*. It is:

"helpful for looking *backward* rather than *forward*, for what it *excludes* rather than what it *contains*. [Strategic planning] cannot tell managers where they are going, only where they have been. It is useful for managing today's business, the business that already exists".[59]

This results from the tendency to smooth out established past trends and exclude discontinuities in an attempt to make the competitive landscape more tractable. This extrapolation of past data to form a basis for the future is what Fischhoff calls "hindsightful foresight".[60]

Two Can Play Porter

Porter's theoretical architecture has a particular frame of reference to past understands of historical change and current affairs; this, however, is a lens that is tainted with bias and is tenuous at best. Porter claims that the "diamond" model can be used to *predict* the emergence of future competitive advantage based on pre-established competences and capabilities. Indeed, whilst Porter claims that it *is* predictive, he does not avail himself or support his assertions with any form of prediction. This prevents Porter's framework from being falsified, either through the refutation of the prediction or a methodology against which to corroborate it.[61] Instead, Porter presents four case studies, the German printing press industry, the American patient monitoring industry, the Italian ceramic tile industry and the Japanese robotics industry.[62] In all cases, each example offers a sizable, data-laden analysis of past business environments according to his theoretical interpretation

[59] Hurst, D, 1986, in Mintzburg, H, 1994, 180
[60] Fischhoff, B, 1980, "For Those Condemned to Study the Past"*, New Directions for Methodology of Social and Behavioural Science*, 4:79-94
[61] Popper, K, 1960 (1957) *The Poverty of Historicism,* London: Routledge and Kegan Paul; Stewart, M, 2009, *The Management Myth*, London: W.W. Norton & Company
[62] Porter, M, E., 1990, *op. cit.*

expressed in the "diamond" model. This does everything to explain strong past performance in hindsight, and indeed in the present, but nothing to predict in foresight. [63] This arguably fits with Taleb's definition of "naïve empiricism".[64] Stuart also provides support for this argument, commenting:

> "When Porter cites real-world cases that appear to confirm his "theory" of competitive advantage, in fact he is merely celebrating coincidences between empirical data points and the contours of his preconceived framework […] [cases] are "just-so" stories whose only real contribution is to make sense of the past, not to predict the future." [65]

China, now undoubtedly a global economic power, is nowhere mentioned in *The Competitive Advantage of Nations*, despite meaningful market reforms being initiated 12 years prior to its authorshi A retrodictive analysis of China's economic development might reveal that Deng Xiaoping's Open Door Policy *(context for firm strategy and rivalry)* greatly facilitated Foreign Direct Investment (FDI) and mass industrial employment *(demand conditions)*.[66] This brought China closer to market-orientation through the institution of Special Economic Zones (SEZs) and infrastructure investments *(factor conditions)*, leading to increasing export sophistication and diversification *(related and supporting industries)*.[67] Moreover, SEZs are noted by Zeng as being a particular form of industrial clustering and a competitiveness-enhancing policy instrument. This example shows that it is possible to select confirmatory information and apply this information to a framework as axiom, *ex post*, amounting to little more than a set of analytic retrodictions, as opposed to the synthesis claimed. The Open Door Policy greatly facilitated FDI entry and Special Economic Zones (SEZs) constituted deliberate government policy to expedite export-oriented growth. Chinese exports as a percentage of GDP rose from 9.1 percent in 1985 to 37.8 percent by 2008.

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[63] Stewart, M, 2009, *op. cit.*

[64] Naïve empiricism defined here as the "tendency to look for instances that confirm our story and our vision of the world […] [taking] past instances that corroborate your theories and you treat them as *evidence*". (Source: Taleb, N, N., 2007 (2010), *op. cit.*, 55

[65] *Ibid,* p 206-207

[66] Jarreau, J. and Poncet, S. *So histication of China's ex orts and foreign s illovers* (2009), available at http://www.cerdi.org/Colloque/CHINE2009/papiers/Jarreau.pdf. Accessed on 26.11.10

[67] *Ibid.*

These changes could be attributed to the benefits of increased product sophistication in Chinese manufacturing stemming from technological spillovers from foreign firms. [68] As Jarreau and Poncet note, "areas where specific policies of liberalization and of openness to trade and foreign investment were put in place, such as […] (SEZs) […] exhibit the highest levels of export sophistication".[69] Indeed, the provinces of Shanghai and Guangdong, which show a high concentration of SEZs, show a level of sophistication exceeding 20 percent compared to provinces without SEZs.[70] These changes marked a transition from imitation to innovation and increasing levels of export sophistication precisely within SEZs.[71] Kim has noted that this development model was very successful for both Japan and South Korea in the post war period. [72]

Predicting Strategic Decline: an Ex-Post Exercise

Might Sony have modelled a scenario in which their competitive advantage in the consumer electronics business was in severe decline? The answer is most likely in the negative. As "the Apple of its day", [73] Sony had, since 1979 and throughout the 1980s and 1990s, been major innovators (after much imitation in the post war period) in first the cassette Walkman, CD technology in conjunction with Philips and then the CD Walkman.[74] For the financial year 2013-2014, Sony has prematurely announced that it has made a net loss of one billion USD.[75] This news came three months after the company lost $2.2 billion in market value after earnings forecasts were cut. Though

[68] Export sophistication' is defined as a decreasing percentage of production in low-tech products (toys, textiles and pottery), and increases in medium-tech (automobiles, chemical fertilizers and paint) to high-tech items (televisions, turbines and pharmaceuticals. Chinese law is organized to facilitate technological spillovers (weak appropriability regime) and protect domestic producers from legal action.

[69] *Ibid,* 13

[70] *Ibid.*

[71] Jarreau, J. and Poncet, S. 2009, *op. cit.*

[72] Kim, L, 1997, Imitation to Innovation The Dynamics of Korea's Technological Learning, Boston: Harvard Business School Press

[73] Walters, R, Dec 31st 2012, "The Rise and Fall of the Sony Empire", available at http://www.cultofmac.com/2221/hello-macs-are-about-to-get-interesting-again/, accessed on 30.01.14

[74] *Ibid.*

[75] Yasu, M, and Grace Huang, G, Feb 06, 2014, Sony Forecasts $1.1 Billion Loss as Hirai Misses TV Profit Goal, available at http://washpost.bloomberg.com/Story?docId=1376-N0EUU86JTSEO01-41D0JF1CNBB4F35NN0HBHJOVP1, accessed on 07.02.2014

Sony remains high competitive in other areas, it did not do well in this particular market segment.

The decline of Sony's lead in recorded music began when Steve Jobs announced the iPod. This, however, is an easily identifiable retrodiction. However, as an emergent technology, the fate of the iPod is perhaps not so clear-cut. As another article notes: "Initially seen as a desperate, [expensive] niche product, the iPod went on to save [nearly bankrupt] Apple, establishing it as a media powerhouse".[76] It also took two to three years for Apple's market position to consolidate due to technological inertia and slow adoption of the product. Neither was Apple the first market-mover, and the company did not invent he MP3 player (iPod) smartphone (iPhone) or tablet (iPad): it just made them more appealing, with other companies following suit and creating entirely new industries in these devices shortly thereafter. Indeed, as a strategic response, Sony attempted to launch several lines of MP3 players and its own "Connect" online music store which was not commercially successful and ultimately discontinued.[77] Apple also outsourced the manufacture of many of its components from the Foxconn corporation factories in the *Guandong* province of China, an SEZ.[78]

Product, *marketing* and *process innovation* are arguably the evolutionary forces at play in this particular example; and this outcome would have been neither best nor the most likely from Sony's perspective, and most probably missed by a technology forecast. Relating to the generic strategies, with hindsight it is possible to identify Apple's "focus" and "differentiation" as the source of its competitive advantage in these product markets, and Apple was able in part to command a higher price point by virtue of this. However, the iPod was initially ridiculed (treated anacronym for "idiots price our devices") when it was launched, before it became a sensation and globally adopted.[79] This transition took *three years*, and although bold, it was by no means clear

[76] Walters, R, Dec 31st 2012, "The Rise and Fall of the Sony Empire", available at http://www.cultofmac.com/2221/hello-macs-are-about-to-get-interesting-again/, accessed on 30.01.14

[77] Isaacson, W, 2011, *Steve Jobs,* Simon and Schuster: London and New York

[78] Jarreau, J. and Poncet, S, 2009, *op. cit.*

[79] Jun 10th 2004, "Rational Consumer: The Meaning of IPod", available at http://www.econo mist.com/ node/2724432, accessed on 30.01.14

how events would unfold.

As Porter notes "It is hard for firms steeped in an old technological paradigm to perceive the significance of a new one. It is often harder for them to respond to it".[80] Porter is both correct and incorrect; correct because it is indeed hard for incumbent firms to respond to new challenges; incorrect for all of the aforementioned methodological problems. A technological paradigm does not become a technological paradigm until after it has become one; it is an *ex post* realisation as opposed to *ex ante* categorisation. This is, however, arguably connected to the first problem, because if a threat looks like a fad, there is no need to respond to it. Although, if a new product gains critical mass, the incumbent version will suffer obsolescence. In a conundrum such as this, there can only be one strategic option: "Innovation is the best strategy for survival, and it is a strategy from which consumers and citizens, as well as corporations, all benefit", (on which, see Chapter Three), but is itself an inherently risky venture.[81]

Implications for Competitive Advantage

In 1996, Leslie Hannah, conducted a study that traced the trajectory and fortunes of the world 100 largest firms, each with a market capitalisation of at least $26 million and employing 10,000 or more people, with an average employee age of 32 years, from 1912 through to 1995. These companies had survived shakeouts, merger waves, booms and busts over the early 20th Century. Most of them failed. These firms ranged across countries, and industries, from the largest company in 1912, US-based US Steel (741 million), down to 10 per cent of its original size by 1995; third largest UK-based J&P Coats with a market cap of 287 million, down by 70 per cent by 1995; and the German Krupp at 14th with a market cap of 130, down to 20 per cent of this size by 1995.[82] By 1922, 10 of the top 100 largest companies had disappeared, and by 1995, 48 had gone. Of the remaining 52, 19 were no longer in the top 100. A few, such as Procter and

[80] Porter, M, E., 1990, *op.* cit., 46.
[81] Hartford, T, 2011, *op. cit.*
[82] Hannah, L., 1999, "Marshall's Trees and the Global Forest": Were Giant Redwoods Different?, 253-294, in Lamoreaux, N, R., Raff, D, M, G., Temin, R, eds, Learning by doing in markets, firms, and countries University of Chicago Press.

Gamble and General Electric and oil companies Chevron and Exxon, had grown larger.[83]

Economic geographical changes are also telling: 54 of the top 100 were US-based, declining to 40 by 1995, whereas Japan gained 21 from none in 1912. Hannah writes:

> "How, then, can large corporations retain their positions, continue to add value and expand their capabilities? The only reasonable answer is: "with great difficulty […] profits were often a reward for large-scale investments in production; management and marketing […] such advantages are often fleeting and contingent."[84]

Hannah argues that the structural advantages of the "giants" of the 20th Century corporations benefited strongly from path dependent processes, making them difficult to replicate. The evidence suggests that large corporations are not able to sustain the entrenchment of their particular competencies indefinitely, since these competencies are technologically, socially and economically and therefore temporally contingent.[85] The architecture of competitive advantage, Hannah notes, is constantly threatened by imitation. Above average performance and the strategic advantage of the first mover quickly trends towards normal profits. Imitation and strategic decline set in as firms steer the gales of creative destruction. This creates a double incentive where, on the one hand, firms seek competitive advantage and on the other hand, other firms emulate. In this, the attempt to protect against competition to maintain such a fleeting advantage appears a wanton fancy in the face of the economic reality of unpredictable yet cyclical decline and failure.[86]

Iterated Expectations and Impossible Knowledge

The *law of iterated expectations* states that: "if I expect something at some date in the future, then I already expect that something at present".[87] If what is expected can be

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[83] *Ibid.*
[84] *Ibid,* 17-18
[85] *Ibid.*
[86] Omerod, P, 2005, *Why Most Things Fail,* London: Faber and Faber
[87] *Ibid,* 172

known, then it is no longer expected and is by definition known. Equally, "[when] *understand[ing] the future to the point of being able to predict it, you need to incorporate elements from this future itself*".[88] The significance of this in terms of the current example might be applied as follows; if Sony could have predicted that the iPod and online music distribution was going to be such a profitable and successful product and platform, it would have been Sony's creation. This would equally apply to any other scenario of competitive challenge.

Yet even if this were possible, both Popper and Harper note that this endogenous feature of uncertainty means that acquiring information on competitors has the potential to *transform rather than eliminate* uncertainty.[89] Actors' strategic moves are based on making predictions about the predictions of other actors. They must then determine their expectations about competitor's expectations, and these become ever more complex as the number of competitors increases. [90] The result is that actors are more likely to take on different and more anticipatory actions under these circumstances.

Popper demonstrates that the course of human history is intimately interwoven with the growth of knowledge. Popper argues that it is impossible to predict the growth of knowledge, science and technical innovation by either rational (*a priori)* or scientific (*a posteriori)* methods.[91] As such, it is impossible to predict the future development of human history. Popper writes:

> "No scientific predictor […] can predict, by scientific methods, its own future. Attempts to do so are only attained after the fact, when it is too late […] all the thoughts and all the activities of historicists aim at interpreting the past in order to predict the future."[92]

This means that not only is a theoretical history of human history impossible, but

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[88] *Loc. cit.* Taleb's emphasis.
[89] Harper, D, 2000 (1996), *Entrepreneurship and the Market Process*, London: Routledge
[90] *Ibid*
[91] Popper, K, 1960 (1957) *The Poverty of Historicism,* London: Routledge and Kegan Paul
[92] *Ibid*, 49.

that the attempt to construct one is fraught with erroneous, narrative-dependent causality. Where the course of human history and technological innovation is unpredictable, and prescriptive strategy attempts to relate firms to their future assumed environments, then the outcomes of decision making related to the extension of human knowledge must be far from certain and tenuous at best. This means that outlining the "evolutionary" and "competitive" forces is of limited practical utility in strategic terms, going forward.

First-rate Physics

Theoretical physics is the only discipline where, in the vast majority of cases, pure theory can lead to pure practice, barring some cases such as the wide-scale rejection of superstring theory.[93] For example, a solar eclipse can be predicted to within a minute, a millennium in advance.[94] And the existence of the Higgs Boson was derived theoretically up to 40 years before its actual discovery.[95] In contrast, Michael Berry examines iterative processes and illustrates the difficulty of predicting something as simple as the movement of billiard balls across a table with infinite precision.[96] Given a stationary ball, a number of roughly accurate assumptions regarding some basic parameters can allow one to accurately predict the first hit against another ball. The second hit requires a greater number of more accurate assumptions. By the fifty-sixth hit "*every single elementary particle of the universe* needs to be present in your assumptions!"[97] Startlingly, this example is only on a two-dimensional billiard table: "consider the additional burden of having to incorporate predictions about *where these variables will be in the future"*.[98] When this example is considered with respect to the biases, ideologies and tautologies of the strategic process discussed in this chapter, the

[93] McKie, R, 8th Oct 2006, "String theory: Is it science's ultimate dead end? Available at http://www.theguardian.com/science/2006/oct/08/research.highereducation, accessed on 05. 04. 2014
[94] Sagan, C, 1996, *The Demon Haunted World: Science as a Candle in the Dark*, New York: Ballantine Books
[95] Clegg, B, 2013, *op. cit.*
[96] Berry, M, 1978, "Regular And Irregular Motion, topics In Non-Linear Mehcanics," ed, S. Jorna, *American Institute of Physics Conference roceedings*, 46, p 16-120.
[97] Taleb, 2010 (2007), *op. cit.*, 178.
[98] *Loc. cit.*

nature of uncertainty is suddenly understood in terms that go far beyond the mere complexity of physical laws, rendering its vagaries increasingly opaque.

Conclusion to Chapter II

It is perhaps ironic, on the one hand, that many different offerings in strategy highlight the inertia and roadblocks to innovation (Hussey/Porter) yet at the same time put forward conceptual system that preclude the aspect that these systems seek to address: to help firms function in difficult, "turbulent" environments. In answering the second research question, this chapter has demonstrated, that the attempt to relate to uncertainty is fraught with methodological error. The grand fallacy of strategic planning is that it is a potent analyser, but an impotent synthesiser, "strategic planning is not strategy formation"[99], that *analysis is not synthesis.* Moreover, in making firms *option-blind*, strategy is damaging to the innovativeness and ultimately long term survival of the organisation, making firms less able to exploit the first mover advantage that Porter's positioning advocates.

Ultimately, this concerns the failure of approximation to represent reality both in the accurate historical context and a related failure to synthesise a plausible future context and the compounding problem that the approximation of reality would not give any indication of a future reality. Clearly, strategy needs to be overhauled. The aim of this chapter has been both negative and normative: to learn what strategy *should not* be. This negative approach must internalise and recognise ecological realities rather than proceeding from the conceptual fiat and tautological framework that pervade the related management disciplines.[100] A new strategy must proceed from the *acceptance and recognition* of epistemic opacity as well as the fact that strategic outcomes are more often than not path dependent and therefore not replicable

[99] Mintzburg, H, 1994, *op. cit.*, 312
[100] Stewart, M, 2009, *op. cit.*

Chapter III: A Emergent Strategy

Introduction to Chapter III:

Given that strategic planning is not strategy formation, it is therefore incumbent upon the present analysis put forward a new approach that avoids the weaknesses of the prescriptive schools and meaningfully contributes to helping firms relate to their emergent, uncertain environment. Chapter three, in two sections seeks to answer the third research question by doing just this. The first section begins by marking a theoretical point of departure away from the prescriptive schools (in accordance with their general relative decline) and towards the descriptive school (and their relative rise). This chapter, draws insight from the "learning" which sees strategy as an emergent process and then, drawing a variety of sources such as Mintzburg and Stacey, by charting a path towards an emergent strategy. The approach is marked first and foremost by the application of convexity; a distribution of outcomes that favours upside rather than downside. Convexity is expressed in trial and error; the opportunity to attempt something is the primary means by which experience can be gained and strategic steps taken. Equally important is an emphasis on tacit, uncodified knowledge, necessarily supported by trial and error. Trial and error allows can allow fortuitous combinations to "accidents" to occur leading to unpredictable results. These ideas find theoretical support in Stacey's and Fonseca's respective concepts of "transformative teleology" and "redundant diversity" in innovation processes.

Section two instrumentalises these insights, and blends in others, to support these theoretical claims by tracing a line through the history to invention, from flooded mine in 19th century Cornwall, England to Wi-fi in the early 21st century. This shows that it is marked by happenstance and unpredictable turns with utterly unpredictable outcome. Not only this, but this process is geographically "impure", that is to say, with a considerable amount of cross fertilisation of innovation across borders with direct sources that are difficult to discern. This section also takes up the debate regarding first and second mover advantages, in light of the non-historicised evidence from invention. The analysis shows that imitation always follows behind innovation, and these concepts are not only inter-related but also co-dependent. This means that an

emergent strategy must facilitate innovation as much as possible.

Section I:

Away From Strategic Planning and Strategic Management

Mintzburg notes that there has been a transition away from the "prescriptive" schools and towards the "descriptive" schools of strategy.[101] Figure 6 shows the decline of the former, and rise of the latter, within the 10 distinct strategy schools:

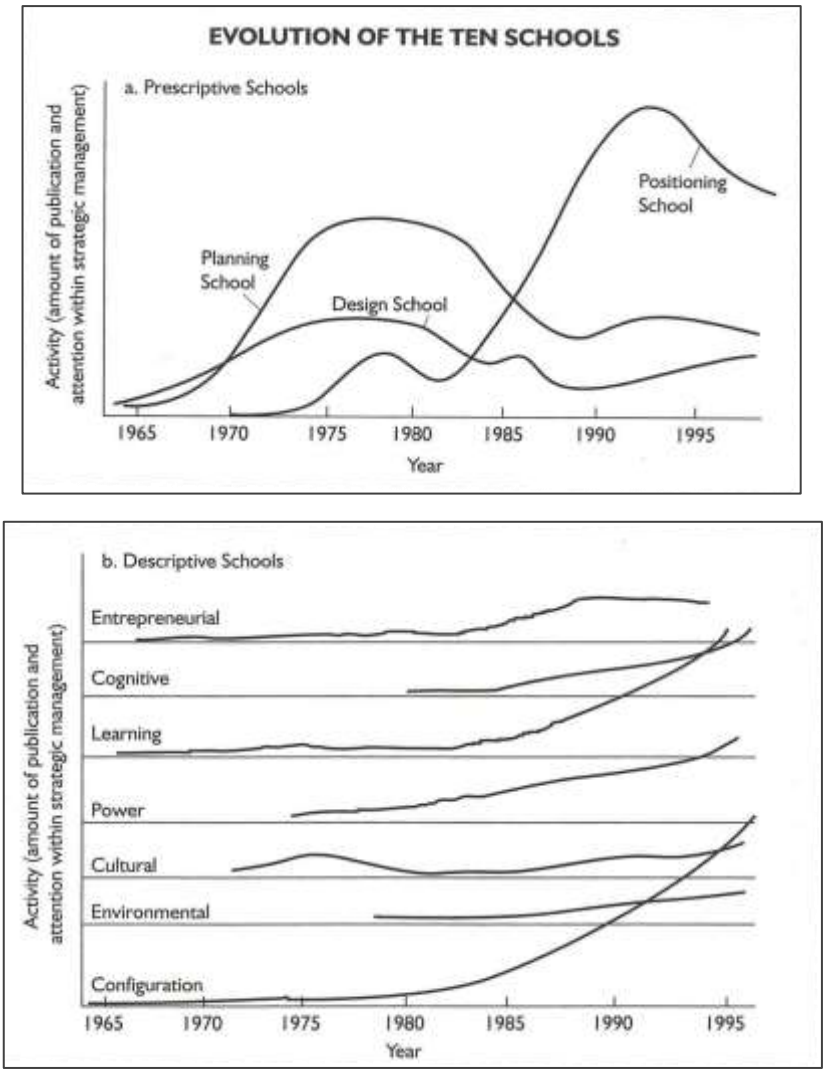

Figure 6: The rise (decline) of the prescriptive (descriptive) schools.[102]

[101] *Ibid.*
[102] *Ibid*, 353

Figure six shows the relative decline of the three prescriptive schools and the rise of the six descriptive schools, and the final "configuration". Chapter One outlined both the contribution from the "planning" school, also known as "strategic planning", as well that of the "positioning" school, known as "strategic management". Mintzburg argues that the positioning school, exemplified by Porter's contribution, "did not radically depart from the premises of the planning school"[103], but did add the idea of limited, generic strategies, whereas the planning and design schools allowed for a much broader range.[104] The similarities, therefore, allow for the same critique to be levelled against both, as has been outlined in Chapter Two. In figure seven below, Mintzburg locates the ten strategic schools along a rational-to-natural, predictable-to-unpredictable continuum:

[103] *Ibid*, 83
[104] *Ibid.*

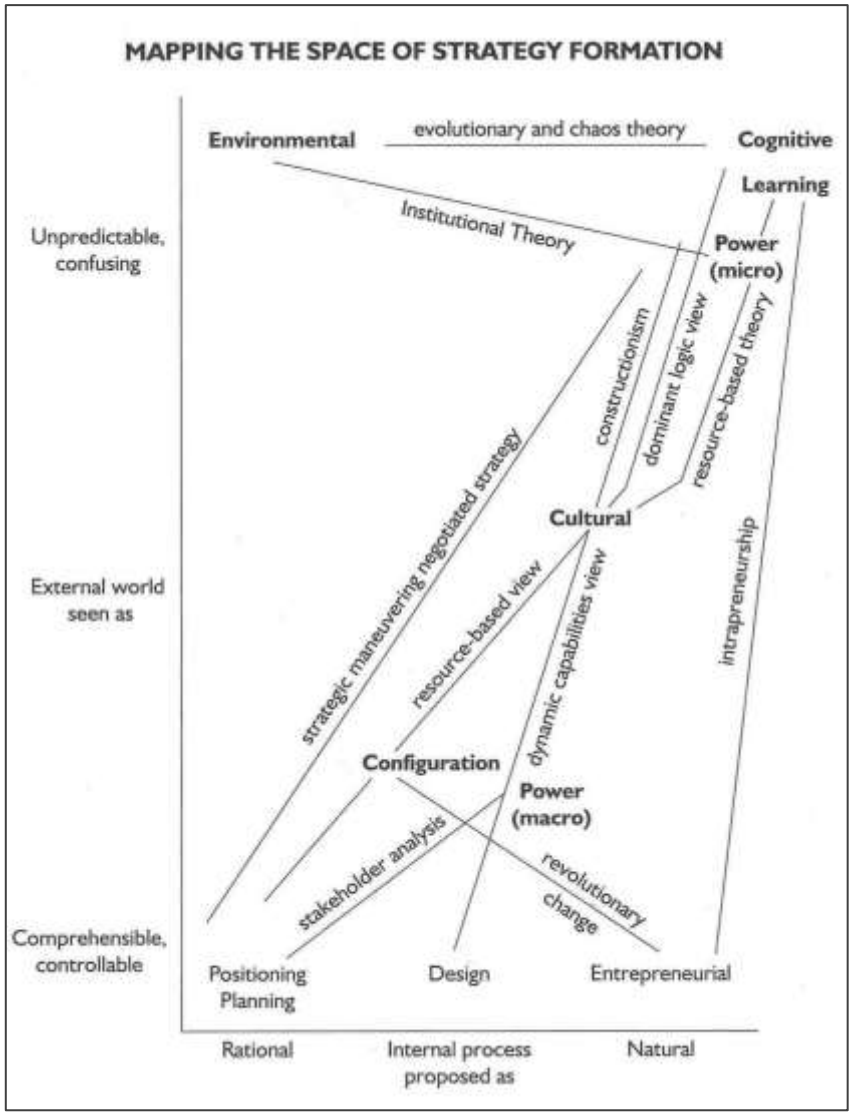

Figure 7: The ten strategic schools on the double-continuum[105]

Figure seven shows that the learning school, which sees strategy as an emergent process, is located, along with the cognitive school, away from the "rational" and "predictable, controllable", and is much more in line with the "natural" and "unpredictable", with an influence of chaos theory coming from the environmental school. The section that follows outlines important insights derived from the learning school, serving as a theoretical point of departure from which these insights can be instrumentalised in Section II.

[105] *Ibid*, 369

A Break from the Past: Towards Emergent Strategic Learning

It is not possible to reconcile the prescriptions of the planning and positioning schools with a modified approach that places emphasis on strategy as an emergent process. This is for the simple reason that an emergent strategy rejects the tautologies of the planning school and the backward iterated analytical approach of the positioning school, refuted on epistemological grounds in Chapter Two. An emergent strategy based predominantly on the learning school instead greatly de-emphasises the role of causality in each of these approaches, instead placing its focus on a path independent approach that leads to path dependent outcomes, recognising that to do so would negate the ecological realities of competitive dynamics under uncertainty. This insight appreciates (in line with the cognitive school, it is worth noting) the proper role for the complexity of deterministic interactions.

Here, an essential point of departure exists, away from explicit knowledge and towards tacit knowledge. Tacit knowledge is uncodified understandings passed between individuals[106], sometimes manifesting as heuristics, general "rules of thumb" that are used as shortcuts instead of the type of "rational" decision making that neoclassical economics has traditionally assumed.[107] Nonaka and Takeuchi, in submitting an explanation for the success of the innovation within Japanese firms, argue that it is the importance of "tacit knowledge as the less formal and systematic side of knowledge" which traditional western training on "manuals, books and lectures" does not capture, and is therefore not as effective.[108] This is because the manner in which knowledge is aggregated will dictate the options available, be they individuals or firms. The imperative lies in aggregating from the widest pool possible. In *The Use of Knowledge of in Society,* Hayek argues that in a free society, one must both be able to make use of the knowledge that one has acquired and be able to benefit from knowledge that is not directly acquired. Echoing Popper, Hayek makes a non-teleological argument, arguing that there

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[106] *Ibid,* Nonaka, I., & Takeuchi, H, 1997 (1995), *The knowledge-creating company,* Oxford: Oxford University Press

[107] Tversky, A., & Kahneman, D, 1974, "Judgment under uncertainty: Heuristics and biases", *science*, *185* (4157), 1124-1131.

[108] Nonaka, I., & Takeuchi, H, in Mintzberg, H, Ahlstrand, B, & Lampel, J., 1998, *op. cit.,* 210

are no ideas that necessarily guide humans to a *higher* form of civilization, and that the knowledge possessed by others is an essential precondition for the successful pursuit of individual aims as well as knowledge growth. Critically, the accumulated knowledge of this pursuit exists nowhere is an integrated whole, implicating spatially, temporally and geographically diffuse (tacit) knowledge. This knowledge cannot be captured by statistical measures. For these reasons, Hayek writes:

"The advance and even the presentation of civilization are dependent upon *a maximum of opportunities for accidents to happen* […] [a]ll we can do is to increase the chance that some special constellation of individual endowment and circumstance will result in the shaping of some new tool or the improvement of an old one, and to improve the prospect that such innovation will become rapidly known to those who can take advantage of it. [emphasis added]"[109]

The inverse, Hayek argues, is unthinkable: "the subjection of knowledge to reason would be the attempt only of that which is totally predictable in its results, there would be no reason or no occasion for non-knowledge to appear".[110] The parallels between Hayek's critique of other central planners and the critique of strategic planning are indeed striking. Where Hayek's *central planner* seeks to aggregate knowledge of an entire society and nation through statistics and "rigorous analysis", the *firm* attempts to aggregate knowledge and gather data concerning market and competitor behaviour, as well as other technical information to reduce the turbulence and uncertainty of the business environment. If that firm follows a prescriptive school approach, the exclusion of tacit information is a failure of the aggregation of knowledge. Knowledge is dispersed amongst countless individuals, who possessing very little knowledge. It is not possible to know which individual has the best aptitude to deal with a particular problem. This creates a greater role for exogenous sources of potential innovation, outside of firms, directly chiming with the learning school approach.

In further support of the learning school approach, Mintzburg cites Ralph Stacey. Stacey argues, as this analysis has in Chapter Two, that sets of deterministic

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[109] Hayek, F, A., *The Creative Powers of a Free Civilisation*, in Hamowy, R, ed, 2011, The Collected Works of F.A Hayek, Vol. 17: *The Constitution of Liberty: The Definitive Edition*, London and New York: Routledge, 80-81

[110] *Ibid.*

relationships lead to perturbations, permutations and unpredictable outcomes, and that "order produces chaos and chaos can lead to new order".[111] Stacey's own writings on the subject of chaos, complexity and management arguably extend Popper's epistemological argument regarding knowledge growth (though *The Poverty of Historicism* is not directly cited) as a critique of the prescriptive school by considering the journey from "Rational Teleology"[112], grounded in the 19th Century idealist philosophy of Immanual Kant, to a "Formative Teleology"[113], and then finally to a "Transformative Teleology".[114] Transformative Teleology is marked by a "sustainable paradox" characterised on the one hand by "identity" (consisting of the known, sameness and certainty) and the "novel" (consisting of discontinuity, difference and the unknown).[115] Stacey's teleology is not a teleology in the historical and philosophical sense, since in Stacey's case it makes no allusion toward a journey with a perceived. In this sense, it is a paradoxically a non-teleological teleology.

Fonseca, picks up on this antagonistic paradox and conducts an important exploration of innovation under complexity.[116] Here, critiquing Mintzburg (amongst others) for characterising "innovativeness" as a manageable process, it is argued that there has been a fundamental confusion between historical inputs which have led to predominantly linear outcomes and modern processes which lead more towards nonlinear outcomes.[117] This is because there has "been a monumental shift" in economic inputs away from "energy and matter" and towards "information and knowledge", themselves being very scalable in nature; our understanding of causality

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[111] Stacey, R, 1992, in Mintzburg, Mintzberg, H, Ahlstrand, B, & Lampel, J., 1998, *op. cit.*, 222

[112] Defined as "The cause of human action is human motivation is expressed in autonomously chosen goals and means of achieving them arrived through rational reasoning" (source: Stacey, R, 2001, 26)

[113] Defined as " a systemic theory of causality in which a system unfolds patterns of behaviour that are already unfolded in its structure in movement to a mature state that can be known in advance" " (source: Stacey, R, 2001, 27)

[114] Defined as "a future which is under perpetual construction by the movement of human action itself" " (source: Stacey, R, 2001, 162-163)

[115] Stacey, R. D., 2002, Complexity and management: fad or radical change to systems thinking? London: Routledge, Stacey, R, D., 2001, *Complex Responsive Processes in organizations: Learning and knowledge creation*. London: Routledge.

[116] Fonseca, J, 2001, *Complexity and innovation in organizations*. London: Routledge

[117] *Ibid,*; Mintzburg, H, in Quinn, J. B., Mintzberg, H., & James, R. M., 1988, *The Strategy Process: Concepts, Contexts, And Cases*, Englewood Cliffs: Prentice-Hall.

and change must also reflect this.[118] This means that we have "an illusion of control", as Arther argues, writing in *Harvard Business Review*[119] and that the old notion of "measurement and calculation do not apply" as they used to.[120]

Echoing Stacey, Fonseca puts forward a similar view, contending that the paradox of innovation is "the activity of innovating so as to create security stability is that which produces insecurity and instability".[121] Fonseca seeks to understand this paradox within the context of innovation as matter where "innovative meaning" arises as: "the emergent continuity and transformation of patterns of human interaction, understood as on-going, ordinary complex responsive processes of human relating in local situations in the *living present*"[122]. This means that innovation is about creating and sustaining a diverse, emergent dialogue in real-time under the paradoxical dynamic of understanding and misunderstanding at once. This is an intriguing insight, and is related to the methodological bias in Chapter Two through the concept of "critical levels of redundant diversity". Redundant diversity[123] is itself easy to criticise *ex post*, precisely because it looks wasteful *in hindsight*, the only viewpoint from which a clear path seems obvious, and it can also open itself up to other methodological biases. This sphere of interrelation depends on processes of communicative interaction that are both *self-organising and unpredictable* (as Hayek and Taleb respectively argue).

Section II:

Moving Forward

Having created the theoretical point of departure away from the planning and positioning schools, it is essential at this point to begin to instrumentalise these insights in a practical way. This strikes a clear demarcation point between implementation/formulation and thinking/acting. The proposed approach is based on

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[118] *Ibid*, 6.
[119] Arthur, W. B. (1996). Increasing Returns and. *Harvard business review*, *74*(4), 100-109.
[120] Fonseca, J, 2001, *Loc. cit.*
[121] *Ibid, 4*
[122] *Ibid,* 3
[123] This philosophical point manifest very clearly and instrumentally in Philip Scranton's concept of "technological uncertainty", on which, later.

the non-predictive view, rejecting the wild and dangerous effects of prediction and biased, construed causality. Building on this leads to an introduction about the concepts of concavity and convexity. These are distributions of effects and dispersals such that the former exhibits more of the downside (negative) and the latter more of the upside (positive) outcomes.

The expression of concavity and convexity has trial and error processes as its central tenet, but proceeds to "layer" more concepts to give a more complete picture of strategic learning as an emergent process. This approach instantly rejects the basis of scenario planning and many other facets of the traditional strategic approach exemplified by the prescriptive schools. This is because this thesis recognises the complexity of causal interactions (borrowed in part from the cognitive school) and is cognisant that " the traditional image of strategy formation has been a fantasy, [and] did not correspond to what actually happens in organisations".[124] It is the emphasis on trial and error that represents an important conceptual point of departure due to the rejection of causality and the dependence on iterated and extrapolated narrative.

[124] *Ibid*, 171

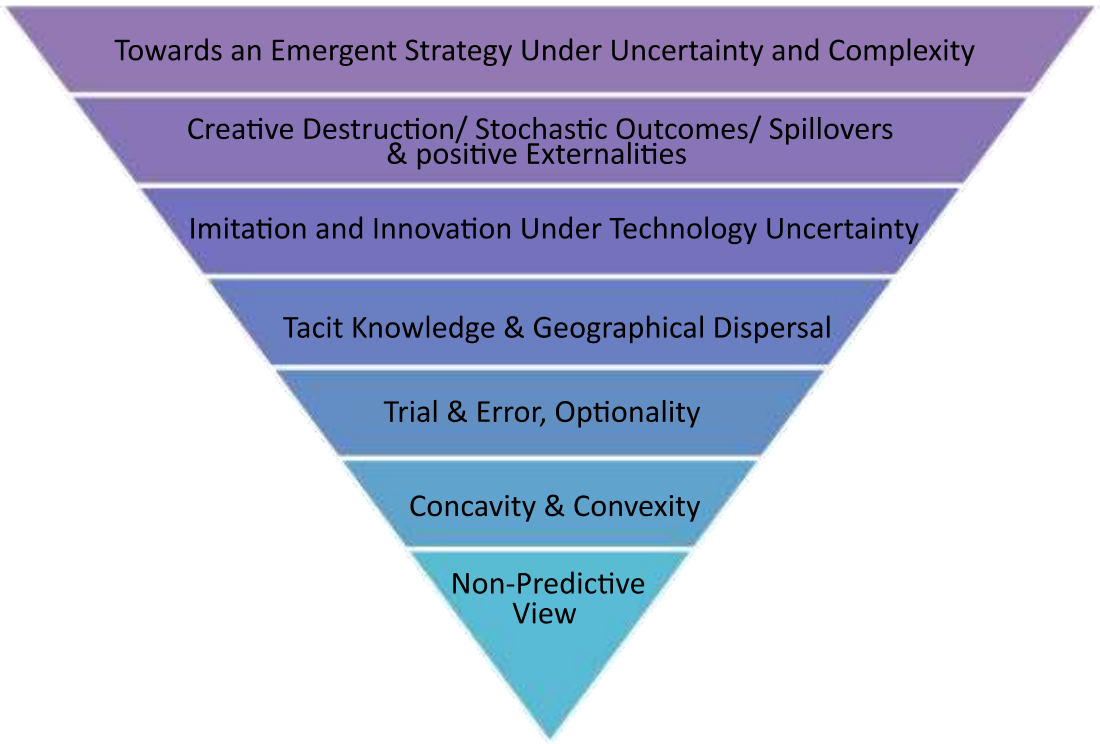

Figure 8: Towards emergent strategy under uncertainty/opacity

Figure eight shows that after considering the role of trial and error, the role of options are best evaluated through the method of trial and error. The importance of this is that time and again throughout history, practical experimentation tends to feed theory and narrative. This is evident in the natural sciences, and similar arguments can be applied to the arena of strategic business management, where theory and tautology is applied *ex post* as opposed to *ex ante*, and the story is then retold backwards. This chapter then goes on to consider tacit knowledge and geographical dispersal[125] amongst all individuals and organisations (as argued by Hayek amongst others, on which later), tracing this through as a thread in the history of invention. This will show that there is considerable technological uncertainty (as outlined by Scranton, on which later) interacting with both imitation and innovation. These processes are very much open to random or stochastic disturbances, which have the potential to be positive and

[125] The role of tacit knowledge is also considered in clusters in chapter four, and is a recurring theme throughout.

negative in unpredictable ways, allowing some innovations to suffocate. These insights will lead to a better understanding of an emergent strategy under uncertainty through accounting for complexity. The learning approach to strategy does of course have some weaknesses. These, however, are left to one side until Chapter Four where these weaknesses are addressed in terms of the entrepreneurial school that is particularly relevant for the case study.

From the Predictive to the Non-Predictive View

The predictive view that characterises the strategic discipline is narrative-dependent; it forces decision-makers to attempt to predict the future based on a perceived vulnerability to it. Predictions must therefore be very accurate.[126] This has the consequence of inducing option-blindness through pseudo path-independence. This in turn may make firms more vulnerable to the creative destructive tendencies of the market system.[127] The result is that firms become inert, vulnerable to future changes, creating a perceived need to predict and adapt. [128] Under opacity, it is easier to recognise and measure vulnerabilities than it is to attempt to predict the outcome of an event with considerable negative impact; the latter being far less tractable and measurable than the former. [129]

Conversely, the non–predictive view recognises the path dependent nature of future knowledge growth and puts forward a strategy that considers and is able to explore a multiplicity of options, requiring less information rather than more. This can maintain the creativity of firms, allow firms to benefit from future changes by innovating, making firms less vulnerable to the winds of creative destruction. At the heart of the non-predictive view lies an emphasis on *exposure and payoff*. Here, the outcome of given decisions is rarely symmetrical, with an equal level of exposure and payoff. Rather, the outcomes of decisions are commonly *asymmetrical*, having more or less payoff in relation to exposure. The non-predictive view seeks to domesticate

[126] Taleb, N. N., 2012, *op. cit.*
[127] Schumpeter, J, 1942, *op. cit.*
[128] Taleb, N. N., 2012, *op. cit.*
[129] *Ibid.*

rather than tame uncertainty, recognising instead that it is impossible to tame uncertainty because of the intractable nature of the likelihood of surprise events on the one hand and the tractable nature of vulnerabilities on the other hand. [130]

All in the Options and Asymmetry

In the orthodox approach to strategy, decision-making has a tendency towards the *concave*. There is more downside (unbounded) than upside (bounded), vulnerability to prediction errors, path-dependency, and considerable volatility. An irreversible, path dependent strategy that is non-opportunistic is more vulnerable to random perturbations. Figure nine outlines the concave nature of strategic decision making. [131]

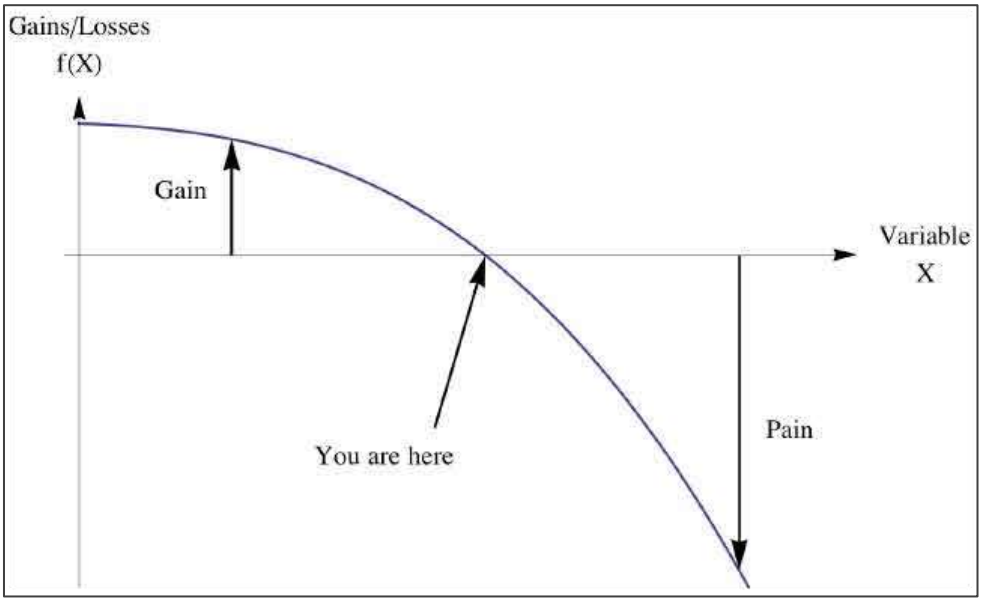

Figure 9: Concavity.[132]

The new strategy seeks to be *convex*: more upside (unbounded) than downside (bounded), less vulnerable to prediction errors, path-independent, benefitting more from epistemic opacity. Figure ten outlines the convex path.

[130] *Ibid.*
[131] *Ibid.*
[132] *Ibid.*

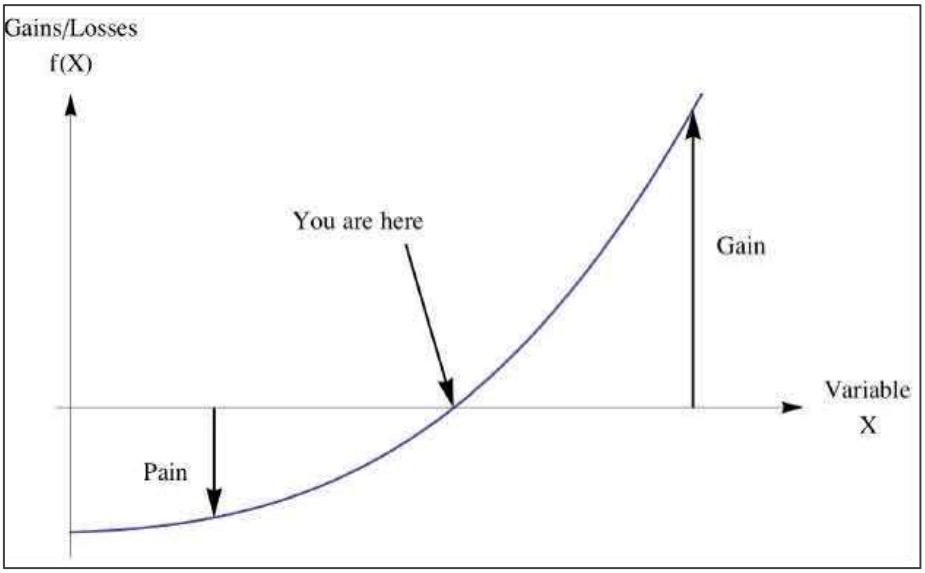

Figure 10: Convexity.[133]

An accumulation of decisions under a given framework that favour concavity also favour nonlinear damages, accumulates risk and is less vulnerable to intractable and sometimes severe volatility. The inverse, a framework that favours *scalable benef*its that characterises the convex, increases the likelihood of benefitting from stochastic changes. The goal of a new strategy must be to be on the *favourable side* of this asymmetry. Options offer potential technologies and innovations of immense value that cannot be known and can be discovered either by fiat or by the beginning or end of a certain time period by accident. They can be of immense value once discovered. This is not to say that the convex approach has no downsides. Downsides exist, however, they are small and bounded, whereas the gains are potentially large. Writing for *Harvard Business Review*, Courtney, Kirkland and Viguerie briefly discuss options as one of the strategic tools to deal with uncertainty, highlighting the asymmetric payoff structure and the idea of small scale trials.[134]

Trial and Error as Optionality

The agent of the convex strategy is the option, and the agent of the option is trial and

[133] *Ibid.*
[134] Harvard Business Review, 1999, *Harvard Business Review On Managing Uncertainty*, Boston: Harvard Business Review Press

error. Trial and error is a diffuse yet directed process with unknown outcomes. This relates trial and error to convexity because it affords the possibility of a large payoff and errors have the potential to provide information regarding what has not worked, giving an implicit approximation of what might work. The interactions between outcomes, trials and subsequent errors provides additional information at each step, and this process is guided by the rationality of the person undertaking it. Karl Popper shows that trial and error is an essential tenet of the theory of the growth of knowledge. The growth of knowledge involves: "endless testing, the constant overthrow of existing scientific theories and their replacement by wholly new and better kinds of knowledge" in a system that is "unidirectional, irreversible, and is *fundamentally discontinuous* in nature".[135] Trial and error is a negative approach since each error provides additional information, about what does not work. This result is a progressive approximation towards a given result. The growth of human knowledge is nothing if not the history of trial and error; it is not necessarily devoid of narrative, nor is it successful without it, but it is not narrative-dependent.[136] Hartford, in his 2011 offering *Adapt: Why Success Always Starts with Failure*, emphasises three important points in relation to the trial and error approach. First, expect failure, as any organisational or technological venture will inevitably bring error. Second, for this reason, errors have to be *survivable*; this echoes the previous point relating the convex strategy that highlights the need to limit the downside. Third, it is important to know *when* you failed. This is important for the negative element of the approach. If it can be known when one has failed, then what does *not* work can be known, leading to greater approximation of what might work.[137]

A Word on Bacon

According trials and error its proper place in the history of scientific (and more broadly

[135] Harper, D, 2000 (1996), *op. cit.* 61. Emphasis added.
[136] Taleb, N, N., 2012, *op. cit.*
[137] Hartford, T, 2011, *op. cit.*

of general knowledge growth) is at once essential for understanding the process of creation under uncertainty. Branches of the philosophy of science and epistemology have argued since Francis Bacon that it is theoretical science that informs scientific practice through its subsequent application. This manifests as the "strategic" and "Baconian" linear model", as follows:

Figure 11: The Strategic Linear Model

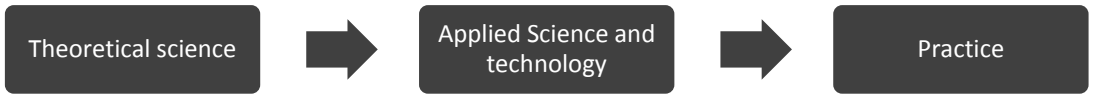

Figure 12: The Baconian Linear Model.[138]

Despite finding some validity, there is considerable evidence against this thesis by way of counterexample. Counterexample shows that the linear model in many cases is exactly backward and that, in actual fact, the role of practice in actualising outcomes is far and above that of theory. Figure 13 shows the revised model.

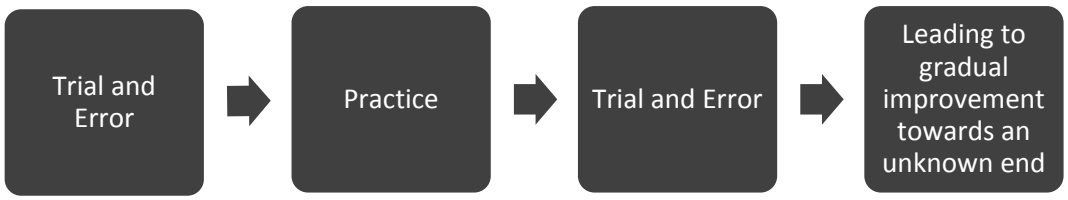

Figure 13: The Revised Model

Mintzburg, Hartford and Taleb provide evidence for the "backward enforcement" of the top-down linear model on necessarily decentralised, self-organising actions. Mintzburg cites Pascale's account of the example of Honda attempting to enter the US

[138] Kealey, T, 2009, *op. cit.*

market for motorbikes. Part of Boston Consulting Group's (BCG) explanation was that "[Honda's] marketing strategies were directed towards developing […] high volume models". [139] Juxtapose this with Honda's side of the story, and the difference is stark: "in truth, we had no strategy other than the idea of selling something in the United States".[140] Taleb and Haug showed that options traders have, heuristically speaking, "vastly, vastly more sophistication" than options theorems put forward by finance scholars such as the Girsanov Theorem, and that not only did these traders emphatically not use "exotic" formulas and models, but they "refused to touch them"; this is why Taleb argues that "history is written by the losers".[141] Finally, Hartford argues that the success of Google is precisely because it is an "evolutionary organisation" that is able to adapt to changing conditions, citing Gary Hamel who contends that Google is providing a "greenhouse" worth of strategies, products and offerings. Hartford notes that Google's corporate strategy "*is to have no corporate strategy*."[142]

At least two related concepts unite these three examples: the emphasis on trial and error, and positive emergent outcomes. For Honda in the USA, it was the latter, revolving around being seen by the right people in the right place at the right time, for which there is absolutely no substitute. In Taleb's case, skilled and experienced options traders are able to perform actions using sophisticated heuristics that mimic complex mathematical formulas, which are written as they catch up with trader performance. For Google, 80% of their products "will fail – but that doesn't matter, because people will remember the ones that stick." As long as the successes make up for the failures (read more upside than downside), this will be successful. Successes will be remembered, and the failures fall into the dustbin of history – an interesting manifestation of the survivorship bias.

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[139] BCG, 1975, 59, quoted in Mintzberg, H, Ahlstrand, B, & Lampel, J., 1998, *op. cit.*, 202

[140] Pascale, R. T, 1984, "Perspectives on strategy: The real story behind Honda's success". *California Management Review*, 26(3): 47-72.

[141] Taleb, N, N., 2012, *op. cit.* 219

[142] Hartford, T, 2011, *op. cit.* 214

The Minimum Re-write Rule

The only antidote to backward iteration of this kind is Tetlock's "minimal re-write" rule. This involves altering as few "well-established" historical facts as possible, and attempts to increase historical accuracy.[143] Taleb has also referred to this as "epilogism".[144] Epistemic opacity makes the links between antecedents and consequents unclear. The history of technological innovation reveals that overlapping geographical distributions advance from different inventors and hobbyists spreading technological development in unpredictable ways, as subsequent sections outline.

The Web of Change: Invention at the Sphere's Edge.

The journey that can be traced from flooded mines in Mid-Nineteenth Century Cornwall, England to high-speed Wi-Fi in the early 21st Century is as fascinating as it is remarkable. What makes this link possible is the "web of change" where knowledge as the artefact and innovation is the result**.**[145] Though a journey through the web of change can be characterised as a linear timeline marked by a series of points/events, it comprises only one of the many millions overlapping pathways which link the past with the present, affecting the future. The outcome of one decision affects the outcome of subsequent decisions in an extraordinary "pinball" process of change: [146]

"We strike out on a course only to find it altered by the actions of another person, somewhere else in space and time. As a result, the world in which we live today is the end-product of millions of […] serendipitous interactions, happening over thousands of years"[147]

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[143] Tetlock, P, E., Belkin, A, eds, 1996, *Counterfactual Thought Experiments in World Politics: Logical, Methodological and Psychological Perspectives*, Princeton: Princeton University Press

[144] Defined as Epilogism: A theory-free method of looking at history by accumulating facts with minimal generalization and being conscious of the side effects of making causal claims. (source: Taleb, N, N., 2007 (2010), *op. cit.*)

[145] Burke, J, 1996, *The Pinball Effect: How Renaissance Water Gardens Made the Carburettor Possible*, London: Little, Brown and Company,

[146] *Ibid*.

[147] *Ibid*, 2-3

It is necessary to retrace these pathways "just as they actually happened", as closely as possible.[148] This is essential for a non-historical account in line with the minimal rewrite rule. This will take account of the bringing forth of the limits to knowledge, the interaction between data that causes change, and the fundamental mechanism of innovation is nothing more than the way data "comes together and connect[s]". [149] The technological innovations in the changes in our social history are the fruits of this process.[150]

Spatial-Temporal Dispersals in Invention:

Thomas Newcomen was one of the first to put a commercial steam engine into operation, in 1712 as a mine drainage device. Newcomen was a barely literate blacksmith and ironmonger with no contact with the scientific establishment of the time.[151] Rather, Newcomen's story is one of the practical applications based on personal experience, with much trial and error. Based in rural Devon, Newcomen was aware that the tin mines in neighbouring Cornwall were flooding, and there was a need for a pump Kealey writes:

> "[I]t took [Newcomen] ten years of exhaustive experimentation to develop into a working machine, was the stuff of intuitive genius, but it was no more than the intuition of a creative man familiar with pumps, the domestic steam kettle and cold streams. No theoretical science was involved."[152]

Newcomen's was not a solely individual endeavour as he was informed by Robert Hooke of the work of Denis Papin. This offered a direct route to the troubled and indebted experimentation process and may have expedited developments and formed the mechanical basis for Newcomen's engine.[153] Later, James Watt was a mathematical instrument maker, asked by the University of Glasgow to repair a Newcomen engine in

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[148] *Ibid*, 4.
[149] Burke, J, 1996, *Loc. cit*
[150] *Ibid*, 5.
[151] Kealey, T, 2009, *Sex, Science and Politics,* London: Vintage Books
[152] *Ibid*, 173
[153] McNeil, I, ed, 1990, *An Encyclopaedia of the History of Invention*, London: Routledge

1764 and introduced a wealth of changes and improvements, the main one being the separate condenser.[154] Still, a steam pump to drive factory machinery was "out of the question"[155] until Watt's business partner Matthew Boulton, whom Watt had met in London on trip to file a patent, recognised the market for engines to drive mill machinery.

Separately, Trevithick, himself a self-taught hobby scientist, not only improved the efficiency of Watt's steam engine, but also led to the application of high-pressure steam in the form of a mobile engine. In 1797, Trevithick subverted Watts' condenser patent and eliminated it altogether and it was this, "rather than James Watt's self-imposed restriction to atmospheric pressure working, that allowed the development of locomotion".[156] George Stephenson, himself an " ill-educated, barely literate barely numerate self-taught artisan" [157] developed Trevithick's Initial designs and by 1830 the *Rocket* took passengers at 30mph on the Liverpool-Manchester Line, the first of such steam railways. As steam locomotives proliferated and came to share the same track, the telegraph was used by Charles Minot in 1851 to prevent disasters and coordinate the trains in the United States on the New York-Eerie Railroad.

Telegraphs communicated in Morse code, developed by Samual Morse. Morse was a painter by training, with little knowledge of electricity and a wife who was deaf. Morse is said to developed the code by tapping messages to her in different combinations on her hand. Morse secured private funding after failing to receive public funding along with business partner Amos Kendall, and started the first telegraph service between Washington D.C and Baltimore.

Thomas Edison is famous foremost for having developed the incandescent light bulb, and is known to have said "If I find 10,000 ways something won't work, I haven't failed. I am not discouraged, because every wrong attempt discarded is just one more

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[154] *Ibid.*
[155] Burke, J, 1996, *op. cit.* 36
[156] McNeil, I, ed, 1990, *op. cit.* 442
[157] Kealey, T, 2009, *op. cit.* 179

step forward."[158] During the trial and error process, the "Edison Effect", the build-up of carbon deposits around the base of the bulb was discovered. This was an important starting point for Lee De Forest, who discovered that the signal coming out of the bulb would receive a considerable boost when a small metal grid was placed between the hot filament and cold base plate of the bulb. De Forest's invention was called the *Audion*, and depended upon Edison's vacuum technology from the light bulb. Among its plethora of uses, it was of immediate significance to the newly invented radio, which was new and ironically barely audible, desperately in need of amplification. [159]

Fifteen years prior to the Audion, in 1895, William Marconi used a Morse telegraph key linked up to a sperk-gap generator invented by Heinrich Hertz in 1865 to make and break a connection so that it occurred in sets of three short bursts (Morse letter 'S'). The wireless telegraph was first transmitted by a distance of one and then two kilometers. Six years later, in 1901, the "S" was transmitted from England to Newfoundland, Canada. Shortly thereafter, transmissions were made all over the world between stationary and moving receivers, with the signal amplification necessary for these distances made possible by the amplification of Audion, the invention of the wired telegraph and Morse Code. [160]

More related developments occurred in wireless technology. In 1910, Theodore Wulf demonstrated that ionized atoms reflected radio waves when he showed that ionization was greater at the top of the Eiffel tower rather than at the bottom. The next year, Victor Hess took successively higher and higher air balloon flights and noticed that the ionization level carried on increasing. Hess called these rays "Hess Rays" and believed that they originated from outer space. In 1933 Karl Jansky, an engineer working on long-range telephone communications, discovered an ineradicable background "interference" in whichever direction the antenna was pointing. They had both inadvertently discovered the Cosmic Microwave Background (CMB). This reignited

[158] Hartford, T, 2011, *op. cit.* 126
[159] Burke, J, 1996, *op. cit.* 36
[160] *Ibid.*

interest in the Big Bang theory, the interest in which was in decline because it was said that the microwave radiation could never be measured. [161] From this, the field of radio-astronomy was born and further developed by Arno Penzias and Robert Wilson of Bell Laboratories out of the "cosmic rays" and by Grote Reber, an unknown radio repairman who created the first of many radio maps of the sky out of a chicken wire antenna in the back garden of his home.[162]

In 1934, John Mauchly was then inspired to solve a calculation problem he was having when, on a visit to Chicago, he saw that a group of cosmic ray researchers with extremely signal-sensitive and responsive vacuum tubes registered one hundred thousand cosmic ray particle impacts per second. Mauchly began to adapt this technique to his own problem, but then WWII started. The innovation in armaments during the war created many calculation problems. [163] A single projectile trajectory required 750 multiplications, consuming immense labour on the part of the human mathematicians. Mauchly applied his experimental vacuum tube method, based off of the cosmic ray researchers. Quite separate from the development taking place at Bletchley Park in the United Kingdom around the same period that decoded the ENIGMA machine, Mauchly's paper "The Use of High Speed Vacuum Tubes for Calculating" was ignored in 1942 and then accepted in 1943. With $800,000 in government funding and completed in 1946, the Electronic Numerical Integrator And Computer (ENIAC) was 33 meters long, 1 meter deep, contained 17,000 vacuum tubes and consumed 174 kilowatts of power. It could calculate in a day what the human calculators could in an entire year; Mauchly called them "computers". [164]

Much later, towards the end of the 21st Century, John O'Sullivan, an electrical engineer, began applying the Fourier transform to radio-astronomy. [165] Based on this

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[161] *Ibid.*
[162] Kealey, T, 2009, *op. cit.*
[163] Burke, J, 1996, *op. cit.* 36
[164] Burke, J, 1996, *op. cit.*
[165] The fourier transform is a mathematical function that can be employed to transform signals between time and frequency series reversibly (source: Bracewell, R. N., 1980, Fourier transform and its applications.)

and previous research, multi-interference in radio communications between networked computers was reduced. This led to the Commonwealth Scientific and Industrial Research Organisation (CSIRO) patenting the standard technologies that form the basis of the Institute of Electrical and Electronic Engineers (IEEE) protocols behind Wifi standards *802.11g* and *n* in 2003 and 2009 respectively**.**[166] In more developments from radio-astronomy at the time of writing, the BICEP2 research collaboration experiment telescopes have discovered that the CMB, once believed to be uniform (once also believed to be immeasurable, see above), exhibits a "polarization signal considerably stronger than many cosmologists expected".[167] This has led to the discovery of "cosmic inflation".

A Non-Historical Analysis, with Strategic Implications

This single branch of the web of change provides a rich historical record. Combined with other sources, at once it brings forth a number of points. It vividly illustrates the clear, fundamental and unshakeable unpredictability of the changes, influences, interactions and interrelations that characterise the emergence of change. The overemphasis on the importance of theoretical conception preceding the practical implementation "linear" model is made clearer and close to categorically refuted. The single most important conclusion to isolate is that experiment rather theory is the primary method for pushing forth the boundaries of knowledge. The new strategy must place experimentation at the heart of an agenda that continually explores the limits of what is known to be possible. In so doing, the firm that pursues this strategy will be less vulnerable to prediction errors, because the strategy furnishes options upon the organisations that pursue it.

Scranton critically examines the concept of technology uncertainty in the post - World War II (WWII) period, showing how the RAND corporation criticised the "the

[166] O'Sullivan, J, D., Graham R. Daniels, G, R., Terence M. P. Percival, T, M, P. et al., 1996, "Wireless LAN", available at http://worldwide.espacenet.com/publicationDetails/biblio?CC=US&NR=5487069&KC=&FT=E&locale=en_EP, accessed on 15.03.2014

[167] Harvard–Smithsonian Center for Astrophysics. "Tremors of the Big Bang: First direct evidence of cosmic inflation." ScienceDaily, 17 March 2014. <www.sciencedaily.com/releases/ 2014/03 /140317125850.htm>.

absence of strong central direction, and alleged duplication, competition, and waste."[168] To make this assertion, however, is to imply knowledge of the outcome of such "wasteful" explorations *ex ante*, when this knowledge can only be obtained *ex post*, thus conflating the management of the known and probing the unknown. Additionally, the innovation process is marked by duplication, waste, competition and most importantly *failure.*[169] Where this process produces more upside than downside, it is convex; in Scranton's case, it led to creation of the jet engine, which needless to say has been one of the most important innovations of the 20th century. Here, it is not sufficient to speak of "diversification" of risk but the exploration of the possibilities. Scranton writes:

> "Technological uncertainty is the perennial companion of technological Innovation […] when a new technical artefact or capability is *emergent*, even those who have designed and fabricated it cannot have an effective understanding of its capabilities, its operations in use, the materials of which it was made, or the science underlying its materiality. […] it is rare in the history of technology and science that "knowledge why" precedes and shapes "knowledge how." Indeed, humans have long made and made use of objects whose inner structures and relations were unknown. In many cases, exploring such phenomena has been irrelevant to the effectiveness of the object."[170]

The processes outlined by Scranton, those of "duplication" and "waste" onto which RAND heaped criticism, bare a striking resemblance to Fonseca's "redundant diversity". So important in a "transformation of misunderstanding", they led to innovative outcomes through the constant alignment of different patterns of conversation. This is at once an intriguing insight. Coupled with the power of epistemic opacity is the fact that it is almost always impossible, given the stochastic disturbances created by incomplete information, to tell whether what the *full plethora of uses* for a given technology might be, or, in the context of competition, whether one technology will usurp another and by consequence the firms that produce it. When William Marconi

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[168] Scranton, P, 2006, "Urgency, uncertainty, and innovation: Building jet engines in postwar America" Scranton *Management & Organizational History* 2006 1: 128

[169] Scranton, P, 2003, "The Challenge of Technological Uncertainty", *Management Learning* 34, 379–82; Hartford, T, 2011, *op. cit.*

[170] Scranton, P, 2003, *op. cit.*

used radio waves to transmit the letter "S", the emergence of the CMB would never have entered into his imagination, so far was it beyond the issue of locomotion. The process of creative destruction combined with the optionality of trial and error is essential for innovation. Here, Baumol also makes a strong case for the importance of non-routine innovation in generating revolutionary ideas:[171]

> "[T]he innovation that constitutes a quantum leap will probably never become the predictable product of R&D, but many have typically come from the offbeat efforts of the unpredictable, imaginative entrepreneur, independent and unorthodox."[172]

The journey through the web of change marks the intrepid venture as involving some risk-taking, implicating "entrepreneurship"[173]. However, it can clearly be shown that the profit-seeking imperative of entrepreneurship is not sufficient in actualising value propositions towards realised inventions in practice. This typically requires a combination of entrepreneurial, technical and financial resources. This combination is quite simply not present for many innovators, unnecessarily creating many "losers". Indeed, a great number of inventors were emphatically not entrepreneurs with all of the necessary skills, and are remembered in relative obscurity and not necessarily for their technological genius, but more their commercial failure; Richard Trevithick is one such example: a great mechanical genius that died penniless but felt "satisfied by the great secret pleasure and laudable pride […] in my breast from […] maturing new principles and new arrangements […] of boundless value to my country".[174] This brings the motivation of the innovator into question, and it has long been recognized that it is "the joy of creating of getting things done, or simply of exercising one's ingenuity".[175] The objective for many will be financial gain, but in many cases in can be simply the satisfaction of seeing inventions come to fruition. The availability of appropriate finance is as such a means and an end in the former case, and more of a means in the latter.

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[171] *Ibid.*
[172] *Ibid*, 33
[173] Entrepreneurship defined as "profit-seeking activity aimed at identifying and solving ill-specified problem in structurally uncertain and complex ways" (source: Harper, D, 2000 (1996), 3).
[174] Burton, A, in Kealey, T, 2009, *op. cit.* 179.
[175] Schumpeter, J, A., in Swedeberg, R, ed, 2000, *Entrepreneurship,* Oxford and New York: Oxford University Press, 70.

The necessity of commercial acumen exacerbates the survivorship bias and reduces the likelihood of innovators succeeding in profiting from their inventions, This is to say that business acumen is somewhat separate from invention, but the combination of the two is necessary in order for invention to succeed in having transformative, creative destructive effects as the "fundamental phenomenon of economic development". [176] This consideration recognises commercialisation as the principle obstacle rather than a sufficient supply in innovative people and/or ideas.[177] Partnership and intellectual property have historically increased the likelihood of commercial success. Examples of successful partnerships include James Watt, who was awarded three patents in 1769, 1781 and 1782 for the separate condenser, rotative engine and double-acting engine. Matthew Boulton helped Watt to market the improved steam engine. Although it was no means guaranteed, the historical record notes that the combination of scientific and engineering talents on Watt's side with business acumen on Boulton's side "ensured the success of the partnership and of Watt's engine".[178] Equally, the availability of credit to the innovator is often critical to the success of a given venture, particularly if it is technologically sophisticated and therefore relatively capital intensive.[179] This places new importance on mechanisms that allows innovators to pursue their non-pecuniary motivation, whilst providing recourse to funding to allow them to do so.

The emergent nature of technological uncertainty also shows that it is context dependent, that is to say, linked with the socio-economic and political context within which it operates. Where each innovation leads to subsequent innovations from previous innovations, this created a chain of innovative interdependence where one technology was dependent on the existence of another for its own development. This is also related to the truly global geographical dispersal of this innovation over an

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[176] *Ibid*, 58

[177] Gans, J, A., Scott Stern, S, 2003, "The Product Market And The Market for "Ideas": Commercialization Strategies for Technology Entrepreneurs" *Research Policy* 32: 333–350

[178] McNeil, I, ed, 1990, *op. cit.*, 276

[179] Gans, J, A., Scott Stern, S, 2003, *op. cit.*

extended period of time, both in terms of parallel developments and in terms of the continuation of innovation in a separate space.

Innovation within a free enterprise system exhibits a somewhat optimal growth process with important welfare properties. [180] The diffusion of knowledge and innovation brings about 'spillover effects' created by 'creative destruction externalities'.[181] Both serve to create a sharp, asymmetric difference between the private and social returns on innovation. Spillover effects do not necessarily accrue to inventors/innovators/firms themselves only. Baumol notes that no more than 20 percent of monetary benefits of a given innovation accrue directly to the innovator. [182] This may be a very conservative estimate. Economic historian Joel Moykr cites Nordhaus who suggests that as little as "2.2 percent of invention surplus is captured by the inventor himself".[183] This means that people who have not contributed to its development, including competitors, enjoy a considerable portion of the benefits of innovation. Conversely, if innovators were able to appropriate fully 100 percent of the benefits of innovation, no benefits would accrue to anybody else.

One example of this is John Mauchly's ENIAC. The vacuum tube technology put to work in computation of vast quantities of data had an unrelated parallel in the United Kingdom, with researchers such as Alan Turing at Bletchley Park using *Colossus*. This highlights the socio-economic, political and technological context dependence of such inventions. WWII created the exigencies to which the new technological, and the new existence of sophisticated vacuum tubes made this possible. Likewise, Samuel Morse was American, but Marconi was an Italian, who having travelled to London to find success for his technology, gave aerial transmission of Morse code a British origin. Victor Hess was Austrian American and John O'Sullivan is Australian.

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[180] Baumol, W. J., 2002, *The Free Market Innovation Machine,* Princeton: Princeton University Press, 5
[181] *Loc. cit*.
[182] *Ibid*.
[183] Landes, D. S., Mokyr, J., & Baumol, W. J. eds, 2012, *The invention of Enterprise: Entrepreneurship from ancient Mesopotamia to modern times*. Princeton University Press, 195

This has important implication for strategy. On the one hand, the role of local clustering in fomenting technologies is well known as a boon to innovation. On the other hand, an immense amount of technological innovation shows disjointed parallel developments. Furthermore, this implicates formal, in-house R&D to the extent that while it is useful as a model, it cannot replicate the random aggregation of the interactions of knowledge that characterise the connections in the web of change. This is because it necessarily excludes the ecological realities of technological development and dispersal. This means that R&D, in whatever form it may take, is necessarily circumscribed by the way in which knowledge and data is sourced and connected. For these reasons, it is difficult to see how this considerable geographical dispersal fits within the confines of Porter's national competitiveness theory. A nationally competitive industry must, according to Porter's understanding, benefit from the inventions (as knowledge and technological spillovers) from a diffuse spread of individuals in distant countries. The lens is too narrow.

A new strategy must be able to unite the best of the local with the best of the global, that is to say, harness the benefits of localised agglomerations of knowledge that characterise industries, and be able to and harness the ecological reality of knowledge dispersal through more diverse knowledge sourcing. This must be one of the most important achievements of a new strategy. The new strategy must also contain within it a mechanism to facilitate entrepreneurship for entrepreneur with little or no recourse to funds. In doing this, the process of trial and error will be facilitated. Moreover, the third tenet of a new strategy must be to provide a mechanism to facilitate the trial and error process in the non-teleological fashion that has so marked technological innovation throughout the centuries.

Science, R&D and Public Goods: An Impure Result

Baumol asserts the "well-known public good property of information"[184], of innovation

[184] *Ibid,* 51. Baumol's emphasis.

and of R&D. A public good must not prevent somebody else from using the thing in question (thus it is non-excludable) and for the utility/usability to not be depleted in such a way as to leave subsequent users worse-off (non-rival).[185] Accordingly, pure information is a public good by this definition. However, there are serious limitations in the intellectual and technical abilities of the majority of the public and of society at large in understanding and instrumentalising scientific information.

This means that the information is excludable in practice due to its highly specialised nature. The social returns of particular inventions derive from the practical utility generated in the knowledge, not from its pure existence. The importance of scientific knowledge as an impure public good becomes clear when it comes down to the tacit (uncodified) knowledge that is so essential to conducting research, as noted by Hayek.

"Any particular discovery may benefit others more than the discoverer, yet over a period of time, with enough piece s of information being pooled, chance will ensure that the advantages are distributed between all players."[186]

This also implicates frequent and vigorous knowledge exchange between scientists as a necessary precondition for innovation, where the challenge of misunderstanding presents itself most strongly. On the one hand, this should enhance the distributive effects as an increasingly greater number of people have access to information. On the other hand, this implicates imitation as a key follow-on process from innovation, as outlined in Chapter Two.

To the Innovator or Imitator Go The Spoils?

It is very difficult to disentangle the relationship between innovation and imitation. It

[185] Samuelson, P. A., 1954, "The pure theory of public expenditure", *The Review Of Economics And Statistics*, 387-389.
[186] Kealey, T, 2009, *op. cit.,* 336

remains to be seen which, in fact, has the greater advantage, since ultimately each arguably pushes the boundaries on the limits of knowledge, albeit in different ways. Porter argues that early movers have a strategic advantage.[187] In innovating, firms are able to sustain this position and can be built on by adding subsequent advantages. Arrow argues that there is a disincentive to innovate if the accumulation of learning and experience can be easily appropriated by an imitator.[188] Yet Kealey shows that the profit motive is stronger than this disincentive and that innovation takes place in spite of imitation, arguing that "it is better to be an opportunist than a pioneer."[189]

Imitation is not easy, nor does it embody a significant cost incentive as against innovation. Mansfield shows that imitation represents 65 percent of the costs[190] and 70 percent of the time as innovating.[191] These results are surprising, because it would be expected that imitation would take up far less time and far fewer resources. Mansfield also emphasises the importance of tacit knowledge embedded in the research process. Mansfield writes: "extensive technical information based on highly specialised experience […] is not divulged in patents and is relatively inaccessible (at least for a period of time) to potential imitators".[192] Not only is the profit motive strong enough to impel innovators to innovate at the risk of imitation, it can also impel imitators to go to great lengths to imitate, and in some cases further; Mansfield's study shows imitation costs can in some cases exceed 100% of the original cost. In each of the three cases, in innovation, imitation and the necessary time/cost trade-off in doing so, due to the possible positive profits in doing so.[193]

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[187] Porter, M, E., 1990, *op. cit.*

[188] Arrow, K, J., 1962, "The Economic Implications of Learning by Doing" *The Review of Economic Studies,* 29(3): 155-173

[189] Kealey, T, 2009, 202-203

[190] Cost is defined here as: "all costs of developing and introducing the imitative product, including applied research, product specification, pilot plant or prototype construction, investment in plant and equipment, and manufacturing and marketing start-up" (source: Mansfield, E, Schwartz, M and Wagner, S, Dec., 1981 "Costs and Patents: An Empirical Study" *The Economic Journal*, 91(36), 907)

[191] Time defined as: "the length of time elapsing from the beginning of the imitator's applied research (if there was any) on the imitative product to the date of its commercial introduction" (source: *Ibid,* 907)

[192] Mansfield, E, Schwartz, M and Wagner, S, Dec., 1981 "Costs and Patents: An Empirical Study" *The Economic Journal*, 91(36) (source, *Ibid,* 910)

[193] Alchain, A, 1950, *op. cit.*

Here, the *first mover necessarily begets the second mover***.** Rather than the second mover as "free rider", it can often be second, or indeed third and fourth movers that lead to meaningful subsequent extensions of knowledge based upon the initial "push" by the first mover. In this way, technological innovation diffuses through society and for this reason, innovation and imitation can be said to be co-dependent.

Conclusion to Chapter III

The modern world is as much the product of the sum of serendipitous interactions between geographically disperse and agglomerated units as it is the product of what is forgone; the formulation of an emergent strategy must respond and interact with such social, economic, organisational and technological and ultimately ecological realities. In answering the third research question, it can be argued that that prescriptive strategic approaches have to a considerable extent ignored the ecological realities of technological innovation; in fact a nebulous and diffuse spread of ideas over time and space undergoing vigorous and various spatio-temporal interactions between different collections of knowledge embodied within diffuse individuals. This should through a non-predictive view, something that has not hitherto been adequately accommodated in the prescriptive approach, and is more readily appreciated in the descriptive "learning" approach. This chapter has attempted to make apparent the necessity to place greater emphasis on emergent technological, "redundant diversity", uncertainty and entrepreneurship within an emergent strategy.

To do this, a new strategy must integrate a greater number of exogenous sources of influence, with positive impact on the growth of knowledge based on these new inputs. This should consequently increase the private and social benefits/returns to innovation. Equally, the new strategy must recognise that imitation in some form is inevitable, a fundamental aspect both of the market system as an essential part of the diffusion of innovation, an important welfare property of the market process. This places a new imperative on organisations, the imperative of constant innovation through the extension of experimentation by trial and error. This means that the firm will be a first mover in some cases, a second mover in others.

Chapter IV: Open Innovation In the Icelandic Ocean Cluster

Introduction to Chapter IV

Chapter three argued in favour of an emergent approach, and put together a conceptual argument as to the different ingredients that were necessary to bring an emergent strategy about. This chapter, on the one hand, conducts some theoretical reconciliations between overlapping approaches, leading then to the introduction of the case study. Then, section two outlines practical tools that can be used to being about an emergent, convex strategy, gleaning insights from the relevant literature.

Section one introduces the concept of clusters, briefly touched on in chapter one, and reconciles the concept of clusters, still grounded in Porter's position approach, with the insight gleaned from emergent strategy. This section relates clusters to uncertainty, emergent strategy, innovation and OI. Here, it is argued that cluster are themselves emergent forms of agglomeration, and that there are considerable opportunities to develop these strengths further through the application of OI principles. These are then tied to weaknesses of emergent strategy, namely the potential lack of direction. When reconciled with entrepreneurial strategy, this creates a kind of "emergent vision" that is adaptable, but still has direction. This is possible in the context of the IOC, because it can seen that the vision of CEO Thor Sigfusson has been instrumental in the development of the cluster collaboration. This chapter also reconciles "OI" with innovation by arguing that OI can act as a tool for innovation, and that these fields are analytically rather than functionally separate.

Section two explores OI principles is greater detail and ideas that are relevant for the application to the case study. These revolve around CS and CF. The central argument in this section is the idea that clusters can initiate OI strategies, thereby capturing the benefits of co-location (as clusters often do) and combining these with the benefits of diffuse and exogenous knowledge inputs for positive but unpredictable effect. OI principles represent a direct expression of convex effects where it is possible to achieve large benefits and relatively smaller costs.

Section I:

What are Clusters?

Briefly touched on in Chapter One, a cluster is a form of local cooperation and a primary means by which different nations compete in the global market. Drawing on Marshall's "industrial districts", Porter identifies clusters as important tools for responding to emerging competitive pressures, embodying one aspect of the national "diamond" model, but they are best seen as a manifestation of the interactions among all four facets.[194] Clusters[195] are held to be a natural form of economic agglomeration, a deliberate effort to foment and operationalise a natural cluster is known as a cluster initiative (CI), defined as "organized efforts to enhance the competitiveness of a cluster" involving a range of actors including involving private industry, public authorities and academic institutions. [196]

Reconciling Clusters, Emergent Strategy, Innovation and Uncertainty

Important reconciliations are necessary: clusters form an important aspect of Porter's understanding of national competitive advantage, which is grounded in his theory of the prescriptive schools; in turn a facet of the positioning school. The present analysis argues for a re-conceptualisation of clusters within the learning school of strategy, for two reasons. First, clusters have been shown to be successful precisely because they are able to learn and innovate in an emergent way as local centres of knowledge. This is arguably due to tacit information flows within clusters and

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[194] Porter, M. E., in Porter, M. E., 1998, *On Competition*, Harvard: Harvard Business Review, p3-53

[195] Defined as "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions such as universities, standards agencies, and trade associations [...] whose value as a whole is greater than the sum of its parts [my emphasis]" (Source: Porter, M. E., in Porter, M. E., 1998, On Competition, Harvard: Harvard Business Review, p 197-213); also defined by Enright as "groups of firms in the same or related industries whose development is interdependent" (Source: Enright, M, J., in Ffowcs-Williams, I, 2012, *The Cluster Navigators' Handbook: Building Competitiveness Through Smart S ecialisation,* Cluster Navigators Limited: New Zealand, 12)

[196] Sölvell, Ö., Lindqvist, G., Ketels, C., 2003, *The Cluster Initiative Greenbook*, available at http://www.europeinnova.eu/c/document_library/get_file?folderId=148900&name=DLFE-6119.pdf, accessed on 01. 12. 2012, 9

subsequent evidence of their innovation levels as measured by patenting activity, as discussed in Chapter Three.[197] Second, there are considerable emergent possibilities for clusters to develop these strengths further, using and applying the principles of Open Innovation (OI). Recognising of course that OI is an entirely separate field of research does not mean that an instrumental proposal cannot be put forward whereby OI principles are combined with an emergent (as well as an entrepreneurial strategy, on which later) approach. In doing this, it is recognised that there are benefits to dispersed as well as localised knowledge (also demonstrated in Chapter Three) and seeks to combine each for the better, global with local, that OI can address so well. This arguably supports the understandings of the learning school outlined in Chapter Three: that the application of OI principles to clusters may provide a step forwards in the transformative teleology and contribute to the burgeoning interaction that characterise the kinds of interactions, conversations and misunderstandings necessary for innovation.[198] Figure 14 links these concepts schematically.

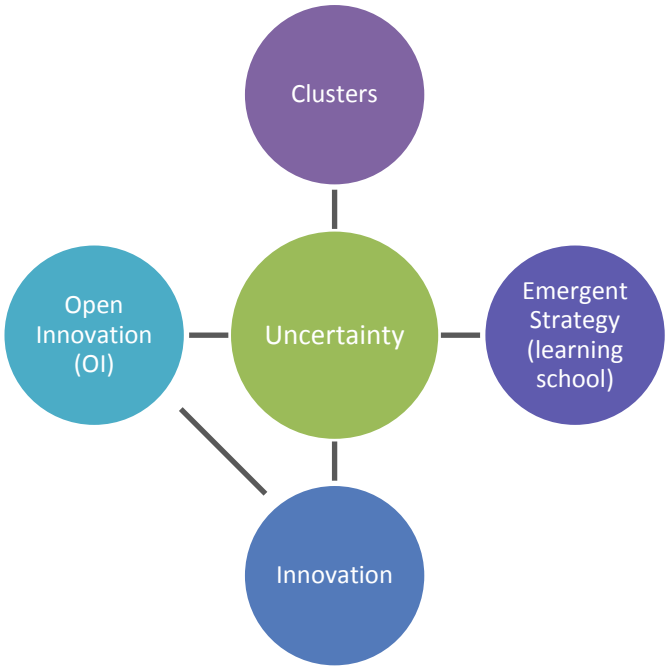

Figure 14: An Important Link

[197] Sölvoll, O, 2008, *Clusters: Balancing Evolutionary and Constructive Forces,* available at http://www.cluster-research.org/redbook.htm, accessed on 30. 03. 2014

[198] Fonseca, J, 2001, *op. cit.*; Scranton, P, 2003, *op.* cit; Stacey, R, D., 2001, *op. cit.*

Combining Vision with Learning: Emergent Vision?

Chapter Two critiqued the prescriptive schools from the standpoint of the descriptive learning school. The present analysis does not seek to offer unqualified support for the learning school, and instead seeks to reconcile the weaknesses of the learning school with the strengths of the entrepreneurial school, the latter tending to view strategy as a "visionary process".[199] The learning school can be critiqued on the grounds of the lack of an articulated strategy, and therefore it does not provide the "strong strategic vision that come from centralised entrepreneurship more than decentralised learning".[200] This is to say that the emergent sources of strategy can be blended with the entrepreneurial approach, where the latter provides guidance to the former, and the former new sources of ideas to foment the latter, allowing for further progression, in unpredictable ways, balancing the deliberate with the emergent. This ties in with Mintzburg's idea that the combination of "deliberate" and "emergent" strategy leads to "realised strategy".[201] However, as Hartford and Hamel have argued, this does not appear to be a problem for Google, but every company and context is different in significant or subtle ways, so this is not necessarily a guiding principle. Figure 15 shows how this can be further integrated into the concepts outlined above:

[199] Mintzberg, H, Ahlstrand, B, & Lampel, J., 1998, *op. cit.*, 5.
[200] *Ibid*, 225
[201] *Ibid.*

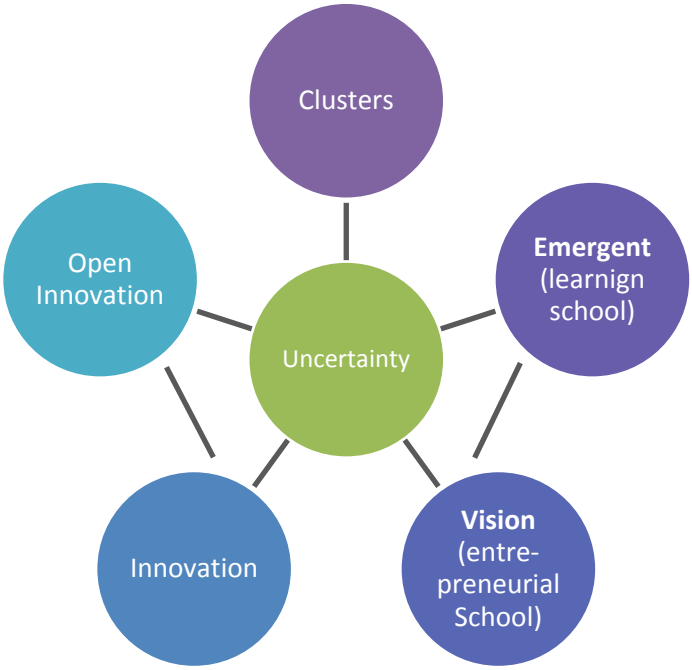

Figure 15: Putting it All Together

The entrepreneurship school stresses the importance of perspective, intuition, experience and insight, and entrepreneurs in this sense can be either founders, managers of self-owned business and the non-owning innovative leader of an organisation.[202] Schumpeter considers the entrepreneur to be the bringer of new combinations of productive activity, arising out of the old combinations, and so leading to creative destruction.[203] The entrepreneurial school seeks out new opportunities, bear considerable risks and uncertainty in the process of realising vision, and is based predominantly around the role of the CEO. Strategy here is semi-conscious, that is to say, deliberate and emergent. Organisations led by an entrepreneurial strategy are also malleable. Another important characteristic of the entrepreneur is that they "do not just see things from a new perspective, they get others to see them too. Hence they have "vision".[204] However, there is a balance here to the extent that if the vision is too homogenous, then it may become the same vision, thereby stifling the diversity that is

[202] *Ibid.*
[203] Schumpeter, J, 1942, *op. cit.*
[204] Mintzberg, H, Ahlstrand, B, & Lampel, J., 1998, *op. cit.*

so necessary for innovation.[205] Although it would not be possible to say exactly where on this continuum would be the right place, it is worthwhile recognising the tension between the two.

A Brief History of The Icelandic Ocean Cluster

The Iceland Ocean Cluster (IOC) began when founder and CEO Thor Sigfusson built upon on the working relationships leading to the gradual fulfilment of his vision of a cooperative platform between the different but disconnected firms involved in the many sectors of the Icelandic ocean and related industries. Since its inception in 2010, the IOC has grown from 13 to 50 firms and has led to a number of clear successes and promising projects, with a strategy that can be said to be primarily based around further engagement through a number of collaborative, multi-disciplinary projects, both within the cluster (on which, later), but also with other clusters in Iceland such as the logistics cluster[206] and the North Atlantic region. Clearly, the role of Sigfusson's leadership and management brought the cluster into existence and provides the broad lines, sense of direction and strategic vision. Here, the present analysis seeks to make a contribution to the strategic vision of the cluster through the facilitation of a trial-and-error based strategy firmly based on OI principles, with proven track records of success in other organisations. An OI-based learning and entrepreneurship strategy seeks to provide *new opportunities* (through the provision of necessary *inputs*), or provide new ways of developing *existing opportunities* (through the provision of necessary means). Figure 16 shows a map of the IOC:

[205] Fonseca, J, 2002, *op. cit.*

[206] It is beyond the scope of the present analysis to consider the links between the IOC and other clusters in Iceland. However, this remains a promising avenue for future research.

Figure 16: Map of IOC, consisting of 11 smaller clusters

As figure 16 demonstrates, “turning waste into value” is only one small aspect of total operations of the IOC, which fall into one of 13 smaller groups. The present analysis focuses chiefly on three of above groups: “biotechnology”; “ocean processing” and “fisheries and fish processing” and is discussed in subsequent sections. Before outlining the current operation of the cluster in more detail, it is important to review the literature on clusters to see why they are successful, as well as to show they can be strengths can be supported further.

Introduction to Cluster Theory

The existing literature explores and analyses several pertinent questions relating to

cluster development. The *Greenbook,* a worldwide analysis of 238 CIs worldwide finds that the *five* most common objectives of CIs are: foster networks among people; promote expansion of existing firms; establish networks among firms; facilitate higher innovativeness; promote innovation. [207] Many of the actions undertaken by CIs and the policies implemented by governments (including funding) around the focus on *enhancing the capacity of a cluster for innovation and entrepreneurship* through the provision of necessary resources and policy facilitations.[208] Innovation is emphasised because it is observed that the exigencies of global competition require that clusters, embodying technologically related activities and innovation, need to constantly upgrade their innovative capacity.[209] Ifor Williams quotes Radjou:

"What R&D theory shows us is that the best way you can seed innovation is if all the stakeholders are in the same place […] honing the co-location of the different stakeholders accelerates knowledge-sharing and development of new products and services in a way in way that you can't do if they are scattered."[210]

Sölvell demonstrates statistical support for clusters and innovativeness as measured by patenting activity, showing an R^2 of 0.375 – an adequate positive correlation.[211] Along similar lines*, The Economist* and the OECD argue that getting the right people is the most important factor in developing successful clusters and entrepreneurial capacity.[212] There is also a positive correlation between clustering and innovation as measured by patenting activity.[213] The source of the increased innovation is one of the primary advantages of cluster cooperation as against firms working individually. This derives from the ability of clusters to generate spillovers, linkages, externalities, commonalities and complementarities.[214] These effects can be accounted for to the

[207] Sölvoll, O, 2008, *op. cit.*
[208] *Ibid*.
[209] Ffowcs-Williams, I, 2012, *op. cit.*; Sölvoll, O, 2008, *Clusters: Balancing Evolutionary and Constructive Forces,* available at http://www.cluster-research.org/redbook.htm, accessed on 30. 03. 2014
[210] *Ibid,* 30
[211] Sölvoll, O, 2008, *Clusters: Balancing Evolutionary and Constructive Forces,* available at http://www.cluster-research.org/redbook.htm, accessed on 30. 03. 2014
[212] Potter, J., Miranda, G., eds., *Clusters, Innovation and Entrepreneurship*, available at http://www.oecd.org/cfe/clustersinnovationandentrepreneurshihtm, accessed on 01. 12. 2012.
[213] Sölvell, Ö, Lindqvist, G, Ketels, C, 2003, *op. cit.*
[214] Porter, M. E., in Porter, M, E., 1998, *On Competition*, Harvard: Harvard Business Review, 3-53

extent that one firm gains knowledge and it leads to a particular discovery, the knowledge and the benefits of that particular discovery accrue broadly to local multiple firms.[215] Taleb notes that when an entity is comprised of several facets, it is greater than the value of those units taken individually, and the overall entity benefits from *superadditivity,* based off of the mathematical super-additive function. [216] This gives collaboration "explorative upside"[217].

Complementarities can be considered the most important feature of nascent entrepreneurial ventures. This places greater emphasis on commercialization strategies; an entrepreneur may have IP protection but lack sufficient scale and lack of access to *complementary assets* and resources such as laboratories and business and management services and technical assistance.[218] This could force nascent ventures into a "market for ideas" where they sell their idea to a larger firm, thereby "reducing the number and impact of spin-offs and small ventures. [219] On the other hand, the provision of complementary assets increases the likelihood that entrepreneurs will create successful ventures. The provision of complementary assets arguably leads to the creation of commonalities, since firms come to benefit from each other's activities.

Linking the innovation and externalities generated by clustering is the creation, spread and diffusion of tacit information. Tacit information is the information that exists which is uncodified and difficult to communicate over long distances, which is why it is mostly beneficial on a small, localised geographical scale. The importance of tacit information, as noted in earlier chapters is embodied at many levels, but has mainly been discussed in this analysis in terms of science, innovation and imitation. The power of tacit information is that when it is embodied in clusters, it reaches a range of firms rather just an individual firm, as groups of people working together across a wide

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[215] Delgado, M, Porter, M. E., Stern, S, *Clusters, Convergence, And Economic erformance,* Working Paper 18250, available of http://www.nber.org/papers/w18250, accessed 02. 12. 2012
[216] Taleb, N, N., 2012, *op. cit.*
[217] *Ibid.*
[218] Teece, David J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. Research Policy 15 (6): 285-305.
[219] Gans, J, A., Scott, Stern, S, 2003, *op. cit.*

range of activities. Porter, Williams, Sölvell, Lindquist and Ketels all note the importance of tacit information diffusion within clusters.[220]

IOC: Fisheries Base Industry Turning Waste into Added Value

For Iceland, the fishing industry is a base industry, one where knowledge has been building for over 100 years.[221] Numerous other industries that serve the base industry emerge around it. This provides a foundation for a diverse range of other industries that may subsequently become considerably larger than the initial base industry. [222] The base industry is notable for its overall economic effects, over and above its direct effects.[223] The overall contribution of fisheries and related sectors in the ocean cluster was 27.1% of GDP in 2011, up from 26% in 2010. [224] This can be further broken down into the direct contribution of 10.5% in 2011, a 5% increase since 2010; an indirect contribution [225]of 7.3% and a demand effect [226] of 8.5%. Turnover in the independent exports of these supporting sectors was estimated at 42 billion ISK in 2010, with 1.5% of the direct and indirect added value from the fisheries sector. The IOC states that 25,000 to 35,000 are created either directly or indirectly, and 2,250 direct jobs have been created due to the operations of companies connected with the fisheries sector with a total turnover of ISK 38bn, 4% of Icelandic exports. [227]

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[220] Porter, M. E., 2000, *op. cit. op. cit.* Sölvell, Ö, Lindqvist, G, Ketels, C, 2003, Sölvoll, O, 2008, *op.* cit, Ffowcs-Williams, I, 2012, *op. cit.*

[221] Base industry defined as "the economic base is an industry or a collection of industries that is disproportionately important to a region's economy in the sense that other economic industries depend on the operation of the economic base but not vice versa, at least not to the same extent." (Source: Sigfusson, T, Arnason, R, 2012, 6)

[222] Sigfusson, T, Arnason, R, 2012, *The im ortance of the Iceland Ocean Cluster for the Icelandic economy*, available at http://www.sjavarklasinn.is/wp-content/uploads/2012/03/Sjavarklasinn_Skyrsla-enska-low.pdfm, accessed on 28. 01. 2014

[223] Sigfusson, T, Gestasson, H, M., *Iceland's Ocean Economy: The Economic Impact And performance Of The Ocean Cluster In 2011*2012, http://www.sjavarklasinn.is/wp-content/uploads/2012/12/IcelandsOceanEconomy2011.pdf

[224] *Ibid.*

[225] Indirect contribution defined as "value added by industries that supply the fishing industry with resources or further process fishing industry products)

[226] Demand effect defined as "value added by sector that provide fishing industry with goods and services"

[227] Sigfusson, T, Arnason, R, 2012, *op. cit.*

Between 1981 and 2011, Icelandic Cod landings have fallen from 460,000 to 180,000 tonnes, a decline of slightly over 60%, while the total export value has increased from $340 to $680 million, an increase of 100%. Export values per each landed kilogram increased by 554% from $0.7 to $3.8. This period was also marked by a change in the composition of the value of different exports. In 1981, 75% of total export value stemmed from frozen fish fillets and whole. By 2011 this category accounted for only 23% of total export value. By contrast, "other", value derived from advanced marine processing and biotechnology has grown from 25% to 77% of total export value. Figure 16 visualises these changes:

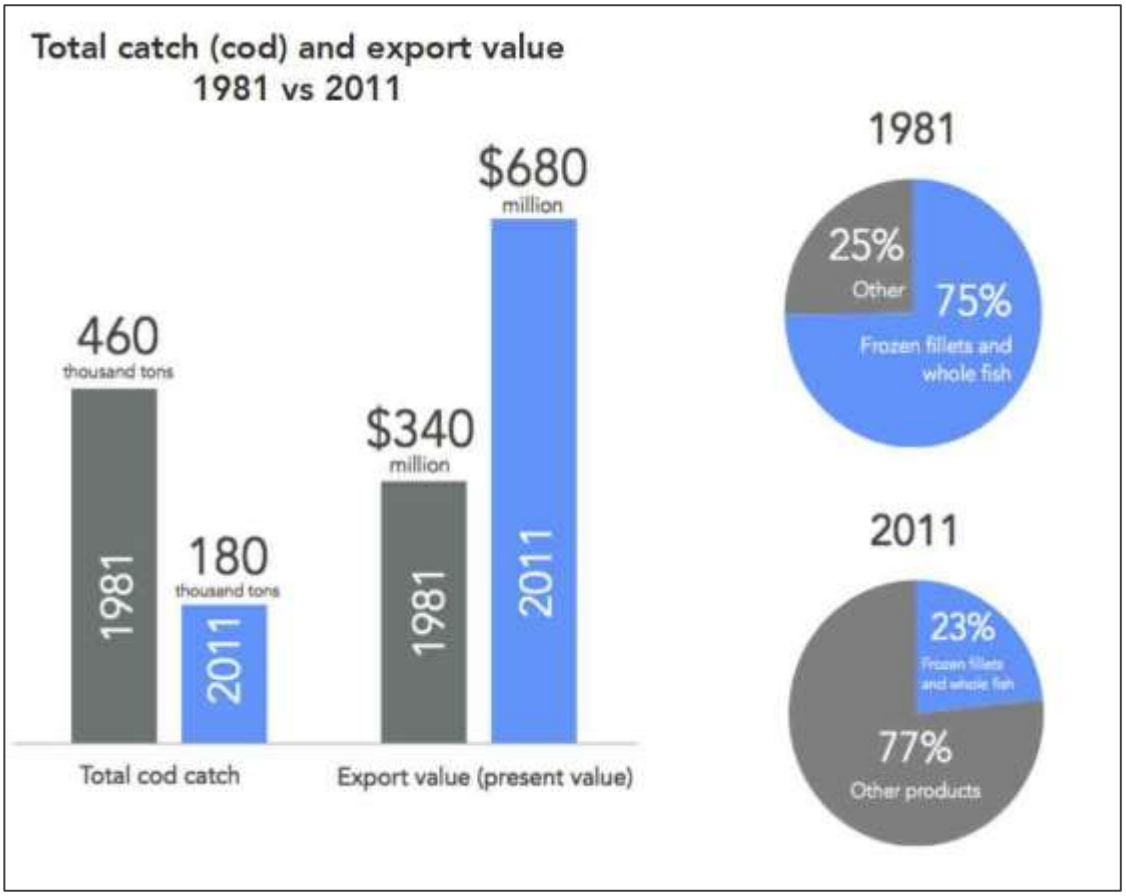

Figure 17:Shift in value added in Icelandic fishing industry [228]

This change is marked by nascent high technology industries growing around the

[228]Gestsson, H, M., *Ocean Cluster Analysis: April 2013, available at* available at http://www.sjavarklasinn.is/en/frettir/greining-sjavarklasans/, accessed on 0-2. 02. 2014

fishing industry. This increase in export value per landed tonne can be accounted for bythe added value from products derived from Cod, rather than the cod itself; the burgeoning industries in the Icelandic fishing sector centred around modernisation of practices, product diversification and innovation.[229] Figure 18 shows the raw material utilisation rates for a number of North Atlantic nations, with Iceland being the highest at 76%, a margin of 22% above average.

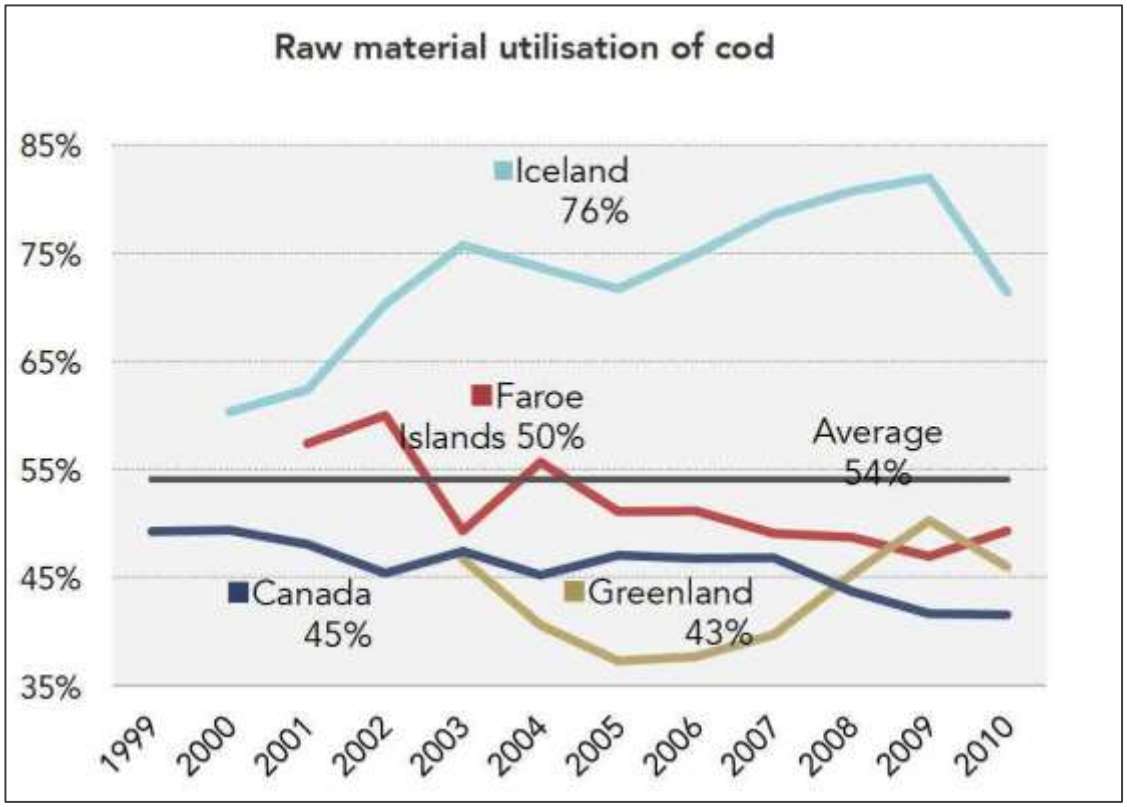

Figure 18: Raw material utilisation across a spread of North Atlantic nations.[230]

In recent times, Iceland's raw material utilisation has risen further, to 80%. In addition, the ocean technology sector is growing faster than the traditional fishing industry and much faster than the Icelandic economy as a whole, with a turnover of €414 million turnover in 2012, a 13% increase since 2011 (inflation adjusted) when the

[229] *Ibid*
[230] Iceland Ocean Cluster, *What Are Clusters?* Presentation given 17. 12. 2013, Reykjavik, Iceland.

sector's turnover totalled €364 million.[231] GDP growth was just 1.6% during the same period.

Current Operations

The Icelandic Ocean Cluster broadly follows Ifor Williams "Cluster Navigators" framework for cluster development. Cluster Navigators is based off of a five-phase, twelve step process.[232] Table 1 outlines the phases and steps.

Phase A	Step 1: Introducing Relevance Step 2: Identifying, Prioritising Clusters
Phase B	Step 3: Initial Analysis Step 4: Cluster Governance
Phase C	Step 5: Preferred Future Step 6: Initial Strategy Step 7: Short-term, Tactical Agenda
Phase D	Step 8: Formalising and Launching Step 9: In-depth Analysis, Bench-Marking
Phase E	Step 10: Long-term, Strategic Agenda Step 11: Linking the Cluster Step 12: Measurement and Evaluation

Table 1: Cluster Navigators Framework.[233]

The IOC recognises that it is at a key juncture, having developed an initial strategy and a "short term tactical agenda", placing many of the "low hanging fruits" under development, IOC now seeks to develop a "long term strategic agenda". To this end, IOC has pursued regional collaborative projects with other ocean clusters in the North

[231] Gestsson, H, M., *Ocean Cluster Analysis,* June 10 2013, available at http://www.sjavarklasinn.is/en/frettir/greining-sjavarklasans/, accessed on 0-2. 02. 2014
[232] Ffowcs-Williams, I, 2012, *op. cit.*
[233] Ffowcs-Williams, I, 2012, *op. cit.*

Atlantic region through the North Atlantic Ocean Cluster Alliance (NAOCA), which is largely responsible for formalising the approach and placing it into a clear and coherent entity. Figure 19 provides an overview of the difference in raw material utilisation between a typical European Cod and a typical Icelandic Cod:

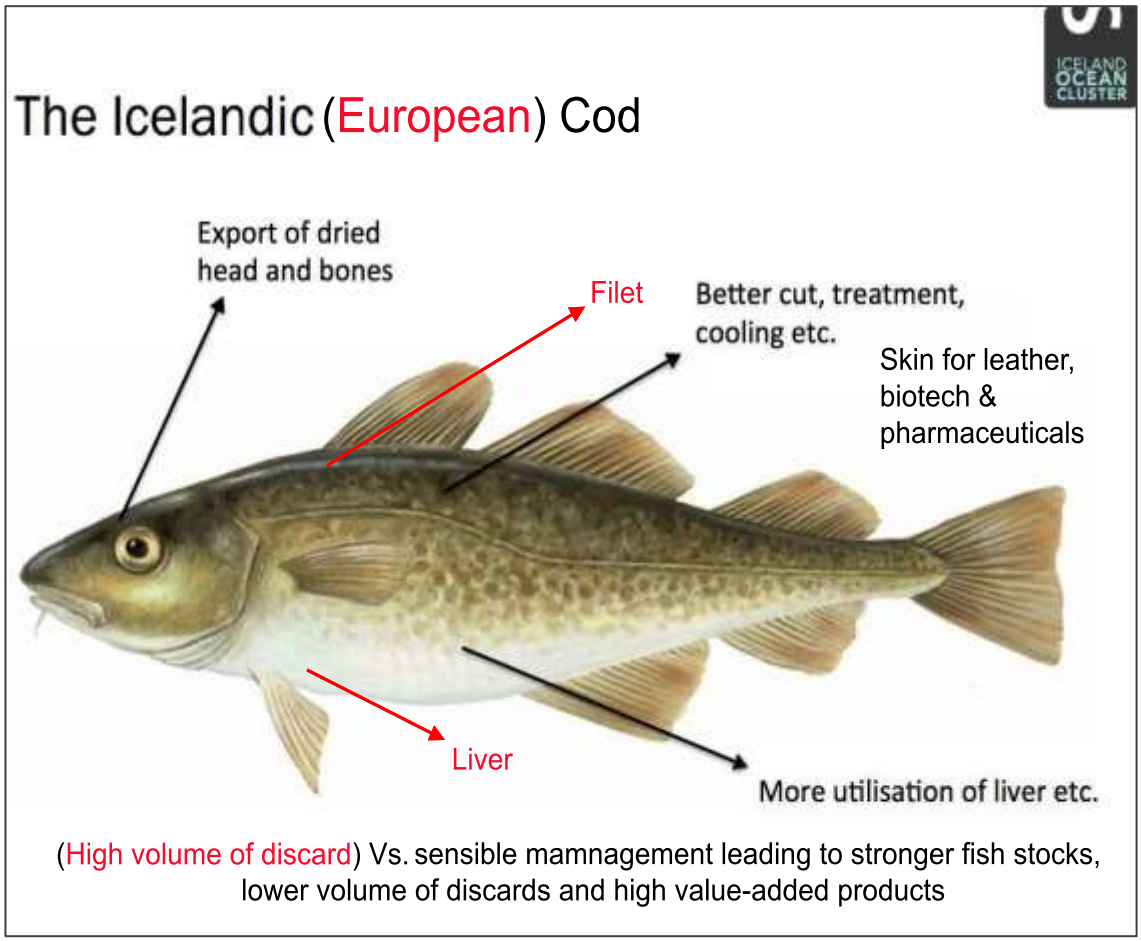

Figure 19: The typical European Cod, and Icelandic Cod, juxtaposed.[234]

As for its own activities, the IOC has developed the "value pyramid" as a way to understand the value added and derived from cod, as well as other marine resources. Figure 20 shows the "Value Pyramid":

[234] Composite graphic. Source: Iceland Ocean Cluster, 2013, *What Are Clusters?*, Presentation given 17. 12. 2013, Reykjavik, Iceland.

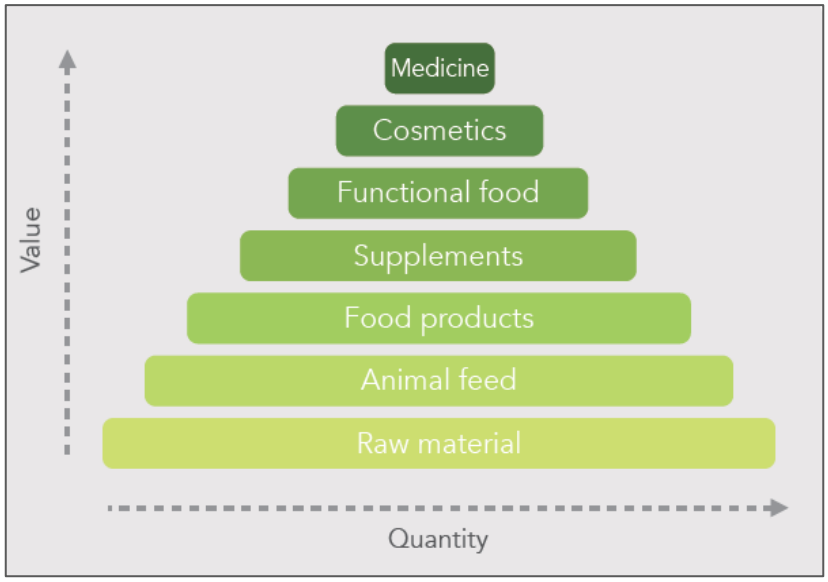

Figure 20: IOC value "Pyramid".[235]

The value pyramid shows all of the products that can be produced where the "raw material" is the fish itself. There are a number of companies[236] that are producing high-value-added products from Icelandic fisheries. *Lysi* hf. Is one of the largest marine processing firms in Iceland, producing Cod liver oil.[237] *Andrá* processes Cod Doc, Penzim Gel, Penzim Lotion, ZoPure Serum droplets, all of which are products with cosmetic, restorative and medicinal properties relating to joint and muscle ointment, acne treatment and skin moisturisation and the gels, lotions and serums utilise typsine enzymes derived from Cod intestinal tracts, useful for wound and diabetes-related lesions. *Stofnfiskur* is developing North Atlantic salmon ova with infection resistant anti-microbial peptides; *Zymetech,* part of the "Codland" collaboration between seven different Icelandic fisheries is another company working on using trypsine enzymes for curative biotech and pharmaceutical applications. Research into trypsine enzymes has identified a number of additional potential uses for trypsine enzymes in these industries.[238] Also part of the

[235] Vigfusson, B, Bjornsson, F, Gestsson, H, M., Helgadottir, S, 2013, *Ocean Cluster Analysis: October 03, 2013,* available at http://www.sjavarklasinn.is/en/frettir/greining-sjavarklasans, accessed 02. 02. 2014

[236] An exhaustive overview is not offered here, and the companies noted are some of those in the main focus areas of "biotechnology" and "ocean technology".

[237] Sigfusson, T, Arnason, R, 2012, The importance of the Iceland Ocean Cluster for the Icelandic economy, available at http://www.sjavarklasinn.is/wp-content/uploads/2012/03/Sjavarklasinn_Skyrsla-enska-low.pdfm , accessed on 28. 01. 2014

[238] Gudmundsdóttir, A, Hilmarsson, H and Stefansson, B, 2013, "Potential Use of Atlantic Cod Trypsin in Biomedicine," *BioMed Research International*, 2013, p 1-11

Codland collaboration is *North taste*, a Canadian company manufacturing natural flavour enhancers and *Aegir Seafood*, producing canned liver products of various types. Codland aims to become the "Silicon Valley" of total utilisation.[239]

To be sure, only some of the extensive possibilities, both known and unknown, have been explored by the IOC. Marine biotechnology can include techniques such as bioprocessing and bioharvesting; bioprospecting and bioremediation, process biotechnology techniques with applications that may include health, food, cosmetics, aquaculture and agriculture, fisheries, manufacturing, environmental remediation, biofilms and corrosion, biomaterials, and research tools. [240] Given technological uncertainty, there may be other processes which are currently unexplored, inconceivable or simply unapparent at this stage. There is no doubt that the fields of ocean biotechnology and advanced fish processing carry substantial economic opportunities. These opportunities need work, capital, research and development. The importance of better utilisation of catches is greater now than ever before.[241] Figure 21 shows the range of products, based off of the value pyramid, that are now available due to the value added marine processing and biotechnology industries:

[239] Codland, ehf, n.d, "Iceland as a seafood leader?", available at http://codland.is/silicon-valley-of-total-utilization/, accessed on 15. 03. 2014

[240] Arnason, V, J., *North Atlantic Ocean Clusters: increasing Opportunities Through Coo eraiton*, available at http://www.sjavarklasinn.is/wp-content/uploads/2012/07/North-Atlantic-Ocean-Clusters-report.pdf, accessed on. 02. 02. 2014

[241] Vigfusson, B, Bjornsson, F, Gestsson, H, M., Helgadottir, S, 2013, *Ocean Cluster Analysis: October 03, 2013, op. cit.*

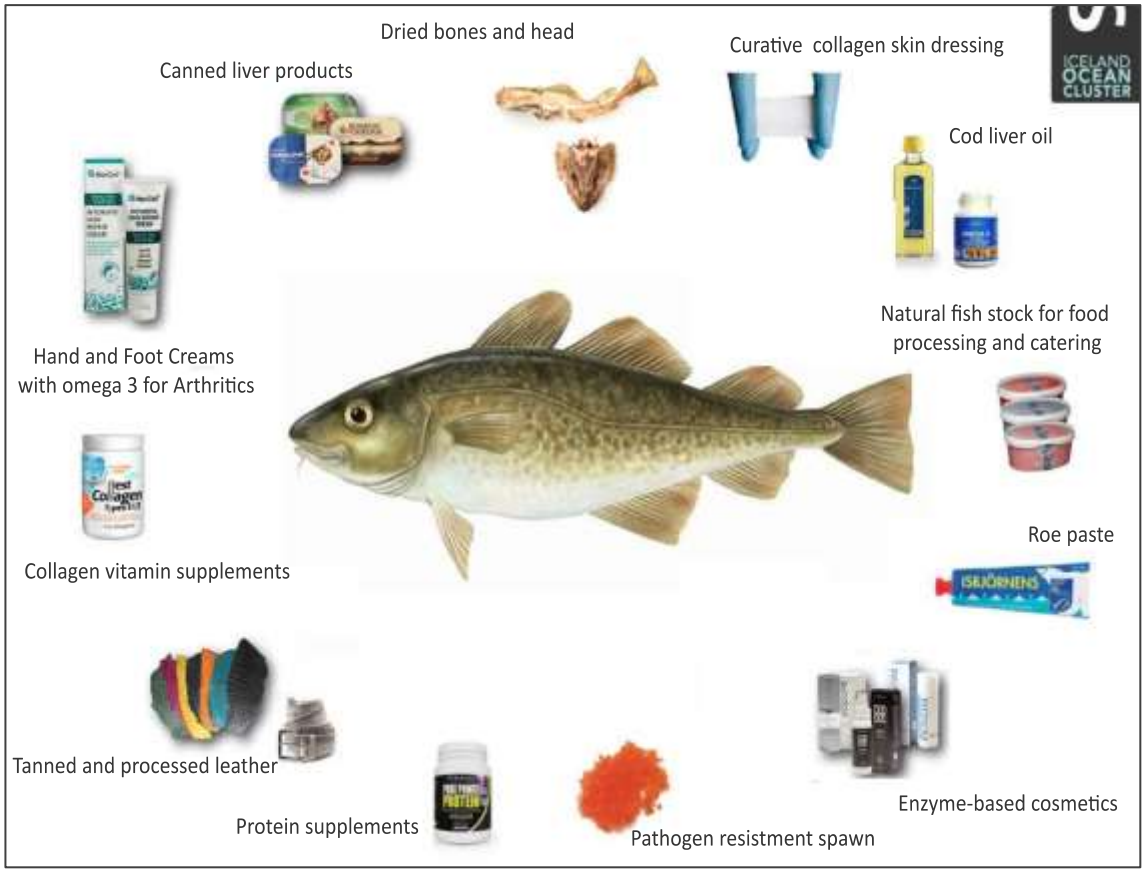

Figure 21: Advanced cod-derived products from Iceland.[242]

Collaboration, Collaboration, Collaboration

The NAOCA was initiated by IOC and supported by Nordic Innovation and Nora with the overall aim of strengthening the image of the North Atlantic marine industry and to strengthen relationships between the different stakeholders, with the relationships between entrepreneurs being particularly important. Regionally in the North Atlantic, considerable strides are being taken in the areas marine food, marine energy, marine transport, marine biotechnology.[243] The formal collaboration between these clusters is the NAOCA, a "network of networks" between Western Canada, Denmark, Faroe Islands, Finland, Greenland, Iceland and Norway. There are also initial collaborations being undertaken with non-members of NAOCA in Ireland, Scotland and Sweden. The

[242] Composite diagram of the author's creation. Source: Iceland Ocean Cluster, 2013, *op. cit.*
[243] Arnason, V, J., *op. cit*

mission of the NAOCA is to:

"[Work] together in identifying areas where members of respective clusters can collaborate to develop and implement initiatives related to information sharing, research and development, partnerships and business development opportunities." [244]

The principle challenge here is to expand upon the regional aspects of clusters. In this instance, clusters can work extremely well as co-locational units within borders, but these borders do act as barriers. Successful measures at the national level are more difficult to implement regionally or even globally, the main challenge lies in engaging different stakeholders that might have common interests. To answer this question will be very important for helping the IOC and indeed the other members of NOACA to move from a short-term tactical agenda to a long-term strategic agenda. The IOC writes:

"By increasing collaboration between scientists, industry, and countries, the talent pool will become larger and deeper and the ideas rippling out from it will extend their reach to ever more distant shores and with ever-increasing power of impact." [245]

There are a number of implemented measures that are helping to achieve the cross border engagement and collaboration that is necessary in order to achieve the transition from the tactical to the strategic, short to long term. Table two lists these projects with a description of each:

Project	**Project Summary**
Codland	A group of companies collaborating to increase the raw material utilisation of Cod through advanced products, broadly seeking to create the "silicon valley" of seafood.
Project Sharing Iceland: *Verkefnamiðlun*	Cluster members post project and tasks that need completion in an effort to connect with students of various backgrounds, interests and education degrees.

[244] *Ibid*, 46
[245] *Ibid.*

	Very encouraging results so far.
Project Sharing Faroe Islands:	Collaboration between IOC and *Vinnuhúsið* (ministry of industry) Modelled on *Verkefnamiðlun.* Also showing encouraging initial results.
Green Fishing Vessel	Collaborative project between the technology group of IOC and NCE Maritime Norway with the aim of developing a cooperative solution for an eco-friendly fishing vessel.
Green Marine	Collaboration of 10 Icelandic companies: 3X Tec, Promens, Polar, Thor Ice, Samey, Trefjar, Marport, Navis, Dis and Naust to increase productivity, reduce oil consumption and increase profits.

Table 2: Current collaborations of the IOC

As mentioned in a previous section, the above project in table two to a large extent summarises the IOC strategy – multi-disciplinary collaborative projects to engage diverse stakeholders with the aim of identifying shared opportunities and possibilities. As Section Two of this chapter will argue and as Chapter Five will outline in more detail, the initial successes of the cluster provide a strong basis upon which to build an Open Innovation Strategy (OIS). An OIS established around these projects, based on the understandings from the learning and entrepreneurial schools may help to further this long-term strategic agenda.

Section II:

From Closed to Open Innovation

Having explored some of the current operations of the IOC, it is now possible to apply the ideas explored in earlier chapters. Proceeding from the understanding that tacit, diverse and diffuse knowledge pervades all parts of society in all countries and all cultures and at all times necessitates a re-conceptualisation both of innovation and

the ways in which it is possible for firms to innovate. It is in this sense that the analysis turns to Open Innovation (OI) as a method for initiating innovative exchange.

The modern utilisation of information technology has afforded a gradual revolution in the way in which society uses markets. This is because there has been a move away from *closed innovation* (CI)[246] towards OI.[247] One of the principle ideas behind OI is the inclusion and influence of external innovation partners (EIP) within permeable firm boundaries. It is beneficial to have EIPs because, as dispersed knowledge sources, they are sometimes able to provide solutions to problems that internal innovation sources either have not reached or would expend and require considerable investment in R&D in order to reach particular goals. The principles of OI represent a clear link with convexity and optionality to the extent that they have a potentially large upside in relation to the downside, which can be limited. OI frees up optionality through trial and error; in the case of CS, a problem is broadcast to a population that is an order of magnitude larger than it would have been. This has the potential to marshal widespread trial and error towards a solution, often at little or no cost to the organisation using OI. In the case of CF, entrepreneurs can try to marshal funding (trial) from the diffuse crowd and allow market awareness (also an order of magnitude larger) to decide rather than through top down decision making or depending on pure luck.

Clusters as Open Innovators

Consider the following two quotations: "people prefer to work in close proximity to one another, *distance is not so dead"*.[248]

The same author, Suroweicki, contends that:

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[246] Closed Innovation defined as "Companies generate their own ideas and develop them, build them, market them, distribute them, service them, finance them and support them on their own" (source: Sloane, P, ed, 2011, *A Guide to Open Innovation and Crowdsourcing: Expert Tips and Advice,* London: Kogan Page, 5)

[247] Open Innovation defined as "valuable ideas can come from inside or outside the company and can go to market from inside or outside the company" (*Ibid.*)

[248] Surowiecki, J, 2004, *The Wisdom of Crowds: Why The Many Are Smarter Than the Few,* London: Abacus, 163. Emphasis added.

"Independence is important to intelligent decision making because independent individuals are more likely to have new information rather than the same old data that everybody is familiar with the smartest groups are made of are made of people with diverse perspectives who are able to stay independent of each other." [249]

Reconciling these two contrasting viewpoints leads to the contention that clusters are excellent candidates for OI. This is because they exhibit the potential to unite all of the strengths of clusters such as the superadditive element manifesting as linkages, commonalities and externalities, embodied tacit information and the worldwide diffusion of knowledge outside the cluster, and counter the potential weakness of low market reach while making their boundaries more permeable. OI itself is primarily categorised by a wider range of exogenous inputs and a greater degree of disaggregation. The boundary of the firm is much more permeable and open to influence. As such, this thesis argues for and puts forward the development and implementation of cluster-based open innovation (CBOI), leading to a productive combination of exogenous and endogenous sources of influence and potential innovations.

Crowdsourcing: An Introduction

Crowdsourcing (CS) was defined by Jeff Howe in 2006, [250] where a second definition highlights the similarities with open source.[251] CS, however, is not a recent phenomenon per se and "have cracked some of toughest technological and scientific problem in history". [252] Here, Lakhani refers to the open call in the Seventeenth Century to the first inventor of a system that could determine longitude at sea, the

[249] *Ibid*, 41

[250] Crowdsourcing defined as "[…] the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the from of an open call. This can take the from of peer-production (when the job is performed collaboratively), but is also often undertaken by sole individuals. The crucial prerequisite is the use of the *o en call format* and the large network of potential laborers"[emphasis added]." (source: Howe, J, Wired Magazine, 14th June, 2006, "The Rise of Crowdsourcing" http://www.wired.com/wired/archive/14.06/crowds.html)

[251] A second definition that qualifies it more within the modern era defines CS as "the application of Open Source principles to fields outside of software". (source: Sloane, P, ed, 2011, *op. cit.*, 8)

[252] Lakhani, K.R., Boudreau, K, J., 2013, "Using the Crowd as an innovation Partner" *Harvard Business Review*, April, 61.

winner receiving £15,000 for a highly accurate chronometer.[253]

CS has been greatly facilitated by what has been termed "web 2.0", which exhibits three important characteristics: permitting collaboration and facilitating the combination of knowledge and resources, an openness that allows people to contribute freely to different projects, and the ease of use and unprecedented accessibility of information technology.[254] Web 2.0 especially broadens "the capabilities of small firms by allowing user content to inflow and create value for the company." [255] Facilitated by web 2.0, Hopkins outlines four types of CS platforms. First, "collective intelligence" gathers a crowd and the general conditions are set for that crowd to share knowledge, such as a worldwide brainstorming session or for the procurement of individuals to solve technical problems. Second, in "crowd creation", a company turns to its users to create or co-create a product or service. Third, "crowd voting" uses crowd judgement to organise large quantities of data. Crowd voting is often used in conjunction with crowd wisdom and crowd creation as a way of reducing the often vast quantities of information firms gleaned from CS platforms to eliminate some of the submissions. Last, "crowdfunding" (CF) is the diverse sourcing of funds for entrepreneurial, artistic, cultural and charitable purposes.[256] Crowdfunding is growing rapidly in popularity. Kickstarter, the most popular crowdfunding site, started in 2009 and reached $1 billion on March 3rd 2014 (on which, subsequent sections).[257]

Crowdsourcing for Knowledge Synthesis: The Case of InnoCentive

The success of the disaggregation of scientific expertise stems from what Suroweiki has called the "cognitive division of labour." [258] Echoing Fonseca, Hayek and Nonaka and Tackeuchi, Lévy (1997) gives support to the notion of "collective intelligence": "no

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[253] *Ibid.*

[254] Schwienbacher, A, and Benjamin, L, in Cumming, D, ed, 2012, *The Oxford Handbook of Entrepreneurial Finance,* Oxford: Oxford University Press

[255] Sang-Heui, L, DeWester, D and So Ra Park, S, A., 2008, "Web 2.0 and Opportunities for Small Businesses." *Service Business* 2:4, 335-345

[256] Sloane, P, ed, 2011, *op. cit*

[257] Nicks, D, March 3rd 2014, "Kickstarter hits $1 billion in pledges", available at http://time.com/12011/kickstarter-hits-1-billion-in-pledges/, accessed on 15th March 2014

[258] Surowiecki, J, 2004, The Wisdom of Crowds: Why The Many Are Smarter Than the Few, London: Abacus

one knows everything, everyone knows something, and all knowledge resides in humanity".[259] For these reasons, InnoCentive is perhaps the most relevant case study regarding CS for the IOC. InnoCentive is a CS website where some of the world's largest companies place open calls for the solution of specific problems, often requiring scientific expertise. This marks the transition away from a "local search" of solution to problems based on prior experience and knowledge and towards a "broadcast search" which recognises that knowledge is unequally and widely distributed in society. Lakhani's research finds that InnoCentive has facilitated the solution of 1/3 of a sample of problems that R&D-intensive firms had been unsuccessful in solving. [260] Lakhani's study analysed 166 discrete problems across 26 firms in 10 countries, finding an average solution rate of 29.5% with solvers spending approximately 40 hours finding a solution to a given problem. [261] Just under two-thirds (65.8%) were PhD students and prizes for solutions ranged from $2000 to $105,000 depending on the difficulty level involved. [262] One of the most interesting findings of the study shows that:

> "the strongest and most significant effect relates to the presence of *heterogeneous* scientific interests amongst scientists submitting solutions […] the more heterogeneous the scientific interests attached to the solve base by a problem, the more likely the problem is to be solved." [263]

Lakhani cites a specific example where a firm needing to find a particular biomarker, after having spent considerable resources, found three solutions to the identification of a polymer delivery system in an aerospace physicist, a small agribusiness owner, a transdermal drug delivery specialist and an industrial scientist.[264] This example perfectly illustrates the impact that a broadcast search CS strategy can have, and gives practical substance to theoretical arguments made

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[259] Lévy, P, 1997, *Collective Intelligence*, Cambridge, MA: Perseus Books, 7

[260] Lakhani, K. R., Jeppesen, L. B., Lohse, A., and Panetta, J.A., (2007) *The Value of Openness in Scientific Problem Solving* (Harvard Business School Working Paper No. 07–050), available at http://www.hbs.edu/faculty/Publication%20Files/07-050.pdf, accessed on 18.01.2014,

[261] *Ibid.*

[262] *Ibid.*

[263] *Ibid.*

[264] *Ibid.*

throughout this analysis. Furthermore, Lakhani further notes that:

> "the further the focal problem was from the solvers field of expertise, the more likely they were solve it […] it may be advantageous to bring diverse problem solvers together and encourage them to collaborate on solutions that leverage multiple knowledge domains".[265]

The power of CS in this instance is that it can tap into the remarkable heterogeneity of scientific experience, thereby greatly enhancing spillover effects. A company can find a solution that it is aware of and it can equally solve a problem with a solution that it is *unaware* of.

It was also discovered that the award money motivation was not the most influential factor in CS problem solving. Whilst remuneration was clearly a factor, other concerns included the desire to boost professional reputation, obtain publication priority, promotions and grants and access to more prestigious positions (indirect pecuniary rewards).[266] Also cited is the challenge and enjoyment of scientific problem solving as well being the first to solve such a problem; the researchers find intrinsic motivation to be stronger and more significant than the immediate monetary reward. Interestingly, career and social motivations were negatively correlated with winning, suggesting that the intrinsic problem solving motivation increased the likelihood of finding solutions. Moreover, the prizes paid to InnoCentive solvers are far less in value than the value of the solution to the companies offering the prizes.[267]

Crowdfunding

Crowdfunding (CF)[268] as a funding mechanism has its roots in micro financing and CS.

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[265] *Ibid,* p 9, 12-13
[266] *Ibid*,
[267] Brabham, D. C., 2008, "Crowdsourcing as a Model for Problem Solving", *Convergence*, 14(1): 75–90
[268] Crowdfunding defined as "[the] efforts by entrepreneurial individuals and groups – cultural, social and for-profit – to fund their ventures by drawing on relatively small contributions from a relatively large number of individuals using the internet, without standard financial intermediaries". (source: Mollick, E, 2014, Dynamics of Crowdfunding: An Exploratory Study, *Journal of Business Venturing* 29: (2)

[269] There are four models of CF. First, investor or equity crowdfunding gives funders a share of future profits, royalties, a portion of returns or share of real estate investment or other such pecuniary return in exchange for their pledge. Second, in the "patronage model" funders act as philanthropists and expect no return for their "pledge". Third, the "Lending model" where funds are offered as a loan with a rate of return expected, usually stipulated at the outset. Last, in the "reward-based" model, the most prevalent at the time of writing, funders receive a reward for their pledge commonly relative to its size, ranging from a personal thank you from the founder through to a quantity of the product as well as a range of other incentives such as recognition and credit, creative input or the opportunity to go on a special trip and meet the founders.[270] The economist Robert Shiller notes that equity-based CF affords small investors of venture capitalists, noting that forms of innovations are relevant is finance is to remain relevant in the achievement of society's goals, arguing that CF "essentially democratizes finance".[271] Directly citing Hayek, Shiller argues that CF is effective because it aggregates dispersed global knowledge, a claim that can be widely made for any of the other forms of CF.

CF is a viable source of entrepreneurial seed capital but as with all investment, success is uncertain so investors "use partial [incomplete] information to judge the success of particular ventures."[272] These opaque elements place extra impetus on would-be entrepreneurs and innovators to communicate signals of quality in their CF projects, found by Mollick to be one of the biggest predictors of project success (reaching its funding goal). Additionally, Mollick notes that CF acts as a direct and indirect marketing strategy to the extent that products already have an awareness and a certain critical mass and social media presence before being introduced to the wider market. Dispersed knowledge becomes concentrated and raises a greater

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[269] Best, J, 2013, *Crowdfunding's Potential for the Developing World*. infoDev, Finance and Private Sector Development Department. Washington, DC: World Bank, 5., Belleflamme, P, Lambert, T, Schwienbacher, A, 2013, "Crowdfunding: Tapping the Right Crowd", *Journal Of Business Venturi*ng, XYZ

[270] *Ibid.*

[271] Shiller, R, J., 2013, "Capitalism and Financial Innovation"*, Financial Analysts Journal*, 69 (1): 22

[272] Mollick, E, 2014, *op. cit.*

awareness of products. This could be termed *pre-competitive advantage*.

Massolution, a firm that collates knowledge on the CS and CF industries, show that North America is the largest market for fundraising, and there are 452 Crowd Funding Platforms (CFPs) worldwide raising $1.5 billion for over one million campaigns with 191 in USA, 44 in the UK, 29 in the Netherlands, 28 in France, 21 in Brazil. Equity- and lending- based models are the most effective for digital goods, and donation- and reward-based are best for cause-based campaigns. Kickstarter, a reward-based platform has from its inception raised 1,047,703,335 total dollars, with 59,052 successfully funded projects, 894 and 122 million successful and unsuccessful dollars respectively, 50 projects raised over a million dollars and an average success rate of 43.58 percent. CFPs are growing rapidly, with the reward-category is the largest crowdfunding category in terms of the number of CFPs, with a 79% Compounding Annual Growth Rate (CAGR).[273] Equity-based crowdfunding produced the largest amount of funds raised on a per-project basis; 6% thereof was for less than $10,000 and 21% for more than $250,000. [274] In the reward-based category, 50 Kickstarter projects having raised over $1 million. Importantly, whilst the majority of CF projects fail, it is the fact that they gave the opportunity of exposure to such a diverse audience that makes this development so important. In terms of the uncertainty of the venture, this can increase the chances of success, but it clearly no guarantee.

As with CS, crowdfunding ventures have been shown not to be purely driven by financial motivations. Schwienbacher and Benjamin cite and analyse the example of *Media No More,* a French equity-based CFV. Overall, the aim of this investment was to raise money, but it also gathered skills. As such, it begins to "[look] like angel or venture capital funding, with the difference that this time 81 people put their skills and abilities together in order to provide optimal thinking and services".[275] The

273 Massolution, 2012, Crowd Funding Industry Report 2012: Market Trends, Composition and Crowdfunding Platforms, available at http://www.crowdfunding.nl/wp-content/uploads/2012/05/92834651-Massolution-abridged-Crowd-Funding-Industry-Report1.pdf, accessed on 02.04.2014, 14

274 Ibid.

275 Schwienbacher, A, and Benjamin, L, in Cumming, D, ed, 2012, *op. cit*, 17

motivations stem, they suggest, from the desire to participate in innovative projects, to obtain recognition and personal satisfaction. This gives intrinsic motivations a greater role rather than the monetary incentive of an expected return, though clearly this was a factor.

Crowdfunding and Venture Capital: Mutually Exclusive or Complimentary?

Writing for *Harvard Business Review*, in his concluding remarks Zider writes that venture capital:[276]

> "works well for the players it serves: entrepreneurs, institutional investors, investment bankers, and the venture capitalists themselves. […] Whether it meets the needs of the *investing public* is still an open question."[277]

Based on Zider's concerns, the case can be made that CF better meets that needs of the investing public by virtue of its democratic and participatory basis. Here, the critical difference between CF and VC is that where CF is "mainly about raising money, VC is about generating capital".[278] This is an important distinction, and the subsequent examples will show that CF, while slightly disruptive, does indeed occupy a different funding space. This is because while VC has historically been a very important source of entrepreneurial seed capital, VC suffers from a distinct knowledge problem in that the centralised decision-making of a VC firm cannot know which project will succeed and which will fail. Firms are viewed as being at different stages: pre-seed, seed, early stage, formative/expansion stage and later stage.[279] VC and CF generally invest in ventures at different stages. In VC, the focus is on the middle part of the "S" curve. This attempts to avoid the early stages when

[276] Venture capital, defined as "The professional, institutional managers of risk capital that enables and supports the most innovative and promising companies." (source: Thomson Reuters, 2013, *National Venture Ca ital Association Yearbook 2013*, New York, Thomson Reuters, 4)
[277] Zider, B, 1998, "How Venture Capital Works", *Harvard Business Review,* November-December, 139
[278] Massolution, 2012, *op. cit.*
[279] Thomson Reuters, National Venture Capital Association Yearbook 2013, New York, Thomson Reuters

technologies are uncertain, as well as the later stages when consolidations are more likely and inevitable and growth rates slower. Figure 22, from Zider's article, shows how this could play out for a "winner" and a "loser" in three phases in order; "start-up", "adolescence" and "maturity and shakeout":

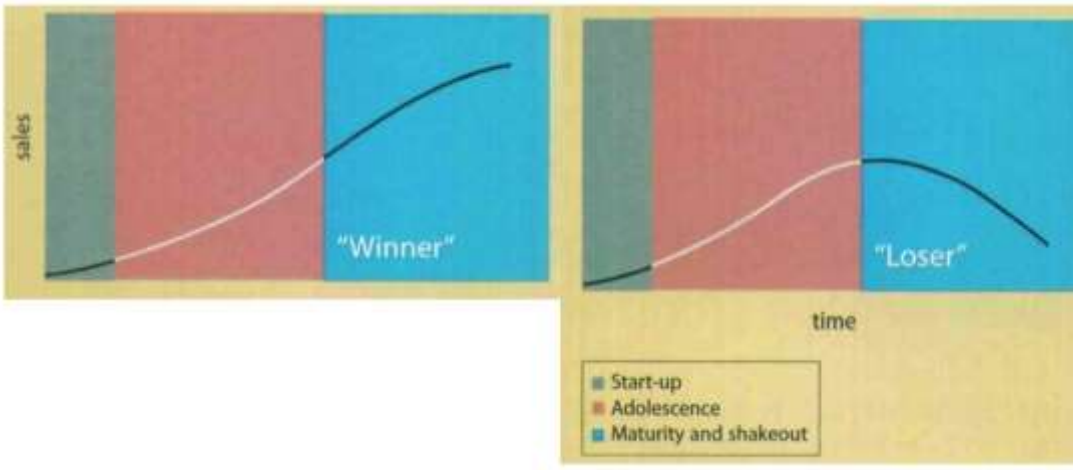

Figure 22: "Winners" and "losers" look the same at a given point. [280]

By contrast, CF generally satisfies seed-stage ventures; the World Bank Group (WBG) notes the existence of a "funding gap" for ventures seeking more than $50,000, but less than $1 million. They write:

"[Venture] capital typically is risk averse which leaves a funding gap for innovative, early-stage companies, especially in developing countries. Crowdfunding is starting to bridge that gap but is also highlighting opportunities for VC investment."[281]

The report goes further, detailing how crowdfunding can be used for climate and clean energy innovation, and that CF is particularly suited to technological, seed stage start-ups.[282] This suggests that CF would be suitable for the IOC, given the number of technological, seed stage start-ups expanding raw material utilisation.

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[280] Source: Zider, B, 1998, *op. cit.* 134

[281] Best, J, 2013, *Crowdfunding's otential for the Develo ing World*. infoDev, Finance and Private Sector Development Department. Washington, DC: World Bank, 17.

[282] *Ibid*.

Mollick notes that the "Pebble" smart watch, Kickstarter's most successful project, was first rejected for VC funding but was able to secure considerable funding VC after receiving support from Kickstarter, going on to raise over $10.2 million from Kickstarter with 68,929 backers.[283] This reduced the potential risk in the venture dramatically, making it a more viable option for VC. This example readily highlights the advantages of CF over VC; CF provides the opportunity for a business to growth based on dispersed knowledge, whereas VC depends on the knowledge of the investors making the large VC investment decision. Thus, the two forms of funding are complementary to the extent that CF solves the knowledge/aggregation problem that VC suffers from. Equally, while CF is clearly able to raise large quantities for funds, additional funding from VC often remains necessary. This means that CF, as in CS, through a more optimal solution to the knowledge problem, may be able to reduce the high failure rate that is a hallmark of the VC industry. Zider notes that the odds of failure for an individual company are high: even with good plans, people and businesses only succeed in 10-17% of cases. [284]

Crowdfunding for Iceland: Karolina Fund

Karolina Fund is Iceland's first CFP, started in 2012. Karolina Fund seeks to go "beyond offering access to finance".[285] Karolina Fund connects CS, CF and project management through the "Project Dock" user interface (UI); a project management tool designed for more effective organisation, structuring, and development of ideas. This serves as a cross between CF, CS and project management to create a platform and a services marketplace. Users create a profile on Karolina Fund and can either create a project, invest in a project and provide or offer a service related to a particular project and as

[283] The New York Times, 2012, "Three years of Kickstarter Projects", available at http://www.nytimes.com/interactive/2012/04/30/technology/three-years-of-kickstarter-projects.html?_r=0, accessed on 02. 02. 2014

[284] Zider, B, 1998, *op. cit.*

[285] Karolina Fund, n.d, *How it Works*, available at http://www.karolinafund.com/page/show/how_it_works, accessed 28.03. 2014

an open call to solicit clients.[286] For example, if you are a service professional and think you may be of service to a particular project, Karolina Fund allows you to offer your services to new clients. Karolina Fund is also a networking and referral platform which shows the track record past projects you have worked on via your profile.[287]

As part of this new approach, entrepreneurs are required to provide a real-time overview of project progression. Funds are released gradually according to a predetermined timetable that encourages greater transparency between investors and creators. This is different from Kickstarter, where updates are important as a transparency mechanism and updates are considered favourable, but are by nature intermittent and funding is released all at once (threshold funding). All users involved in a project will be able to participate (crowd wisdom) in its realisation by contributing to budget estimations, the establishment of to-do lists, and providing the promised service. Pooling know-how on the platform allows disaggregated participants to communicate and work together to make project success more likely. Karolina Fund is currently reward-based and uses threshold funding as does Kickstarter Kickstarter. Project are promoted through text, pictures, to do lists and/or videos and currently is exclusively for the creative industries, and in its two-year history has successfully funded 32 projects with a 70% success rate, ranging from €860 required successfully funded "My Little Free Library Reykjavík" to a park-based community library scheme to the €40,000 required to fund the first circus tent in Iceland, which was 6% overfunded by the end of the funding period. [288] Project starters of course get to keep all of the money, even if it is overfunded, and many crowdfunding projects can be spectacularly overfunded.

The Nordic Crowdfunding Alliance

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[286] *Ibid.*

[287] Karolina Fund, n.d, *About Us*, available at http://www.karolinafund.com/page/show/how_it_works, accessed 28.03. 2014

[288] Karolina Fund, n.d, *roject Index*, available athttp://www.karolinafund.com/project/index, accessed 28.03. 2014

Karolina Fund has, as of March 2014, entered into collaboration with Norden to create a Pan-Nordic CFP platform called the Nordic Crowdfunding Alliance (NCA). This will include CFPS from the Nordic region including *Gründerløkka AS/FØND* (Norway), *Invesdor Oy* (Finland), *Mesenaatti.me Oy* (Finland), and *AMOX/Booomerang.dk* (Denmark).[289] The Alliance will have a "significant impact on the funding opportunities for young entrepreneurs"[290] and the alliance seeks to build on the strengths of individual national programs, and each project on each Nordic CFP will receive exposure on all the other Nordic CFPs. The NCA hopes to give entrepreneurs a larger audience and increased likelihood of achieving critical mass, but hope that collaboration will also be beneficial for network ties, broadening networks across the region through increased visibility. The NCA will be achieved through a central website, but individual projects will ultimately choose whether to have a "wide" or "narrow" broadcast. It seeks to bridge the funding gap noted in the WBG report and in doing so "steer cash strapped start-up to a position where they can prove their concept and go on to raise further funding".[291] As in the example of Pebble, reaching critical mass through crowdfunding can identify a potential product through crowd, disaggregated wisdom and go some way towards helping the venture to develop, and at the very least giving a better chance.

OI-based Geographical Considerations

Despite the nature of its dispersal, CFPs are influenced by a number of geographical factors. Mollick shows that successful CFVs exhibit a geographical concentration that reflects the cultural products of the cities where they are based, showing that projects in music, film and technology have a disproportionate share originating in Nashville

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[289] Norden, 14. 3. 2014, Nordic Crowdfunding Alliance launched http://www.nordicinnovation.org/news/nordic-crowdfunding-alliance-launches/, accessed on 01.04.2014

[290] Clawson, T, 21st March 2014, "Cross Border Crowdfunding The Nordic Way" available at http://www.forbes.com/sites/trevorclawson/2014/03/21/cross-border-crowdfunding-the-nordic-way/, accessed on 15.04. 2014

[291] *Ibid.*

(music), Los Angeles (film industry) and San Francisco (technology) respectively.[292] Individual categories relating to project "type" are more concentrated than the overall population of crowdfunding projects, lending weight to qualitative patterns of project types according to particular geographical areas.[293] Equally, however, "crowdfunding reduces the importance of traditional geographical constraints, even as it potentially poses new ones".[294] Research by Belleflamme, Lambert and Schwienbacher show in their analysis of *Selleband*, a Dutch CFP: "crowdfunding in our setting largely overcomes the distance-related economic frictions usually associated with financing entrepreneurial ventures".[295] They note that while on the one hand distance investing is common for publicly traded companies, average distance between artist, entrepreneurs and investor is 3000 miles, indicating a broad geographic dispersion of investors, challenging existing theories arguing for co-location due to distance sensitive costs. [296] This contrasts with VC where the average distance between VC firm and the target firm is a mere 70 miles, with similar results for "angel" investors. [297] They go further, showing that the average investment level below 50km (considered local) is significantly higher than investment level above 50km (considered distant) and that Local investment are higher ($196) over distant ($74). There are, however, many more distant investors than local investors so they make up for this difference, and differences between local and distant investors are entirely explained by Family and Friends (FF) Grou They also show that local investors do not follow this pattern, instead being more likely to invest early in the cycle, prior to the $10,000 threshold, and that the propensity to invest increases as entrepreneurs visibly accumulate capital.

These geographical considerations show that while space-related themes are important, CF does indeed cast a wider "net" to overcome circumscriptions related to distance sensitive costs, making co-location less necessary than it might otherwise be.

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292 Mollick, E, 2014, *op. cit.*
293 *Ibid.*
294 *Ibid*, 14
295 Belleflamme, P, Lambert, T, Schwienbacher, A, 2013, *op. cit,* 1
296 *Ibid.*
297 *Ibid*.

The significance of this for the present analysis, as argued throughout, is that CF can extend the benefits of co-location, and could act as a boon for the IOC which does benefit from co-location.

Networks

The geographical dynamics of Clusters, entrepreneurship, technological development, the learning and entrepreneurial schools clearly implicates the role of networks, the importance of which has long been noted in the literature on entrepreneurshi Networks take on renewed importance with the growing prominence of social media as a manifestation thereof. Here, "network ties" have been shown to be very important in new ventures, and are often categorised as "strong"[298] and/or "weak"[299].[300] Sigfusson demonstrates that weak networks, which are not as heavily based on personal interaction as strong networks, can lead to strategic advantages in terms of internationalising new ventures.[301] In essence, this is the argument that *breadth* can be at least as strategically beneficial to *depth*. Echoing these findings but in the context of CF, Hekman and Brussee write:

> "Examining the results of the social network analysis we could conclude that successful initiators on Kickstarter have *more friends but a sparser network*. Unsuccessful entrepreneurs on the other hand have a higher average degree, suggesting a denser network. Our analyses suggest that sparse, and thus diverse networks are beneficial for the success of a project."[302]

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[298] Strong ties defined as "high levels of social relationship or personal interaction with high frequency" (source: Sigfusson, T, 2012, *The Strength and Empowerment of Weak Network Ties in International New Ventures*, Reykjavik: Háskolaprent, 14)

[299] Weak ties defined as "non–redundant ties which are not as heavily based on personal interaction among members of the network but may provide strategic advantage in terms of resource availability (*Loc. cit*)

[300] Sigfusson, T, 2012, The Strength and Empowerment of Weak Network Ties in International New Ventures, Reykjavik: Háskolaprent

[301] *Ibid*.

[302] Hekman, E., & Brussee, R. n.d, *Crowdfunding And Online Social Networks,* available at http://www2.mmu.ac.uk/media/mmuacuk/content/documents/carpe/2013-conference/papers/entrepreneurship/Erik%20Hekman,%20Rogier%20Brussee.pdf, accessed on 01.04.2014, 19-20

This appears to emphasise the role of weak network ties, diffuse and widespread, as against strong network ties. Indeed, De Carolis shows that weak network ties aid new ventures in bootstrapping, a term to describe how new ventures support themselves.[303] Mollick also shows that the network size of the social network of individuals seeking funding influences the success of entrepreneurial financing efforts by provides connections to and with funders and provides and an indirect endorsement of project quality, thereby increasing the chance of funding success.[304] For these reasons, CF and CFVs are often well-integrated into social networks.

It can then become very important indeed for organisations, especially clusters, to have and build diffuse networks of weak networks ties, as it may be possible to use these networks to enhance the breadth of the dialogue, "redundant diversity" and hence the capacity for innovation. CS and CF strategies based on OI principles present an effective means of doing so.

Conclusion to Chapter Four

In answering the fourth research question, this chapter concludes that there is considerable integrative scope between the current projects of the IOC and OI, emergent and entrepreneurial strategy. This chapter has put forward two OI options and located these within the overlapping concepts of emergent and entrepreneurial strategy, clusters, innovation and OI to create a strategy that could build on these initial successes. These could enhance creative and scientific capacities, stimulate new investment avenues and push the boundaries of knowledge. CS offers a mechanism to address current and future technical problems in current operations, immediately reduce the opportunity cost of R&D and potentially canvass further advance by making use of the global cognitive division of labour for strategic gain and potentially stimulating the redundant diversity so necessary for innovation. CF provides incipient risk capital to entrepreneurs with little other recourse to funding by filling the noted

[303] De Carolis, D. M., Litzky, B. E., & Eddleston, K. A., 2009, "Why networks enhance the progress of new venture creation: The influence of social capital and cognition." *Entrepreneurship Theory and Practice*, *33*(2): 527-545.
[304] Mollick, E, 2014, *op. cit.*

funding “gap”, utilising weak network ties facilitated through global social networks. The CF strategy can also acts as a boon to VC, public R&D as a secondary tier for further funding opportunities and solves the institutional knowledge problem, removing in some measure the burden of having to pick “winners”. Equally, CF is nascent platform both globally and within Iceland and developing rapidly across the Nordic region through the NCA, and this may be a good time to initiate such a program.

Chapter V:

Open Innovation and Long Term Strategy

Introduction to Chapter V

The final chapter of the present analysis translates the theoretical insights and literatures reviews from previous chapter to put forward a set of tools for bringing about an emergent, visionary strategy. This comes in four sections. Section one considers CS options; section two considers CF options; section three considers CF funding options, considers the roles for institutional private finance and public R&D to supplement CF ventures, considering different combinations of these, including all three in a policy instrument known as a Pre-Seed Fund (PSF). Section four, the final section, outlines the third overall recommendation of the analysis. This final section argues for the establishment of a speculative research fund as another expression of convexity towards an emergent strategy. This involves the creation of a scientific research fund towards uncertain, risky research. The idea for this is that it is better to act at the extremes of a distribution of outcomes and avoid the middle; this can mean large upside and minimal downside. Each section in this chapter considers some potential advantages and disadvantages of each of the possible expressions outlined.

Section I: Crowdsourcing Options

The current operations of the IOC have yielded very promising results and are an excellent start along the uncertain strategic path. Powerful OI-based enablers are now necessary in order to build on existing opportunities and lay the groundwork for creating new opportunities that are as yet uncertain and unpredictable. Disseminating open calls based for technical problems will provide existing projects with a springboard through which to launch a crowdsourcing platform. CBOI has the potential to penetrate many of the existing efforts in place that aim to aid in the collaborative and cooperative objectives of the IOC, and indeed the NAOCA.

When strategic decisions are made based upon pre-existing competencies, it is

implicitly presumed by the actors taking those decisions that they have full knowledge of all of the competencies, not only of their own cluster but of the other clusters with whom they are negotiating, or they depend upon the knowledge of other cluster managers. This brings forth the possibility of falling into one of the ex ante traps of the prescriptive schools. To be sure, many opportunities can be brought forward through such an approach; however, this leaves closed, to a degree, the possibility for links to emerge between heretofore unlinked areas. Here, Hayek's "positive accidents" are necessary.

Echoing Lakhani, the above view is at least partially supported by Nordic Innovation. In *Sustainable Innovation in the Nordic Marine Sector,* it is argued that: "An interesting phenomenon surfaces in three of our case studies: Companies that combine activities and resources from *two different sectors* obtain a solid starting point from which to explore opportunities for innovation [author's emphasis]."[305] The principle strength of the CS approach is that it should aggregate and engage many of the problem solvers with a given competency within each cluster for the overall benefit of both in a form of a trade. Due to the uncertain nature of these connections, it is difficult to be specific about how these could manifest. The reader is asked to recall the example drawn out from Chapter Three from the history of invention. This offers excellent real life examples concerning how inventions reverberate in the living present. Yet to capture stochastic, unlikely outcomes in a more systematic way, the CBOI may prove to be the best way yet. For this reason, the present analysis puts forward the following suggestions and configurations:

1. Open call in Iceland only.
2. Open call within NAOCA.
3. Open call within NAOCA and new and potential members.
4. Open call either through NAOCA, Nordic Innovation or InnoCentive, or all.

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[305] Norden, 2009, *Sustainable Innovation in the Nordic Marine Sector*, *Summery Report* available at http://www.nordicinnovation.org/no/publikasjoner/sustainable-innovation-in-nordic-marine-sector/, accessed on 01. 02. 2014, 4

Each of the above expressions seeks to implement convex outcomes by making the cluster and the solver beneficiaries in a broadcast trial and error process. This seeks more upside than downside, where the upside may stem from the use value of a new discovery, and the downside may be remunerative and associated costs to the solver. Each expression attempts to capture aspects of the ecological and spatial-temporal realities discovered in Chapter Three in relation to invention, given limited resources. The four expressions put forward show different levels of "open"; each more "open" than the last.

The first expression is the least broad and least open of all the calls, seeking only to bridge knowledge gaps by tapping knowledge and understanding within Iceland. This call endeavours to harness scientific expertise from the entire Icelandic scientific community. *Verkefnamiðlun* may be an excellent springboard for this open call.

The second expression is broader, with an open call to similar disciplines in different locations. Here, there is clear room for development since one marine biotechnology unit (in one country) may have problems and solutions that another marine biotechnology unit (in another country) does/does not have. Knowledge and expertise can be traded like-for-like with the expectation of future reciprocation, and there is a possibility of 'scientific secondments" whereby experts take up residency in different countries to acquire knowledge which can then be taken back to the home country at a later stage. This overcomes the tacit information problem highlighted within the innovation/imitation debate expressed in Chapter Three and may even enhance it since it facilitates the spread of tacit knowledge across the clusters and facilitates transfer. This could increase the private and social return to innovation and may generate considerable positive externalities, leading to further advances.

The third expression exhibits the same benefits of the second, whilst making the call more open. In so doing, technical problems are opened up to a wider range of actors. This could involve the creation of a forum and/or website in which the open

calls could be placed which would be freely available to firms within individual clusters and the NOACA. This expression could also function as an integration mechanism for new members of the NAOCA (such as Scotland) and act as the basis for further collaboration.

The fourth expression would be a completely open call, either disseminated through NAOCA and/or Nordic Innovation and be visible to all individuals and organisations. Individual organisations and the clusters within which they reside can utilise already established crowdsourcing approaches and post innovation problems on InnoCentive. It should be noted that InnoCentive has the advantage of global visibility, with problem solvers/scientists from all over the world regularly signing in to look for new challenges. This may offer, as Lakhani discovered, a global solution to a local problem. Speculatively, a marine biotechnology expert in Argentina may have a solution for a problem in Iceland, who can then be brought over or demonstrate the solution at lower cost than the conceivable alternative of in-house development. This also "beats" the uncertainty of not knowing how much solution will cost to develop and, even where the cost is believed to be known, this could be wrong and lead to sizable cost overruns.

Considering each of these expressions, a compromise may be possible between all four. While, on the one hand it is best to have the most open call, the most feasible way to implement such a strategy might be to take the "low-hanging fruits" approach that has been so successful for the IOC until now. A graduated approach might begin with the most "closed" of the "open" calls and gradually expand through all of the expressions, all the way though to the fourth. This may allow for the building up of confidence and critical mass towards a fully open call.

Section II: Crowdfunding Options

The present analysis suggests that the IOC start a CFP. To this end, this thesis puts forward a number of different possible expressions to achieve this, ranging, as in the previous section, from broad to narrow. These include:

1. IOC starts its own CFP, building on *Verkefnamiðlun* and Project Sharing Faroe Islands
2. IOC companies list projects for funding on Karolina Fund (and by extension NCA)
3. IOC list compliant projects on Kickstarter/Karolina Fund)
4. IOC starts proprietary CFP (then joins NCA)
5. NAOCA supported CFP

The first expression builds on the CS-like successes such as *Verkefnamiðlun* and Project Sharing Faroe Islands and opens a CFP link to them. From there, seeking membership to the NCA depending on the success of the venture remains a possibility. In the second expression, the IOC does not use *Verkefnamiðlun* as a springboard but instead launches eligible projects on Karolina Fund. This, however, is contingent upon Karolina Fund's expansion into technology, since currently it is only for the creative industries. Personal correspondence with Karolina Fund reveals they are considering this to be a viable long term strategic option.[306]

In the third expression, the IOC launches eligible projects on Karolina Fund and Kickstarter. This combination may be necessary since the rules of Kickstarter mean that cosmetic products and pharmaceuticals are not accepted as eligible projects, yet remain a possibility for Karolina Fund. This means that the CF potential of Kickstarter is currently somewhat limited for the IOC given the main high-value added products on offer. This does not exclude fish leather producers and other eligible ventures that may be proposed or come to light in future.

[306] Interview with Ingi Rafn Sigurdsson, founder and CEO of Karolina Fund, conducted on 15. 04. 2014

In the fourth expression, the IOC starts a proprietary CFP, does not modify existing projects, and seeks membership of the NCA. This will give the Icelandic marine biotechnology sector a wider Nordic audience and potentially increase the chances of success, to say nothing of other, very important aspects and signals of project quality outlined by Mollick.[307] In the final expression, the NAOCA could launch a proprietary CFP between all of the North Atlantic ocean clusters and then seek to join the NCA. This would create a large CFP across a very wide range of disciplines and sectors with much more volume and critical mass than a proprietary CFP.

Of course, each of the possible expressions and configurations, due to the recent creation of the NCA (including Karolina Fund, as it is a member), has the theoretical possibility of joining the NCA as a new member with some organisation and negotiation with Nordic Innovation. This may greatly assist in giving exposure to small, high-tech Icelandic entrepreneurial ventures, in accordance with the evidence from the research on CF. Another consideration is the choice between equity and reward-based CF. In the former case, restrictions in Icelandic law mean that the maximum number of investors that a CFP could potentially have is 160. Still, 160 shareholders, whilst very far away from the thousands that Kickstarter can draw on, is not a very small number, and it may be possible to work within these legal limits for the time being. This may make the reward-based model more preferable until the point when/if the law changes.[308] Equity-based CF to unlimited shareholders has been made legal in the US thanks to the Jumpstart Our Business Startups (JOBS) Act signed into law in 2012.[309] This may pave the way for changes in Iceland and reduce some political uncertainty as to the future legislative restrictions.

Section III: CF, Public R&D, VC or All Three?

[307] Mollick, E, 2014, *op. cit.*
[308] Interview with Ingi Rafn Sigurdsson, founder and CEO of Karolina Fund, conducted on 15. 04. 2014
[309] Mollick, E, 2014, *op. cit.*

This section explores how the possibility of a CFV going on to secure other, larger quantities sources of funding from traditional funding sources appears to combine the strengths and weaknesses of each: the knowledge problem of traditional funding sources such as VC and Bank loans on the one hand with the commercial scale critical mass problem of CFPs on the other. This implicates the role of traditional funding sources as well as public R&D funding alongside that of CF. Regarding the latter, Norden cites case studies that stress the importance of R&D for sustainable innovation. Firms differ in how they draw on research. Larger firms have in-house R&D units, whereas smaller firms are sometimes connected with external research environments. Furthermore, reinforcing the arguments made by the IOC in relation to the need for cooperation with NAOCA, they write that:

> "It is clear that most of the firms engaged in advanced marine processing are quite small and need further R&D investment. In this respect, research funds will not be sufficient. Private investors and financial firms need to participate in these projects if the [ocean technology] field is to flourish." [310]

This is a good indication of the appropriateness of considering the implementation of crowdfunding into the biotechnology, ocean technology and fish processing industries. Similar to the approach taken above regarding CS, there are several possible expressions that this can take. Each expression can include varying relationships between public R&D funds, institutional private finance (such as VC) and private finance from crowdfunding as follows:

1. 100% CF
2. CF and public R&D (+)
3. CF, VC (+)
4. CF, VC (+) and public R&D (+)

The first expression has the start-up solely funded through CF, with small sums stemming from potentially thousands of individual donors within either a reward-

[310] Sigfusson, T, Gestasson, H, M., 2012, *op. cit.,* 2

based or perhaps an equity-based model, up to 160 shareholders or more pending a change in the law. In the case of biotechnology firms with products on offer, it may be advantageous to pursue a reward-based model and distribute the products on offer in exchange for rewards; this will not require the release of any equity in the firm. However, it may be possible to raise more funds through an equity-based model, particularly if the profit potential is perceived to be higher from sales, growth or both. This has the advantage of being a completely independent and bottom-up form of exploration, with the potential disadvantage of not being able to secure the sums required to bring a solution to market, yet enough to explore the idea, develop further and distribute. Even the most successfully funded Kickstarter projects, having secured millions of dollars, still require additional monies to bring a products or service to market, as in the case of the Pebble Watch (on which, later).

The second expression introduces public sector involvement to the extent that public sector could either *match or exceed* (indicated by (+) above) in addition to the contribution raised through CF. This from of "investment matching" is beneficial because it affords the start-up more capital than would otherwise be obtained; this "funding matching" is already implemented in national innovation programs such as in Norway's Arena Program.[311] This approach has the advantage of providing critical mass through additional funding but has the potential disadvantage of being more open to political manipulation, given a choice of multiple projects through "winning picking" in the event of multiple successful projects. An equitable solution here, given a clear absence of knowledge of outcome, would be a random selection of overfunded projects, each to be allocated limited funds. Whilst seemingly reckless, this approach accepts the uncertainty that comes with partially explored ventures and recognises the fundamental limitations of *a priori* appraisals based on standard analysis techniques such as cost-benefit analysis regarding long term effects, risk and uncertainty.[312] Another approach that may be both preferable and possible would be to fund each in equal measure, giving each a minimum "floor" of support but also

[311] Arnason, V, J., 2011, *op. cit.*

[312] Hanley, N., and Spash, C. L., 1993, *Cost-benefit analysis and the environment*, Cheltenham: Edward Elgar.

affording random interactions their proper role. This has the disadvantage of not providing a given venture with sufficient funding, but maybe more equitable and avoids winner picking as well as avoiding leaving some ventures unfunded.

In the third expression, there is no public sector involvement, and instead has funding either being met or exceeded through VC funding. As previously noted, Mollick outlines a particular the example of the Pebble Watch, a start-up that was initially rejected for VC funding, but was reaccepted having received considerable interest from a Kickstarter campaign, raising 10.2 million dollars from an initial goal of $100,000, more than 100 times the sum initially requested. This expression arguably suffers from the same strengths and weaknesses as the second, private sector focus notwithstanding, with similar decision making problems, demands on organisational and managerial resources and "winner picking". As such, the same solutions, of random selection or equal allotment can again be put forward.

The fourth expression includes all three sources of financing, and is supported by a known and used policy instrument. For example, where the venture in question succeeds in attaining its CF goal, a Pre-Seed Fund (PSF) could then be employed between the VC firm and the public sector. A PSF is a form of Public Private Partnership (PPP) started and implemented in Australia in 2002 whose primary aim was "fostering more investment in nascent high-tech entrepreneurial companies"[313] under the following five objectives:

- To assist the commercialisation of R&D activities undertaken by universities and public sector research agencies by providing financial and managerial advice;
- Encourage private sector investment in R&D activities undertaken in universities and public sector research agencies for commercialisation;
- Build linkages between universities, public sector research agencies, the finance community and business for the commercialisation of R&D activities;

[313] Cumming, D, Johan, S, 2007, "Pre-Seed Government Venture Capital Funds" *Journal of International Entrepreneurship ,* available at http://ssrn.com/abstract=1031005, accessed on 05. 12. 2012., 1

- Build entrepreneurial and intellectual property skills in Australian universities and public sector research agencies;
- Encourage researchers in universities and public sector research agencies to consider the commercial opportunities of their research discoveries.

PSFs are the primary source of seed-stage start-ups in Australia, and have smaller portfolios per manager than wholly private sector VC firms, which means that firms get more time from each manager. [314] Five of these funds were established along a 2:1 ratio, ensuring that the private supplied 50% of the government money. The scheme in total led to a 72.2 million AUS$ public sector and a 36.1 million AUD$ private sector investment, for a total of 104.1 million AUS, and public money is effectively outsourced and co-invested. Research by Cumming, however, has shown that different policy instrument with different purposes have the potential to crowd each other out. This occurred in Australia where PSFs crowded out Innovation Investment Funds (IIF), established in 1997 despite IIF funds having typically supporting high-tech start-ups and PSF funds typically support seed stage companies. This means that such a policy has to be situated carefully between the other innovation policies already in place. This fourth expression has the potential to obtain the most amount of money for start-ups by combining three sources of funding (perhaps under a PSF, perhaps another way). In doing this, it combines disaggregated information sources and inputs CF and other expertise that may be available in experienced bodies within public sector investment bodies and private finance institutions. This is particularly advantageous in the case of research-intensive activities where funding might be required in several stages.

In all of the possible expressions, the power of OI is to bring forward not only an expression of interest from willing participants but also an expression of commitment from investors. The investors in a reward-based CFV are not motivated by profit; however, where a CFV needs further development and expansion beyond bootstrapping, there is room for VC and for public sector R&D to help to provide

[314] *Ibid.*

funding to bring innovation forward.

Section IV: A Barbell Strategy for Speculative Research

The third and final recommendation pertains to the creation of a speculative research fund, based on a barbell strategy. Where vulnerability is tractable, yet risk is intractable, a barbell strategy seeks to protect against the downside of risk and benefit from the upside through the correct proportion and quality of protection/exposure. This would yield discoveries to questions that do not yet exist. To implement such a fund is to recognise that knowledge acquisition is an unpredictable venture, realising that an unexpected result may come from an unexpected procedure, process or manipulation. The aim of the fund would be to facilitate tinkering, small trial and error combination, yielding options to the experimenters for further research. The barbell is a convex expression where, on the one hand, the upside in the event of an important discovery is unlimited in its potential to benefit knowledge growth, scientific discovery and technological uncertainty; the downside of pursuing a unsuccessful line of research can be cut short, and is thus limited.

An excellent abstract example would be in investment; where it can be quite common for investors to hold, say, 80-90% capital in “medium risk” assets with the balance held in cash. A barbell strategy would manifest as the inverse: 80-90 percent of holdings would be conservatively held in cash, but critically for the barbell, the remainder would be held in “very risky, maximally risky, securities”.[315] Where the former example runs the risk of almost total ruin because of the intractable nature of the risk and volatility, with the latter “you cannot possibly lose more than 10 percent, while exposed to maximum upside”.[316] Here, the notion of average risk is rejected, and the asymmetry is evident, but critically it is a *favourable* asymmetry. A barbell

[315] Taleb, N, N., 2012, *op. cit.*, 161
[316] *Loc. cit*

strategy can be applied and expressed in any context composed of extremes "without corruption of the middle".[317]

Such a program is, however, both politically and organisationally sensitive. This is because it hides its benefits. It has a long-term proposal and requires a long time horizon to achieve given outcomes, and it is possible that many years could pass before any discoveries of any value or significance are made.[318] However, when a discovery is made, it could more than compensate for the investment on failed attempts, exhibiting the maximum upside approach embodied in convexity. For this reason, this sort of program lends its self well to easy criticism both politically and organisationally. In figure 23, Taleb depicts the Barbell as follows:

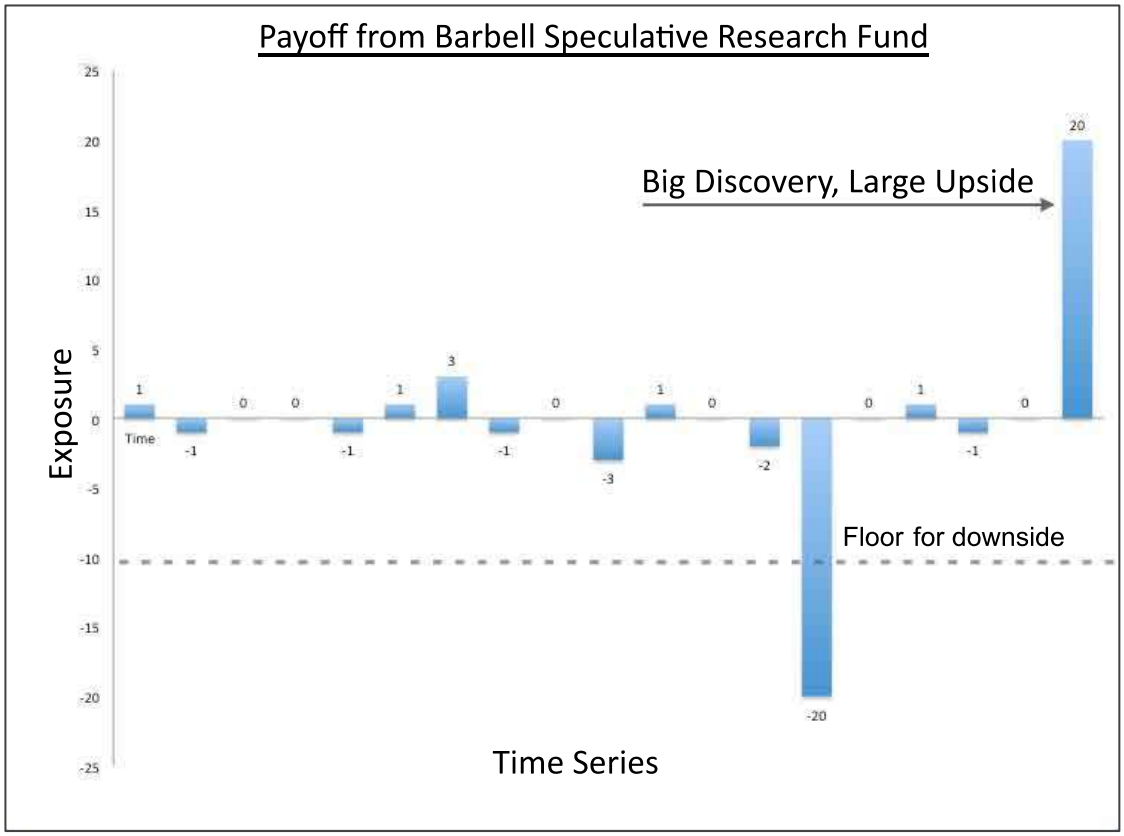

Figure 23: Barbell strategy through time series.[319]

[317] *Loc. cit.*
[318] Taleb, N, N., 2012, *op. cit.*
[319] Composite graphic of the author's creation. Based off of a graphic representation of the barbell strategy in Taleb, N, N., 2012, *op. cit.,* 438.

The barbell strategy can be conceived of as a *pre seed commericalisation strategy*. This could encourage the innovation process by finding and making new, pure scientific discoveries on the one hand, which could then by applied through the broadened use of existing useful by-products, potentially diversifying raw material utilization. Equally, this could encourage the scientists behind any discoveries made to pursue their discoveries further. Just as individual members pay fees to the cluster to support the cluster activities, a conceivable expression of this policy would be to set aside a small percentage of these fees into a separate "pot" that would be dedicated to this fund. This could be combined with a CSS as an open call with experimentation proposals. Given limited funds, imperative to capture unknown knowledge and overcome the teleological fallacy, a random opportunity sample of submitted experimental proposals could be used to help choose projects. As with CFVs, it is conceivable that once a "promising finding" has been identified where none existed previously, the likelihood then of receiving a public sector research grant and/or support from a larger R&D firm would be greater. As in the example of CF, this partially solves the knowledge problem, which can then be lent greater critical mass.

Among the many examples of endogenising trial and error within organizations, Hartford in particular notes the "Skunk Works" division at Lockheed Martin as best representing a Barbell strategy. The engineers and scientists that made up the "Skunk Works" were protected from corporate hierarchies and other interferences. They were responsible for pioneering discoveries in aeronautical engineering, which led to inventions such as the U2 high-altitude reconnaissance aircraft and the ultrasonic Blackbird.[320] In further support, research by Azouley et al., which has juxtaposed the research findings of the National Institute of Health (NIH) as against the HHMI. The former takes an incrementalist, rational approach, choosing projects with short review cycles, abrupt funding cut offs and demonstrating a preference for projects over people. The HHMI, by contrast, affords researchers longer funding cycles, and a

[320] Hartford, T, 2011, *op. cit.*

gradual phasedown of funds over two years, choosing to fund people rather than particular projects. Importantly, it "urges its researchers to take risks, to explore unproven avenues, to embrace the unknown – even if it means uncertainty or the chance of failure."[321] Azouley et al show that the HHMI produces more high-impact articles at a much higher rate than a control group of NIH projects. They also find that the HHMI encourages the exploration of new lines of enquiry and exploring new knowledge.[322] Equally, Hartford notes that there does not appear to be any particular significance and experiments that lead to no findings.

Link to crowdsourcing and Crowdfunding

As a convex approach, the barbell strategy can be used to explain CF, which itself can also be conceptualised as a form of barbell. This is because there are a few extremely large successes, more large and medium success and many successes comprising the successfully funded projects as well as majority losses. The losses are relatively small, contained to individuals risk takers and borne by entrepreneurs themselves, whereas the gains are much more obvious and readily come to the fore for further development and marketing. The same can be said for CS. There is very little to lose from advertising a problem in an open call and much more to gain, and the benefits of achieving a potential solution will in many cases far outweigh the costs associated with prize money and other expenses. Again, this is a case of limited downside and unlimited upside.

A Barbell Strategy for IOC or Iceland?

Having outlined the major concepts and some examples where barbell-like strategies have been implemented, it is now possible to consider how this recommendation can be expressed in the context of the IOC. Here, there are two possible expressions:

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[321] Zoulay, P, Graff, J, S., Zivin and Gustavo, M, 2011, "Incentives and Creativity: Evidence from the Academic Life Sciences." *RAND Journal of Economics*, 42(3): 527-554.
[322] *Ibid.*

1. IOC starts its own barbell strategy.
2. A broader speculative research fund within the NAOCA.
3. Barbell as a long-term policy objective within the pre-existing Icelandic Innovation Framework.

The first expression would see the IOC explore this possibility of establishing a barbell strategy with a small amount of allotted funds. A possible disadvantage of this is that the IOC may not have the requisite capabilities to implement such a program. This is because, in practice, much of the total funds available will be taken up by an operating budget of various expenses. This is not a problem in principle since the barbell does not require considerable sums; it may be possible to set aside a small sum for just such a program. Other organisational problems and conflicts exist, however, such as how best to distribute the costs and benefits of the findings of such research when the findings are funded by multiple entities. A solution would be to allow free use of the ideas and/or intellectual property generated according to a *freedom of contract* standard between all of the parties involved in the fund, including the cluster, according to a particular standard. This is the precise manifestation of cluster collaboration pooling resources for overall benefit; each firm would then be free to use the findings in whichever way it saw fit. The selection process must be based on formal submission of research proposals based on some form of criteria, but to select a project-based on its apparent usefulness suffers from the knowledge problem. As noted in the previous section, this places an imperative upon the selection process and selection criteria, where formal selection methods such as CBA largely fail to capture the possible externalities. Far simpler as it is, though seemingly reckless, to select in a randomly and opportunistically given limited funds. This is particularly fitting for the barbell given the random nature of the research and findings made.

The second expression is largely based off of the first, and therefore requires similar considerations, albeit on a larger scale. The second expression has the added

benefit of pooling more resources, but does mean that there are likely to be more research findings, making the funds available more competitive. This may make the organisation of private and social returns more complicated. Discoveries made in these international settings could be organised according to a freedom of contract, as in the section on CS. The third and final expression may be more of a long-term goal, the least immediately achievable of the three, but possibly the most realistic long-term. The third expression will require the modification, restructuring and/or enlargement of the existing "innovation architecture" within Iceland and perhaps regionally, in line with developments such as the creation of the NCA. As in the second expression, this will require some institutional changes through political decision-making.

Conclusion to Chapter V

In answering the fifth research question, this chapter has put forward three OI-based options that specifically harness uncertainty for the better, in different ways and expressions. As noted throughout the chapter, the option to scale that is to say, begin with the most narrow call and gradually open up may be a pragmatic way to start such a policy, but it also may not lead to any significant. It is the opinion of this author that, in keeping with the principles of OI and the success of open calls, that every effort should be made to make the widest and most open possible call. This is because wider and more open OI strategies will have the highest chance of success as opposed to more narrow calls. The implementation and scaling of these proposals is ultimately at the discretion of the IOC. However, whilst this is a pragmatic choice it can be said that this decision is itself an uncertain strategic decision, an embodiment of the research approach itself.

Conclusion

The present analysis began by recognising fundamental flaws in the prescriptive school approaches to uncertainty. In an attempt to relate firms to their respective business environments, there has been a pervasive attempt to compartmentalise, systematise and future change, into tractable and predictable frameworks. This thesis has argued that this is a mistaken premise. The main lesson that history holds in this regard is that knowledge growth unfolds in unpredictable ways, and not without a healthy dose of trial and error as the basis of with innovation; an ecological, social and economically contingent process. The enactment of the emerging and emergent possibilities depends upon a strategy that can domesticate rather than attempt nullify or control uncertainty. With this borne in mind, nascent developments in social media, network proliferation and the increasing critical mass in OI allow just such a strategy to come to fruition in the IOC under an emergent, visionary strategy. This could build upon the accumulated strategic advantages of the Icelandic ocean industry in terms of raw material utilisation, resource efficiency, waste reduction, diversification and value creation in as yet unpredictable ways.

In order to advance this agenda, this thesis has begged and answered five research questions. The first research question was answered by detailing the prescriptive approach to conceptualising future business environments and the second by highlighting the respective methodological pitfalls. The answer to the third research question sought to remedy the pitfalls with an emergent strategy and understanding change and innovation as technologically uncertain, diverse redundant knowledge growth. The answer to the fourth research question considered some conceptual difficulties and put forward an OI-implementation agenda and introduced the case study. The fifth and final research question was answered by showing that there are many possible configuration form a realistic OI strategy within the IOC that are consistent with the on-going projects and organisation with whom the IOC is currently engaging such as the NAOCA and Norden. In marking the journey form strategic planning to strategic learning, a robust alternative with considerable possibilities has been put forward.

The IOC represents a sea of opportunity. To summarise and conclude, the present analysis puts forward three principle prescriptions. First, a CS strategy is recommended. This is based on the fundamental premise that all knowledge is dispersed, and that technical and organisational problems can be solved through a "broadcast search" approach. Combined with the gains associated from clusters as agglomerative forms and building on existing projects, this holds great promise, both in theory and demonstrably in practice. Second, this analysis recommends the creation of a CFP as means to source entrepreneurial seed capital. This should act as a boon to nascent marine biotechnology firms and indeed other entrepreneurs in the marine sector. Finally, as a boon to future scientific and resource endeavours as well as future entrepreneurs, the establishment of a speculative research fund is recommended. The fund would be the embodiment of the trial and error approach to innovation in the marine sector, continuing the string of successes achieved thus far. Each of these processes allows chance, with a healthy dose of insistence and determination to do much of the work. This recognises that it is not necessary for all of the lights to go green. All that is needed is the tentative orange of possibility.

There are many potential avenues of future research; there is considerable room for exploring the range of possibilities relating to CBOI. The combination of the power of co-location with disaggregated inputs from all over the world may yet yield considerable innovative insights. It is important is to continue analysing the dynamics of CF as a source of seed capital; as the approach becomes more popular, it may be possible to delineate with more precision the factors behind successful projects; though there is a danger here that some projects were successful simply for path dependent reasons, and may lead to erroneous conclusions, as the analysis has noted throughout. Another possible area of future research might be to explore more precisely how CBOI can be integrated with the existing Iceland's and/or indeed the Nordic regions "innovation architecture", particularly with regard to the situating the idea of the speculative research fund within Iceland and regionally such as through Nordic Innovation. A final area of research lies within the IOC itself. In chapter three, the history of invention was outlined in a non-historical manner. It would be an

exciting avenue of research to document and delineate the string of scientific advances that have led to the current state of raw material utilisation, to understand precisely how this happened and to what extent it was path dependent.

The defining characteristic of the ecological is the opaque. Where the emergent is inherently uncertain, so is the future business environment and by consequence the outcomes of future strategic decisions. For this reason, despite encouraging peripheral developments within Iceland, regionally and globally, there is no guarantee of success with any of the possibilities considered and prescriptions put forward by this analysis; neither is any prediction of success offered, because to do so would be to violate the central premise of this analysis. The only prescription therefore, can be trial, and error, somewhere along the way; but then to try, try and try again, in any and all spheres of practice, continually learning along the way, with a vision. Strategy needs trial and error mechanisms because this is the only way to discover what, in practice works, and what does not. This presents immutable risk as it does great rewards.

Glossary

Bootstrapping: methods by which new ventures support themselves during their early and more risky early days

Cluster: "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions such as universities, standards agencies, and trade associations [...] whose value as a whole is greater than the sum of its parts" (Porter); "groups of firms in the same or related industries whose development is interdependent" (Enright).

Concavity: A situation in which there is more t lose than to gain, more downside that upside. Hides risk.

Confirmation bias: identifies elements of the past that appear confirm (or disconfirm) a particular worldview and uses these to confirm a given theory or worldview.

Convexity: a situation in which there is more to gain than to lose, more upside than downside. Hides benefits.

Emergent: when new properties, attributes and connections come forth as a result of interaction and connectivity. Emergence is not the property of any one thing, but a large aggregation of interactions such as "economy" or "society" demonstrates emergent properties. For these reasons, emergence cannot be predicted. Also function of path dependence.

Entrepreneurship: profit-seeking activity aimed at identifying and solving ill-specified problem in structurally uncertain and complex ways.

Epistemic uncertainty: the form of uncertainty creating by unclear causality an information failure at one or many unidentifiable "layers".

Epilogism: A theory-free method of looking at history by accumulating facts with minimal generalization and being conscious of the side effects of making causal claims.

Expert problem: both that experts know less than they think they do, and that others assume that experts know more than they really do. Can result from a combination of naïve empiricism and the conflation of path dependence/independence.

Formative Teleology: a systemic theory of causality in which a system unfolds

patterns of behaviour that are already unfolded in its structure in movement to a mature state that can be known in advance

Hindsight bias: the difference in understanding between expecting events *ex ante* and analysing past events in posteriority, expost.

Incomplete Information (information failure): when some or all information that is necessary to understand or examine processes is missing. Analysis is therefore incomplete

Minimal rewrite rule: combats the narrative-dependence, naïve empiricism and the confirmation bias by attempting a form of historical analysis that represents as many facts about the past as possible and does not manipulate those facts. Implemented by Phillip Tetlock as a methodological premise.

Naïve empiricism: formulating/constructing a theory and then systematically applying that theory to the past. Related to narrative discipline and confirmation bias.

Narrative discipline: creates and fits a story that attempts to make sense of the past; attempts to make the past tractable. Related to platonicity and naïve empiricism, but differing from the latter due to lack of numerical or quantitative analysis.

Non-predictive view: the future does not need to be predicted in order to understood. Not as vulnerable to future changes, characterises a modified approach to strategy. Path independent.

Ontological uncertainty: the form of uncertainty derived from sudden, spontaneous causality. Philosophically distinct but "functionally indistinguishable" to epistemic opacity due to intractable causes through information failure.

Opacity: the pervasive "unclearness" of the past, present and future causes through information failure at one or many "layers" of interacting causes and effects.

Path dependent: when a set of decisions is circumscribed by the decisions made in the past. Path dependence is mainly non-replicable. Related to the predictive view.

Path independent: when a decision or set of decision is not circumscribed by the decision made before it. Path independence lends itself well to replicability. Related to the non-predictive view

Platonicity: the methodological act of reducing a complex and nebulous causal interactions of different factors into more simple forms in order that they may be

better ‘understood’.

Predictive view: the future needs to be predicted in an attempt to understand and adapt to the changes it will bring. Vulnerable to change, the predictive view marks the prescriptive approach. Conflates path dependence with path independence.

Stochastic: Having a random probability distribution or pattern that may be analysed statistically but may not be predicted precisely

Strong Network Tie: high levels of social relationship or personal interaction with high frequency

Survivorship bias: An overrepresentation of success stories (winners) and a corresponding underrepresentation of losers, often far greater in number. The survivorship bias that give the illusion that success is more likely.

Rational Teleology: The cause of human action is human motivation is expressed in autonomously chosen goals and means of achieving them arrived through rational reasoning

Transformative Teleology: a future which is under perpetual construction by the movement of human action itself

Venture Capital: The professional, institutional managers of risk capital that enables and supports the most innovative and promising companies

Weak Network Tie: non–redundant ties which are not as heavily based on personal interaction among members of the network but may provide strategic advantage in terms of resource availability.

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