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Asset Transfer Pricing Models and their role:

A Decision Framework from Complexity Economics and Systems Theory

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Abstract

This thesis reviews the expectations and outcomes of financial models used prior to the 2008 credit crisis and offers a possible solution to the management of the high variety of risks prevalent in the financial markets by ensuring each investment is properly valued as to a range of possible outcomes derived from a due-diligence process that is understood by both parties and uses a sustainable recursive economic model to benchmark such outcomes. More specifically it asks whether the failure in the 2008 Credit Crisis was due to extant models and/or whether the managers had the tools to cope with the variety of risks and strategies needed in a global, complex financial industry. Central to all financial transactions is the exchange of some form of soft or hard asset(s), that generally come under the purview of Asset Transfer Pricing Models ("ATPMs"), and an associated due diligence process designed to expose the risks, processes and rewards for the particular project at hand. Current ATPM's vary in form and do not offer a consistent method by which they are applied. They equally do not state the complete set of variables as they are usually focused on the project at hand and not on on-going management of ex-post investment or the contextual structure within which it must operate. The latter being a nested set of economic processes that are not deterministic in nature and consequently affects the project in a non-linear fashion. Though not part of a ATPMs process the due diligence associated with a project review does not stipulate whether the data is communicated effectively and fully understood such that the financial outcomes expected can materialise. The proposed solution embodies the application of new research methods from the complexity sciences such as; complexity economics, agent, information and network theories; and management cybernetics. The solution takes the form of a set of processes, similar to a due diligence approach, that ensure data is communicated effectively, outcomes are benchmarked against a sustainable business model, and that the variety of outcomes is matched by strategies that can be rapidly implemented to meet events. The sustainable business model used as a benchmark is derived from Stafford Beer's "Viable System Model" ("VSM") whereas a modified Klonowski "Investment Analysis Heuristic" is employed as the associated Due Diligence model to gather data. The modifications being derived from Information Theory to ensure that

efficient communication of data is ensured. The data from the recursive market structure, the processes engaged by the project's agents and the outcomes derived by the VSM are then used to benchmark performance by a modified Cellular Potts Model ("CPM") to show how the rules and parameters evolve over time and whether the expected financial outcomes are sustainable. Alone the process described only assesses the currently available resources' ability to provide the expected investment outcome. In order to ensure the project survives in the event of catastrophic events a prudent level of standby liquidity is required to finance whatever future strategy management perceive necessary to adapt. To this end a "Thought Experiment" and Cross-Case Analysis is conducted using the artefact as a pricing mechanism for Standby Capital, an insurance-like product that supplies liquidity and equity at the point of the event. Four resources therefore provide the central framework of the artefact: Design Science Research Methodology ("DSRM") to develop then test its concepts; the "CPM" as a performance metric whose "Hamiltonian" references the recursive business topography of Stafford Beer's "VSM"; and an adapted Klonowski Investment Analysis Heuristic as a Due-Diligence process. The artefact is called GHOST: a General Heuristic on System & Time. The ontological framework of the artefact moves ATPMs away from their existing deterministic to a probabilistic pricing approach that responds dynamically to changes in strategy. A major consequence of which is that time, as used in corporate finance, be shown to be process dependent and variable. The thesis concludes it is possible to develop a range of tools to manage the variety faced by modern investors/managers and offers lines of research to implement them.

Key Words:

Asset Transfer Pricing Models, Viable System Model, Second-Order Cybernetics, Complexity Economics, Network Theory, Agent-Based Models, Systems-Biology, Information Theory, Cellular Potts Model, and Ethical/Islamic Finance.

Salutations:

I would like to thank all of those that have given me support over the last few years. Most of all to my wife, Susan L Wasilewska, for her emotional support through chemotherapy and Angela Espinosa/Richard Vidgen whose guidance helped this intensely practical mind articulate an idea germinating since he met Stafford in 1996.

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Chapter 1.1: Problem Definition

Chapter 1.1.1: Background

Over the weekend of September 13/14, 2007 the Federal Reserve Bank in New York ("FED") called together the Chief Executive Officers of major Wall Street financial houses to discuss the impending failure and ramifications of Lehman Bro's (Sorkin 2009). Seven years later though the individuals may have changed the same institutions drew the approbation of Paul Volcker (Braithwaite T 2014) the joint architect of many reforms deemed necessary to remediate the financial market structure and what had become the 2008 Global Credit Crisis ("2008 Crisis").

Volcker questions why these "men of high finance" could not manage their own firms to implement the regulatory reforms imposed by a wider society. Embedded in his question is another: did they want or know how too? Whether management "wanted to" is a matter of strategy dependent upon an understanding of the business and its market parameters, but to "know how" presents further questions on whether: existing products and processes; their associated strategies; and operational implementation, were fully understood? If the latter is affirmed then strategies could be adapted and the question becomes why are they stonewalling? If not then a probable management strategy would be to maintain the status quo until such time as economic profitability returns by better processes or the regulators relent.

The importance of Volcker's question for Society cannot be understated for though many governments have installed programs of Quantitative Easing ("QE") to stimulate shop-floor activity over six years little of this added liquidity has met its objective and remains within the banks themselves (Shirreff 2014). Perhaps Volcker should have also enquired whether these institutions know how to adapt existing pricing models to accommodate the new requirements, as well as the variety of forces that impact strategic execution, thereby transforming the new assets into working investments?

In Crisis: Cause, Containment and Cure (Huertas 2011) opens with the cost crises bring upon public finances and finding a cure beneficial to society. Huertas offers a Macro-Economic perspective to regulating the impact and frequency of financial cycles. He offers policy guidance to governors, rules that he sees as the major levers encouraging growth but also recognising the limitations of technology. The core needs are to set leverage, capital and liquidity boundaries for the whole financial system not just the current (2015) banking system. However at the same time he discusses continued economic growth there are market forces such as:

- The maturity of markets;
- Investor confidence;
- The actual state of the financial markets balance sheets;
- Regulatory and political pressure;
- Established market structures; and
- A lack of broadly accepted replacement financial models,

that would conflict with these new boundaries.

Assuming profit, and the ability to monetise it, as a primary driver for asset exchange then the problem begins when determining the financial dynamics of the component parts of the economic system within which the assets are embedded. In addition how data is acquired to assess asset prices also becomes important. As the variety of stresses begin to effect each component's internal and external regulatory functions a new aggregate state emerges: in effect the whole becomes a co-dependent Social-Economic eco-system ("SE/eco-System") closely coupled to a set of global operational methodologies and asset pricing constraints. Regulatory functions in this sense means, but should not be limited to, those parameters, processes and structures put in place to govern the strategic direction of the business.

The co-dependency of asset pricing risks exists beyond the simple and visible currency, interest and public capital markets. For instance though it was believed that the portfolios of global financial institutions were massively over-priced it only became clear when market confidence in a continued economic environment hesitated and fell. As Pettis (Pettis 2001, Pettis 2013) shows the inability to monetise assets leads to liquidity issues where secondary shocks then begin to infect the market value of those assets and "fire-sale" conditions then depress already struggling investors. It is worth noting a financial homily that “the price of an asset depends on the availability of willing investors, their confidence that future earnings can be met, thereafter competitive forces intervene”.

Though Haldane and the Bank of England (Edmonds, Jarrett et al. 2010) gave us a good timeline of the 2008 Credit Crisis Triana (Triana 2012) strikes at the heart of the problem – Value at Risk Models (“VaR”): More specifically the assumption of “Normality- that is central to their operation which in turn is vital to the valuation of all financial instruments used in Asset Transfer Pricing Models.

Chapter 1.1.2: The Breakdown of Asset Transfer Pricing Models

In criticising the core assumptions in the valuation of assets, liabilities and/or risks within Asset Transfer Pricing Models (“ATPMs”) Triana also targets the strategic investment process and a broken regulatory function upon which all ATPMs rely.

Chapter 1.1.2.1: What are ATPMs?

ATPMs are ubiquitous throughout the Economy and for the purposes of this thesis ATPMs will be broadly defined as:

> “A financial model and associated data discovery process employed to test the viability of outcomes for a specific financial investment strategy.”

They can appear simply as purchasing a loaf of bread, as complex as buying a nuclear power station or a portfolio of investments. Whilst the valuation of individual components may be complex the process described above is the same at whatever level of investment operation.

If Triana is correct and the core assumptions of Normality for VaR models false then what other assumptions and models are in error within Corporate Finance (Ho and Yi 2004, Pike, Neale et al. 2012, Berk and DeMarzo 2014, Brealey, Myers et al. 2014)?

Chapter 1.1.2.2: The Curate’s Egg?

Triana and Tett (Tett 2010) raise the issue of how VaR was applied in both a regulatory sense as well as discrete product valuation. Both authors tell of how JPMorgan successfully lobbied the U.S. regulators to allow VaR as a valuation method for capital adequacy purposes and developed CreditMetrics™(Morgan 1997) as an insurance tool for credit risk management: both explicitly raising banks leverage ratios and hence profit.

By shifting the underlying distribution of risk in this way JPMorgan, followed by most banks, effectively undermined another set of models essential to market pricing: The Capital Adequacy Pricing Model ("CAPM") and Arbitrage Pricing Theory ("APT"). What was already considered a "curates egg" by some practitioners, because they assumed perfect information, had its statistical heart as well as its market shaken: Fama (Fama and French 2012), one of the founders of the CAPM, was later to lament its breakdown.

Haldane notes that whilst Sub-Prime triggered the 2008 Credit Crisis it was perpetuated by a fundamental fear of over-valued assets fuelled by models with faulty assumptions. ATPMs relied on VaR, CAPM and APT to arrive at prices and values that were fundamentally miss-priced (Soros 2003, Cooper 2008, Tett 2010, Triana 2012, Shirreff 2014, Desai 2015).

Chapter 1.1.3: On-going Issues

Without alternative models ATPMs still rely on the CAPM and APT to supply pricing for assets and liabilities (Derman 2011). However seven years later the effects of the Crisis are still being felt.

Chapter 1.1.3.1: Liquidity

Appendix 1 details a discussion between the author and a leading manager in the capital markets, Angelo Sirignano, that highlights the on-going dearth of liquidity in the marketplace highlighted by Penner (Penner 2016) and Wigglesworth (Wigglesworth 2015).

Liquidity is the essential oil that drives the economy without which industry would not function and nearly faltered in 2008 (Sorkin 2009, McLean and Nocera 2010).

Chapter 1.1.3.2: Risk Aversion

The objective of ATPMs is to determine whether the seller will meet the projected outcomes of an investment, or meet their appetite for risk? With such a fundamental failure in pricing models the financial market's risk appetite has waned considerably and is reflected in the availability liquidity: The market is risk averse.

Chapter 1.2: Aims and Objectives

Triani's objection to VaR addresses a fundamental problem of all financial models:

- Are the outcomes supported by the data and a strong set of assumptions?
- If the current models are not working what is missing in order for them to restore investment appetite?

Chapter 1.2.1: Is There A Better ATPM?

The lack of liquidity within the capital markets refocuses the question on the managers of both financial and manufacturing's ability to assess the dynamics of the market and the pricing of assets in general.

Creating tractable real-world economic pricing models depends upon:

- Identifying the correct functional objective of the model itself;
- How it is embedded within the wider economy; and
- The component processes and boundary parameters for each and the whole.

This is especially important if there is to be valid criticism of pre-2008 Crisis models. As de Wit (Wit 2009) observed in pricing property local, national and international markets each exhibit different temporal dynamics but are coupled to a central liquidity pool with its own dynamics and governance rules.

Having highlighted a part of the problem to be assets pricing models used in liquidity and capital management they alone are not the culprits. A case needs to be made to show that management/organisation (Keynes 1937) has a vital and dynamic role in executing the ex-anti/ex-post asset acquisition process that achieve the model's outcomes. It needs to show how the network of co-dependency develops (Pettis 2001) and that without proper governance predictive asset pricing breaks down.

Chapter 1.2.2: GHOST: A Thought Experiment

The question is therefore: Can a better ATPM be created to taking into account the issues identified above and those by Tett (Tett 2010) and Triana (Triana 2012)?

Given the data constraints in a competitive marketplace the proposal is create an artefact in the form of a Thought Experiment taking into account the above but also drawing upon the Complexity Sciences where a body of work already exists to address these in Management Cybernetics, Agent Based Models and Network Theory.

The artefact has been given the acronym "GHOST" to represent a "General Heuristic on Systems & Time".

Chapter 1.3: GHOST: General Heuristic on Systems & Time

If the statistical heart of VaR is broken, organisation is a vital part of the dynamics of achieving outcomes and changes in dynamics effect the time over which those outcomes are achieved then the GHOST will require a shift from a "deterministic" set of Corporate Finance algorithms to a "probabilistic" set. It should also differentiate between the various effects different levels of organisation have on outcomes such as those experienced in the 1998/2008 Credit Crises when regulatory structures impacted market liquidity and capacity (Bookstaber 2007, Sorkin 2009)

Chapter 1.3.1: Definition

GHOST will use the same definition as any other ATPM in that it is both a Model and a Due-Diligence process.

Chapter 1.3.2: Outline Approach

GHOST could therefore be considered a "Conversation" between a set of parties seeking to understand the veracity of a proposed outcome that will result in the exchange of assets. To achieve this goal the following needs consideration.

Chapter 1.3.2.1: Understanding What Is At Stake

The conversation can begin informally but should develop rapidly into a framework where all parties know the common goal and at what stage the data, models and conversation itself is positioned.

Chapter 1.3.3: Models: A Benchmark and Derived Scenarios

For practical purposes, see Appendix 1 insights, many of the models in use are hard wired into treasury reporting or company management reports and therefore deterministically based even though they may have varying parameter settings: they would not include the structural/organisational framework mentioned above.

It is therefore proposed that GHOST build a benchmark probabilistic model that includes the required systemic and organisational frameworks from the due-diligence data.

Chapter 1.3.3.1: Existing Asset/Liability and Risk Models

To accommodate the above existing asset/liability and risk models will be used but their outcomes subject to variance by the organisational/systemic components of the benchmark model. This should facilitate a comparison between existing deterministic models and the dynamic probabilistic framework of the benchmark.

Chapter 1.3.3.2: Understanding Organisation: The Viable System Model

There is a considerable body of work that includes organisational/systemic structures and the most complete, so far, is the Viable System Model (“VSM”) (Beer 1959, Beer 1972, Beer and Casti 1975, Beer 1979, Beer 1985, Morlidge 2009) designed by Anthony Stafford Beer. The VSM, Beer’s prior work and the legacy left by him in Management Cybernetics presents a framework from which a benchmark core model could be forged.

Chapter 1.3.3.3: What Are the Agents Doing With The Networks They Create

One drawback of the VSM is its lack of formal framework to analyse the dynamics of agent activity and the networks they create. Although Beer provided for the ability to compensate for this in his “parasympathetic network” it was not articulated in his works. However with the advent of Agent-Based Models and Network Theory

(Kauffman 1993, Arthur 1995, Arthur, Durlauf et al. 1997, Watts 1999, Bianconi and Barab√° si 2001, White 2002, Barabási 2003, Strogatz 2003, Easley and Kleinberg 2010, Squazzoni 2010, Alessandro 2011), not available to Beer, it is possible to frame a network of agents, plan for emerging structures and compare their strategic effect on Beer's VSM.

Chapter 1.3.4: Pulling It All Together: The Cellular Potts Model

Although Beer's VSM may be the core element of GHOST there will still be the need to draw all of the components into one framework with logical parameter outputs that effect the outcomes studied. As the VSM is a model that analyses the current, real time, state of the organisation the need to include agent and network structures, as modelling parameters requires a similar structure that is found in the Cellular Potts Model.

Chapter 1.4: Research Propositions

From Volcker we are asked whether financial managers understood the risks involved and further manage them in real time whereas Tett/Triana identified the rotten heart lying at the heart of VaR as well as how this false prophet of performance was applied along with the CAPM and APT: All effect the outcomes of ATPMs.

The research proposes the following:

1. If VaR's assumptions do not represent a correct set of operational parameters to value assets, liabilities and risks what insights can Management Cybernetics and other Complexity approaches to improve the situation?
2. If organisational structure affects the performance of systems and the timeframes involved how would the theory of viability (VSM) support the better management of financial investment strategies for ATPMs?
3. What roles can Agent-Based Models and Network Theory play in identifying emergent behaviour in financial and economic systems?
4. Is there a framework that can communicate a richer understanding of the risks surrounding the outcomes of ATPMs to all parties using insight from the VSM and other Complexity Sciences?

Chapter 1.5: Research Method

The thesis suggests a Thought Experiment (Sorensen 1992) that will be conducted under a Design Science Research Methodology ("DSRM"), one also favoured by Beer, and borrowing from Peffers (Peffers, Tuunanen et al. 2007) the following graphic outlines the process and the Chapters herein:

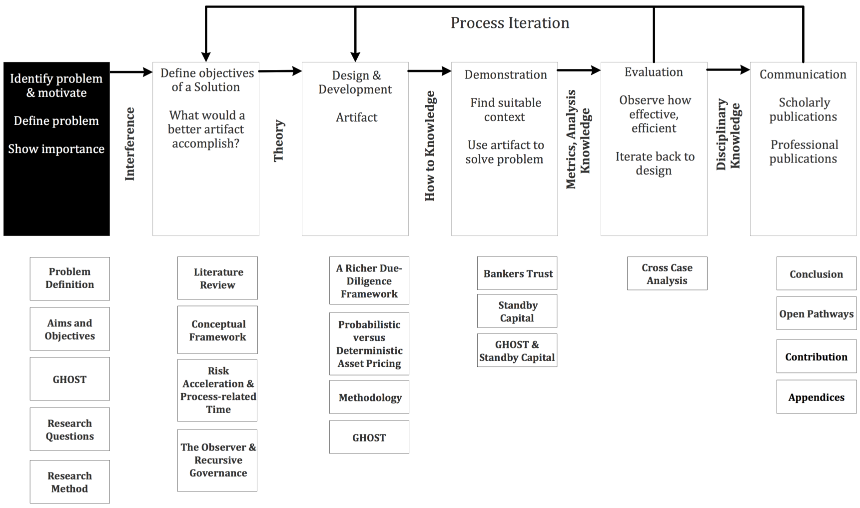


Figure 1: Modified Peffers Diagram - Thesis Chapter Headings

DSRMs are particularly useful as it can provide the rigour to combine: the practical experience in implementing Model-Based Management in start-up businesses (Wasilewski 2010); the need to identify the market structures required to turn theory into practical artefacts; that can then be demonstrated in real world applications. Although other frameworks have been proposed Peffer's overall approach provides a "best fit" for the proposed artefact (GHOST) to augment ATPMs, and the due-diligence frameworks that supports them.

Chapter 1.5.1: Chapter Descriptions

The following is a brief description of each chapter starting with Chapter 2:

- Chapter 2: A literature review of the financial markets, complexity sciences and complementary systems research set in a context to illustrate how the 2008 Credit Crisis emerged as well as the conceptual framework supporting the development of the artefact. Two additional sections address the subjects of the predictability of performance measurement, how observation of markets can changes both risk perception/outcomes and recursive governance.

- Chapter 3: Investigates the Due-Diligence process, why probabilistic pricing models are better informed with respect to deterministic outcomes, the Methodology underlying the thesis, and a description of GHOST.
- Chapter 4: A review of an application of the VSM in a financial institution setting, an explanation of Standby Capital, and how Standby Capital would use GHOST as a pricing mechanism.
- Chapter 5: A cross-case analysis looks at how both Standby Capital and GHOST can be applied to a variety of classes and levels.
- Chapter 6: The conclusions drawn from the research, areas of future research as open pathways to support GHOST, what the contribution to science in general and ATPMs in particular would be, and Appendices support the research.

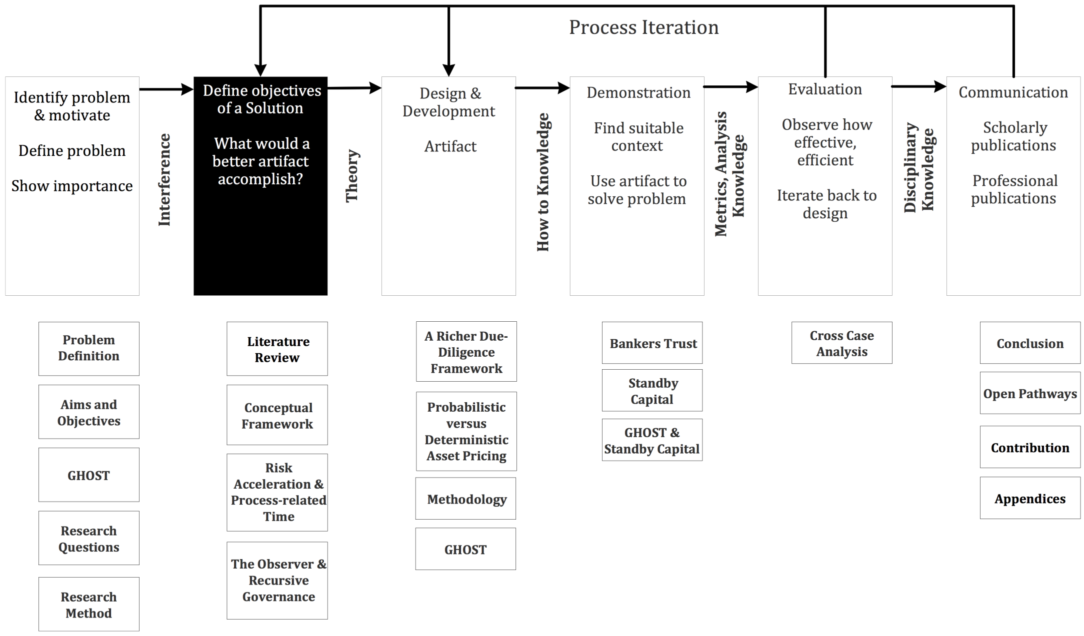


Figure 2: Chapter 2

Chapter 2 - Objective Solution

Chapter 2.0.1: Introduction

This chapter concerns itself with how experience and developed models emerge from acquired and revealed data. Though ATPMs are tightly focused at a transactional level their collective economic impact cannot be over-looked because it will be shown that the model’s form manifests itself at each level of stable economic organisation. Economic in this sense relates to the model and due-diligence required to assess the transfer of assets.

Whereas the Literature Review will contain much concerning the development of business and management methods it will be split into three primary sections:

1. Financial: This section will relate to discrete transactional and micro-economic developments to focus on how and why value is created;
2. Organisational: This section will focus on the models created to understand how organisational risks within transactional processes were developed to manage risk and understand the broader parameters of risk, and its consequences, surrounding a technologically complex society; and

3. Complementary Theories: Concerning both the above but which may not yet be recognised as contributing to a better understanding of the sociological framework within which ATPMs are embedded.

The overall perspective taken will be how emerging models coalesced from new technology, discovered forms and proposed frameworks. How experience fits within evidence-based models will be discussed with the LR as well as the Conceptual Framework but essentially experience (that for which we take for fact), whether subjective or otherwise, needs to be tested regularly. In terms of ATPMs this means that learned processes can fool us if current data does not support it but, as processes do not exist in isolation (see above), it will be shown that individual models can often change the “colour” of information much in the same way colour hues change the perception of its neighbours and add “mood” to the financial environment.

Insights from “The Market Discussion” will be developed but the following from a House of Commons paper on the Credit Crisis timeline (Edmonds, Jarrett et al. 2010) resonates with the key points that emerge:

> “They noted that even if there was a “direct channel of contagion”, there were five “indirect” channels that caused the credit crisis:
>
> > (1) a generalized run on global financial institutions, given lack of information as to who actually held toxic assets and how much;
> >
> > (2) the dependence of many financial systems on short-term funding (both in dollars and in other currencies);
> >
> > (3) a vicious cycle of mark-to-market losses driving fire sales of ABS [asset back securities], which in turn triggered further losses;
> >
> > (4) the realization that financial firms around the world were pursuing similar (flawed) business models and were subject to similar risks; and
> >
> > (5) global swings in risk aversion supported by instantaneous worldwide communications and a shared business culture. [3]
>
> In conclusion, they said:
>
> > The U.S. subprime crisis, rather than being a fundamental driver of the global crisis, may have been merely a trigger for a global bank run and for disillusionment with a risky business model that already had spread around the world.[4] “

It is worth adding their observation from a Ben Bernanke (Bernanke 2009) speech as it reflects upon what the author believes is the central concern of ATPMs being the correct pricing of risks and execution of the business plan to meet investor expectations:

> "The proximate cause of the crisis was the turn of the housing cycle in the United States and the associated rise in delinquencies on subprime mortgages, which imposed substantial losses on many financial institutions and shook investor confidence in credit markets. However, although the subprime debacle triggered the crisis, the developments in the U.S. mortgage market were only one aspect of a much larger and more encompassing credit boom whose impact transcended the mortgage market to affect many other forms of credit. Aspects of this broader credit boom included widespread declines in underwriting standards, breakdowns in lending oversight by investors and rating agencies, increased reliance on complex and opaque credit instruments that proved fragile under stress, and unusually low compensation for risk-taking.[5] " (Superscript Numbers relate to Bernanke referencing)

At the heart of the last sentence above lies Asset Transfer Pricing Models, their associated "Due Diligence" processes and the effect the consequences of unaccounted/discounted events have on cumulatively miss-priced assets.

This thesis aims to show that, what starts as a conversation between sellers and buyers to affect the transfer of assets, can be described in an operational meta-model whose function is to discern the viability of the expected outcomes. The meta-model will be embedded within an artefact that not only embraces existing best practices in risk management [ISO 31000][i] but also links the activities of collective agents in the environment to the networks they create to test the resilience of the resultant financial topographies. The structure of these topographies will be shown to be: heterarchical; recursive; and with governance frameworks that can alter expected investment outcomes through positive/negative feedback processes.

Pettis [(Pettis 2001), Loc 128] contends that the body of work that is Corporate Finance (Ho and Yi 2004, Berk and DeMarzo 2014, Berk, DeMarzo et al. 2015)("C-F") can be adapted to account for a wider set of economic scenarios. However many of the models used within C-F have broken down and it will be shown that, even though ISO 31000 and its associated frameworks, profess to embrace "enterprise and model risk" they too are flawed by not accounting for the topographies above, their effect on the execution processes involved and the consequent investment time-horizons set within investors expectations. What follows therefore explores:

- How ATPMs developed;
    - A brief history;
    - Their components;
    - Their failings in the 2008 Credit Crisis;
- The collective structure of ATPM outcomes;
    - Determinism vs. probabilistic outcomes;
    - Markets, agents and networks;
    - Models and their development;
- Governance & Strategy;
    - Its role in business and regulation;
    - How Nature may offer different models;
    - The development of Management & Second-Order Cybernetics;
- Communication;
    - Data, Information and Noise;
    - What Information Theory may offer; and
- Time;
    - Common, relative and process-dependent.

However the main focus will be to develop an understanding of how developments in agent behaviour, network structures and governance frameworks can be braided with existing best practice to form an artefact providing adaptive real-time pricing.

Chapter 2.0.2: Ordered – Knowledge And The Half-Life of Facts

A necessary requirement to form the opinions upon which ATPM risks: are assessed; models created; and a moral compass developed, is the acquisition of relevant data and how that data emerges as new models.

It will be shown that an ATPM is an idealised set of processes, a model, which distills a financial outcome from a data set comprising the risks, parameters and component processes of the target proposition. This outcome then becomes part of a feed-forward process around which another set of actions will be executed the success of which can only be assured if the data and component processes are managed within the set parameters. Deviation, for whatever reason, can have positive or negative implications (Morlidge 2009, Morlidge 2010, Morlidge and Player 2010, Morlidge 2012) and contingency strategies considered for the latter including catastrophic failure. How the investor manages the ATPM’s outcome depends upon the appetite for risk, their faith in the target investment’s management to execute a strategy and an understanding of the contextual (market) dynamics.

When reviewing models, and the paradigms that support them, we show that the dependency on a model challenges us to continually review its sub-components, parameters and continued efficacy as even Science itself, described as the search for “Ordered Knowledge (Jasanoff 2004)”, has developed a metric “Half-Life” (Arbesman 2012) relating to the veracity of its models. This is even more important when taking into account personal internal models and the businesses strategies employed.

The effects of coherence or dissonance within: an individual at a senior level; the collective effects of cultural/emotional beliefs of markets; and the structural integrity of a business can colour its performance or strategic outcomes. The manifestations of these issues arise from the emergence of changes in the parameters for the type of networks created between individuals and businesses. Coupled with the application of models as their “Half-Life” expires these effects can be amplified.

Chapter 2.0.3: Don’t blame Smith or Keynes

Whilst the collective effect of ATPMs may be reflected in Economics, both “New” & “Classical” (Myrdal 1953, Nasar 2011, Sedlácek 2011, Smith 2011, Capra and Luisi 2014), Keynes (Keynes 1937) was quite clear in his masterwork that organisation was one of the primary drivers of change and therefore a key variable, not only in the specific analysis but also the model itself. By referencing Mandeville (Mandeville 1795) in both the preamble [(Keynes 1937), page 8] and appendices, Keynes included a clue on how he thought events might play out. Equally a broader reading of Smith (Minsky 1975) notes him to be a dynamicist compared to Ricardo (Ricardo 1817), and his followers, who entrenched economic activity in deterministic mathematics.

ATPMs act out on the micro-stage of financial transactional business whereas Keynesian, and other economic theories (Schumpeter and Opie 1934), emerge and address the broader market collective. To reconcile how they interact a section on “Recursive Systems” will address the emergence of self-similar systems and their structure especially when considering governance structures across complex organisational financial structures: both internally to a firm and its relationship to governing bodies.

Chapter 2.1: Literature Review

To restate: An ATPM's framework is taken to be both: a model to achieve a desired financial outcome(s) and a methodology to acquire the data necessary to adequately assess the veracity of those outcomes, given the current state of a variety of parameters relevant to the investment strategy targeted. The parameters relate to those endogenous and exogenous processes necessary to manage the variety of agents, organisations as agents and their attendant behaviours.

Traditionally investment decisions are determined by using peer review, or investor knowledge, of the execution processes involved. Seldom does this process itself account for the number, type and criticality of events necessarily managed to achieve the financial outcome proposed, preferring to assume that the expertise to do so is constantly available. To account for all eventualities would require costly resources so the alternative is to choose from a variety of probable events and match expertise accordingly.

Managing this matching process in a dynamic environment introduces a level of complexity that generally emerges at critical points in the execution process. Without an organised and timely response these divert management focus with consequent effects on the strategic outcomes. W. Ross Ashby (Ashby 1956, Ashby 1960) and latterly Stafford Beer (Beer 1959, Beer 1966, Beer 1972) recognised the value of anticipating these eventualities the former by deriving the Law of Requisite Variety and the latter braiding this Law as a centre piece of the Viable System Model. Both understood that the timing element of financial outcomes and strategies are materially affected without an organised response to critical events. It is this relationship between time, financial outcomes and managing the variety of events that is the essential focus of this thesis.

Developing and using an ATPM depends on three main issues the: definition of financial outcomes; transcription of data; and nature of the models involved. Each have their own embedded complexity and the following literature review will explore these issues within the framework outlined above.

Chapter 2.1.1: Financial Dimension:

Given the above definition ATPMs can fall into simple and complex categories the former being the purchase of a bread-loaf and the latter a regulatory tax arbitrage[ii] (Sikka and Willmott 2010) where an intra-firm transaction may be required to take advantage of different jurisdictions tax regulations to benefit the consolidated profits (PWC 2015). The commonality of buyer-seller, strategic outcome and environmental factors pervades financial transactions as a whole but we would not currently label them ATPMs as the nearest conceptual framework, "transfer pricing methods", usually refers to tax or regulatory arbitrage within organisations (Tumasyan 2009, Sikka and Willmott 2010). However we could infer that the principles behind ATPMs have existed from the time Mankind started to barter and then create wealth (Smith 1991, Ekins and Max-Neef 1992, Nanda and Yun 1996, Smithers and Wright 2000, Beinhocker and Starbuck 2008).

Chapter 2.1.1.1: Price, Value and Expectation

Fundamentally ATPMs focus on the expectations of buyers and sellers for a specific proposals financial outcome. Here a common practical error of mistaking "price" for "value" (Goetzmann and Rouwenhorst 2005) (Beinhocker 2006) pervades practical finance. Where the expectation of the seller may be to gain the best outcome that in their mind would be the value put on the assets the market and/or individual investors may not share their view. In extremis, when markets fail, the value of an asset or firm can approach zero (Sorkin 2009) or indeed a negative market "price".

An outcome therefore depends upon perspective. The seller derives a "value" from an internal model based upon a close understanding of the processes and risks involved whereas the buyer, initially not sharing these, may set a "price" based upon a different understanding. The "understanding" that derives the "expected" "outcome" in each case will be shown to be an internal model of the "assets" environment particular to the buyer/seller. This model can be one: generally accepted within a market/industry; shared within the particular firm; and/or personal to the individual buyer/seller. Trying to reconcile, if possible, the different "expectations" has developed complex processes of which Klonowski (Klonowski 2007) is a good example and one that will form the basis of the "due diligence" process for a meta-model ATPM herein.

During the process of assessing the asset and its environment to derive an outcome the model will likely have to take account of other embedded model outcomes that depends upon the complexity of the asset and why Volcker came to criticise the financial industry post the 2008 Crisis. The embedded outcomes form a set of parameters upon which the overall model then derives its own result.

Chapter 2.1.1.2: ATPM Components

From the above we infer that ATPMs have evolved to encompass a set of embedded models themselves dependent upon market/individual definitions as to value or price depending upon the assets own complexity: For instance the previous example of purchasing a loaf of bread would seem initially simple compared to the acquisition of a nuclear power station. However though the former comprises a less complicated set of embedded assets and processes each share components such as:

1. Accounting conventions for asset valuation, taxation and/or regulatory cost;
2. Endogenous process risks relating to the products involved and/or outcome definition;
3. The organising principle (Keynes 1937);
4. Exogenous environmental dynamics, accounting and risks; and
5. The risks accompanying the product or business model - Model Risk.

For a financial institution (Mercer 1992) this is a complex and complicated (see Conceptual Framework) process where the varying assets and liabilities must first be assessed as to their current value (Holton 2003, Hubbard 2010, Rocco 2012) and then matched in an Asset/Liability Model ("ALM") before contingencies and capital reserves are calculated according to regulatory and accounting rules. In the 1980-1990's the competitive expansion of capital markets was so rapid that it is understandable certain institutions may not have had the time/expertise to meet Volcker's objective of governing the business prudently, rather relying on Bagehot's (Bagehot 1873) "lender of last resort and depending upon the taxpayer to rescue them (Sorkin 2009).

Chapter 2.1.1.2.1: Defining a Context

Cooper (Cooper 2014) and Pincus (Pincus 2009) illustrate the complex social and technological changes spawned by “the Glorious Revolution 1688”. ATPMs moved from a set of discrete concepts of trade to encompassing a reductionist, rationalistic and linear-cause approach. However Aristotle (Capra 1996) believed that without a cohesive framework the “Whole” could not be understood (#3).

How ATPMs evolved, and where they failed, is linked to society’s underlying reductionist perceptions of socio-economic systems; and also to the development of the separate disciplines required within ATPMs that took disparate paths. We’ll explore here a more systemic way of understanding ATPMs, but by reviewing them with modern network and agent behaviour theories, to deduce its complex causal structure.

Chapter 2.1.1.2.2: The Glorious Revolution, US Constitution, Enlightenment and 2008 Credit Crisis

Macaulay (Macaulay 1849) tells of a plot to limit the role of the monarchy, disinherit the Catholic Church and the Papacy from involvement in English affairs. Pincus (Pincus 2009) and Cooper(Cooper 2014) however remove the polite blinkers of Macaulay’s English focus and contextualise them with respect to continental and financial events between Holland, France and the Thirteen Colonies (later to become the United States in 1776).

Both Pincus and Cooper present a picture of a rapidly expanding economy with associated changes in wealth demographics. Tensions between the established governing paradigms and this new “elite” had reached a “tipping” point (Gladwell (Gladwell 2000)) but whilst James II ultimately failed he had successfully cultivated the social network of the day using considered but minimalist strategies that drew upon seemingly dormant anxieties within the populace that when harnessed allowed a bloodless coup.

The simple strategy of abolishing an “Absolutist State” but not “The State” was heavily influence by John Locke 1632-1704 (as were so many of the US Founders) and as

Cooper points out the strategy released the chains of consumerism that led from “an agrarian to a manufacturing society”.

It is the contention here that the rise of consumerism with its simple Asset Transfer Pricing Models (“ATPM”), coupled with a revolutionary form of governance structure, effectively allowed the emergence of a new form of relationship between the State and Society. Though the structure of governance between the U.K. and US Constitution may be different the emergent form of governance from the latter affected the development and role of ATPMs in Commerce.

The roots that led to the establishment of the US Constitution are not the focus here except for: the method by which a core group of individuals debated its creation; the particular contribution of Marshall and Hamilton; and the consequences of maintaining a systemic governance structure in a written form. These created governance that looked back upon itself, recursively, considering the boundaries of operation between the individual and society as well as those parameters that bind them.

Though largely Christian many were also Freemasons and though the latter may be indeed controversial the relative absence of dogma in Masonic philosophy (MacNulty 1991, MacNulty 2006) provided a platform, for some in England but many in the Thirteen Colonies, from which a system of social governance could be created and ultimately guide commercial development. Therefore it was not the theosophical aspects of Christianity or Freemasonry that emerged but the practical structure of balancing (McLaughlin and Davidson 1994) the individual and State objectives through the system of Rights and in the U.S. through a Federalist framework.

However the US Constitution’s Commerce Clause ((United States. 1982), Article 1, Section 8, Clause 3) heavily influenced ATPM development and relates not only to the individual’s right to trade but also the definition of, and how, the State may do likewise: The governance structure coordinates the whole.

Both Chan (Chan 2006) and McLaughlin (McLaughlin and Davidson 1994) reflect upon the influence of classical philosophers on the signatories of the constitution (Spinoza, Voltaire and Newton) but it was John Locke (Locke, Berkeley et al. 1910) that is common to both the English and US “revolutionaries” (Pincus 2009). The Romanticism balanced the emphasis of “reason” by developing the “imagination” and so both should be considered for their influence on ATPM development: one for the logical expression of discrete processes; and the other the intuitive, inductive development of “holistic models” (Kant, from an essay "Answering the Question: What Is Enlightenment?" (German: Beantwortung der Frage: Was ist Aufklärung? 1784)). However whilst Kant saw the liberation of the mind as the final stage of Man’s development Bertrand Russell (Russell 1946) considered it yet another emergent state of mind.

Pre-Enlightenment figures like Euler, Newton, von Leibniz significantly contributed to others fields and debated in the French Salons, English Coffee Houses, Debating Societies, Freemasonry Lodges across Europe and the Americas. One could argue that it was not only the protagonists that spawned the Enlightenment but the mediums that facilitated them: the meeting rooms, churches, synagogues, mosques, lodges and printing presses that provided ready materials.

Assuming the communication medium is important and natural forces of competitive commerce will arise one can see how natural inquiry could lead to improvements in industrial processes through innovation and the scientific method. These began to bear fruit not only in the discrete analysis of the physical forces and the mathematical processes that allowed their measurement but also in biological inquiry that developed a sense of the whole. For instance in France Charles Bernard (1813 – 1878)(Noble 2008) introduced “blind experiments” and the definition of “milieu interieur” (a precursor to homeostasis) that essentially founded system-biology that later Alexander Bogdanov would envelope with his study of social and physical sciences by using Ernst Haeckel’s (1834 – 1919) term “tectology or tektology” (Sacco, Gherardini et al. 2012)(from the Greek “tecton – to build”, to mean “building in general”) to become a precursor of “General System Theory” anticipating von

Newmann's "Universal constructor" (McMullin 2000) and the "universal assembler" in nanotechnology.

By the time James Mill (Mill 1821), David Ricardo (Ricardo 1817) and Jeremy Bentham (Bentham, Mill et al. 1935) (see (O'Brien 1975) history) were developing what was to become Classical Economics. Threadneedle Street, itself home of the Worshipful Company of Merchant Taylors since 1347, soon became a central commercial trading point not only for the Bank of England, the Royal Exchange (also traded in the coffee houses of, Jonathan's, Garraway's and Sweetings), shipping interests in the Baltic Exchange[iii] (originally founded in the "Virginia and Baltic Coffee House (1744)) and the South Sea Company (1711-1850).

Commerce was largely unregulated until the founding of the Bank of England arose from the prior poor management of the English Purse and to battle French maritime dominance. Similarly trading in stocks, dispersed into various coffee houses such as Sweetings, had invited fraud until the London Stock Exchange[iv] was established in 1801.

However The Bank of England's range of activities did not develop at once and though gold backed its value fraud was rife, trading occurred with no central accounting or sense of commercial rigour for stocks to support the growing innovations from scientific discovery and material design (notably rail, mining and wool/cotton industries[v] and advances in paper/steel production[vi]); this left even well respected banks like Overend and Gurney (Overend Gurney & Co. firm London., Howell et al. 1867, Elliott 2006) subject to rumour and failure.

Concurrent to the increasing commercial activity in the City of London with the "colonies" was fractured. Through Benjamin Franklin correspondence, Thomas Jefferson in Paris and John Adams in London, the embryonic Union resolved the "Virginia Plan" by James Madison (Chan 2006). From Chan we see it proposed proportional representation supported by: John Locke's philosophy of consent; Montesquieu's split government; and an emphasis on civil liberties found in the work of Edward Coke (Ryan 2005). Madison, as main architect of the constitution, was heavily influenced by Montesquieu's experiences in seeing: the birth of England's Constitutional Monarchy; Act of Union with Scotland (with whom France had had a long association); and the transition from a stable reign in Louis XIV to the 5-year old Louis XV and consequent social upheaval.

Along with Madison assistance Hamilton added the "Commerce Clause[vii]" (which he defended in a series of "Letters" – The Federalist Papers No. 11) that was described in Gonzales v. Raich, 545 U.S. 1 (2005) as follows (#5): "The Commerce Clause emerged as the "Framers'[viii]" response to the central problem giving rise to the Constitution itself: the absence of any federal commerce power under the Articles of Confederation". Chief Justice John Marshall further ruled in Gibbons v Ogdenix that:

> "*[T]he power of Congress does not stop at the jurisdictional lines of the several states. It would be a very useless power if it could not pass those lines*".

Thus US Constitutional Law defined commerce as an intercourse and as such the power to regulate its actions without and within the Union.

Heavily influenced by Enlightenment thinkers in politics, economics and philosophy the "Framers" of the US Constitution not only sought to define and measure commerce but also to define what it meant, "to regulate". More recently Noble (Noble 2006, Noble 2008, Noble 2010, Noble 2011) was to contrast Spinoza's 1663 Letter XV to Henry Oldenbergx, p. 291 and allegory of:

> *a "worm" living in the "blood" as we do on Earth unable to determine how the each and the whole adapt to one another metaphor about distinctions*

by quoting Bernard's (1854) central concept, the control of the internal environment:

> "*The living organism does not really exist in the milieu extérieur but in the liquid milieu intérieur ..... a complex organism should be looked upon as an assemblage of simple organisms ....that live in the liquid milieu intérieur."*

Noble also presented a paper challenging mathematicians to better understand how life works in "Biophysics and system biology" (Noble 2010) as follows:

> "*Evolutionary theory, in particular, will require re-assessment. To succeed in this, computational and systems biology will need to develop the theoretical framework required to deal with multilevel interactions*"

To arrive at his challenge the collective and iterative developments of the Enlightenment, the Romanticism, two (or more) Industrial Revolutions and two World Wars had created an understanding of regulatory functions and biological systems we saw from:

- Haeckel’s view (who in turn drew upon Lamarck and Darwin) that the social sciences were applications in applied biology which inferred society likewise followed “recapitulation theory” in that “ontogeny recapitulates phylogeny or the individual’s organism's biological development parallels and summarizes its species' evolutionary development (phylogeny)” that echoed Spinoza’s letter to Oldenburg, 1663; and
- Bacon’s inductive reasoning and Descartes algebraic geometry coupled with the work of Euler, Leibniz and Newton.

that formed a basis from which individualism, rationalism and relativity pervaded all forms of scientific and metaphysical enquiry.

Commercially the investment focus on “value” profited from these developments both from the rise of the scientific method and availability of printed views such as Mortimer’s “Every man his own Broker….” 1762 (Mortimer 1762) and illustrated by Goetzmann’s (Goetzmann and Rouwenhorst 2005) who chronicled the development of value and the capital markets.

By 1798 when the US Constitution was ratified the “Framers” had not only established a very modern (in 18th Century terms) governance structure including a definition of commerce and also debated the merits of the definition of “To Regulate” even though some clauses by Randolph never made it to the final document (Barnett & Johnson (Barnett 2001, Johnson 2004) see Barnett (Section M.2)).

If ATPMs are devices that enable commerce, and commerce needs regulating at its various levels for governance purposes, then the structure of ATPMs in general should benefit from the advances in the physical, biological, social aspect of the Complexity Sciences; and understanding how the structure of the US Constitution and the procedural approach of the UK Parliament have allowed these institutions to remain viable over the last 250-years should also provide insight into governing a more discrete transaction in ATPMs and their relationship with the whole.

(Jackson 2003) in his “Systems Thinking: Creative Holism for Managers” details the results of The Enlightenment’s many deductive/inductive philosophical processes and spawned the many views of systems theory so that they can be applied as models to organisation and management of commercial activities.

However as Korzybski (Korzybski and Keyser 1950) pointed out, “*The model is not the territory*” and believing the resultant model is in fact the “reality” is a mistake (Taleb 2007, Taleb 2007) one that has been made serially in science and commerce.

Post the Crash of 1929 Economic Models even though these were largely based upon supposition (Keen 2011); the need to ensure stability at a fundamental commercial level grew and with no dedicated science with which to refer commercial investment practitioners developed models and investment processes of their own (Graham and Meredith 1937, Graham 1949, Graham and Chatman 1996).

It was only post World War II when Anthony Stafford Beer (“Stafford Beer” or “Beer”) developed Management Cybernetics, using the research from the Macy Conferences and his own experience within United Steel, that a coherent and holistic model of commercial governance eventually emerged and grew into the Beer’s Viable System Model.

Chapter 2.1.1.2.3: ATPMs: Risk and Model

At first sight the functional objective of ATPMs is to make a decision on a commercial proposal, its associated operational territories, and strategic goal: in achieving the goal there is a dependency upon a variety of conditional outcomes, many inter-related. ATPMs aim not for “classical equilibrium” but for a commercial “steady state”.

Haldane’s (Haldane 2012) approach, like Arthur’s, was to criticise the basis upon which current commercial models are based choosing to highlight the use of “normality”, the “normal distribution”, and models such as Black-Scholes (Black and Scholes 1973) when employing them to value assets or portfolios of assets (Markowitz 1959). Both cite "real-life" evidence materially differs from the outcomes of current models and where Haldane's focus is the value of assets, or portfolios thereof, Arthur's is the performance of the components and the economy as a whole.

As Knight (Knight 1921) observed, and Bronk (Bronk 2009, Bronk 2010) extended, mathematical analysis is only useful if its models are derived from a proper interpretation of the patterns formed by the system in focus. Arthur (page 3) notes, "equilibrium was a shortcut " that facilitated this process. One could therefore summarise that the performance of a system depends upon: its structure (pattern); the proper definition of an agent; and behaviour and causal relationship of these agents.

In isolation ATPMs can be seen as a "financial mechanism with financial inputs" which strips them of the reason why they were initially instigated. Though indeed a financial mechanism to satisfy a commercial strategy (Arthur 2013), in setting the context for defining Complexity Economics, aptly describes why:

> *"economic agents (firms, consumers, investors) constantly change their actions and strategies in response to the outcome they mutually create. This further changes the outcome, which requires them to adjust afresh"((Arthur 2013), Abstract)*

By defining "*economic agents*" thus Arthur is at once inextricably embedding commercial strategies into "*agents*" and "*agents*" into a definition of an "*economy*". Arthur compounds the complexity of these commercial strategies by noting:

> "*Agents thus live in a world where their beliefs and strategies are constantly being "tested" for survival within an outcome or "ecology" these beliefs and strategies together create*" and
>
> "*These emerge probabilistically, last for some time and dissipate, and they correspond to complex structures in other fields*".

Introducing "*beliefs*" into the equation of commercial strategy allows the why ATPMs are created and how agents with different perspectives can employ them. By deduction this implies that certain elements of their composition may be questioned but the process in testing the outcomes of the strategies must be done through investigation – due diligence in accounting terms.

Having identified economic agents as firms, consumers, investors*,* Arthur introduces the "*recursive loop*" (page 4) and more importantly that early economics did not ask, "*how agents' behaviors would react to the aggregate patterns these created"* but *"what patterns would call for no changes in micro-behavior – or equilibrium"* (page 4).

In referring to Smith (Smith 1776) and recursiveness Arthur omits a clearer example in Mandeville (Mandeville 1723) whose satire articulates the differing objectives between individual agents and that of the collective. Arthur is defining "Complexity Economics" and in doing so comparing it to "Classical Economics" (O'Brien (O'Brien and O'Brien 2004)) with its focus on a contrived "economic equilibrium" or "financial steady-state". He points out this ignores reality with its dynamic and seemingly uncorrelated outcomes and that "CE equilibrium leaves no room for *"adaptation, innovation, structural change, history itself—must be bypassed or dropped from theory*" (Arthur 2013), as:

"*it lives in a Platonic world of order, stasis and knowables*"

he portrays Smith in Classical Economic terms not shared by Desai (Desai 2015). From Beinhocker and Arthur we can compare the milieus in which ATPMs developed:

Table 1: Comparison between Classical & Complexity Economics

	Classical Economics	Complexity Economics
Dynamic	Closed, static, linear systems in equilibrium	Open, dynamic, non-linear systems, far from equilibrium
Agents	Modelled collectively; use complex deductive calculations to make decisions; have complete information; make no errors and have no biases; have no need for learning or adaptation (are already perfect), mostly homogeneous agents	Modelled individually; use inductive rules of thumb to make decisions; have incomplete information; are subject to errors and biases; learn to adapt over time; heterogeneous agents
Networks	Assume agents only interact indirectly through market mechanisms (e.g. auctions)	Explicitly model bi-lateral interactions between individual agents; networks of relationships change over time
Emergence	Micro-and macroeconomics remain separate disciplines	No distinction between micro/macro economics; macro patterns are emergent result of micro level behaviours and interactions.
Evolution	No mechanism for endogenously creating novelty, or growth in order and complexity	The evolutionary process of differentiation, selection and amplification provides the system with novelty and is responsible for its growth in order and complexity
Technology	Technology as given or selected on economic basis	Technology fluid, endogenous to the system
Preferences	Preferences given; Individuals selfish	Formulation of preferences becomes central; individuals not necessarily selfish
Origins from Physical Sciences	Based on 19th-century physics (equilibrium, stability, deterministic dynamics)	Based on Biology (structure, pattern, self-organized, life cycle), See Complexity Economics by W Brian Arthur
Elements	Price and Quantity	Patterns and Possibilities

Sources: Beinhocker(Beinhocker 2007) & Arthur(Arthur 2013)

Chapter 2.1.1.3: ATPMs: A Developing model and the 2008 Crisis

The critics of the 2008 Credit Crisis severely criticised ATPMs for the false asset prices and financial products that resulted in a volatile economy. However ATPMs are just models of a reality and though executed at increasingly alarming speed are only as good as the assumptions many of which are derived from the Enlightenment's reductionist approach and, as we see from Haldane, Beinhocker and Arthur, are themselves functionally flawed or incomplete. From Jankensgard (Jankensgård 2008) we saw some of the traditional metrics used:

Table 2: Jankensgard Risk Measures

Risk measure / Framework	Concept	Comments
Standard deviation	Measures the degree of dispersion around the mean	• Symmetric perception of risk • Relies on normal distribution
Cash Flow at Risk	Measures the maximum loss associated with a certain statistical confidence level	• Asymmetric, i.e. treats losses different than gains • Based on operating cash flow
Lower Partial Moments	Measures risk as the deviations below a target level penalized by a risk aversion coefficient a	• Adopts easily to varying levels of risk aversion • Makes no explicit reference to debt capacity
Conditional Lower Partial Moments	Makes reference to a second probability distribution to separate risky from non-risky shortfalls	• Incorporates information on debt capacity

Source: Jankensgard: Cash Flow at Risk and Debt Capacity(Jankensgård 2008)

However from Rogoff (Reinhart and Rogoff 2009) we now see that the economy has always been volatile. If "equilibrium" is wrong and "steady state" more appropriate should we not investigate the types of models that understand these processes like systems biology and organisational cybernetics and enquire whether they are more appropriate to this commercial "eco-system"?

One of the first individuals to systematically investigate how the organisation of a "firm" affected its performance was A. Stafford Beer who, in 1957 who wrote a report for United Steel (Beer 1957) his teams work in Operational Research and Cybernetics within which he quickly contextualises the need for and role of control systems. His contribution and its relevance for ATPMs are presented later in this and next chapter.

Chapter 2.1.1.4: Definition of an Asset and ATPMs – Current

ATPMs are models of systems that in turn possess a functional or purposive role therefore we can define ATPM as a reflection of those systems in a general way and more specifically as an exchange of resources between one system and another (PWC 2015).

The "assets" can be tangible and/or intangible in nature but which to the other party in the transaction may be prized: tangible in the form of property; or intangible in the ability to work or intellectual property in the form of patents (Stewart (Stewart 1997)).

Solerno (Rothbard and Rothbard 2004, Introduction) informs us of Menger (Menger, Dingwall et al. 1981), Mises(Von Mises and Greaves 2007, Von Mises and Greaves 2007, Von Mises 2009) and latterly Hayek's (Hayek and Shenoy 1979) rigorous approach to economic analysis. However Menger and von Mises emerge from the late 19th into the early 20th Century at a time when the Industrial Revolution had already laid the foundations of the British Empire and the United States itself was developing a taste for expansion (Chan 2006). Menger's deductive approach focused on a practical "humanist" approach, "*All things are subject to the law of cause and effect,*" and "*This great principle knows no exception*" Menger (Menger, Dingwall et al. 1981, p51), as articulated in his opening statements. However we see from Rothbard(Rothbard and Rothbard 2004) that not only did Menger, von Mises and Hayek fall short in identifying the exact causal relationship but that even Rothbard's analysis was shown to be groundless by Keen (Keen 2011), a great proponent of Minsky (Minsky 1986, Minsky 1999).

The issue here is that Political Economists who created their own set of boundaries were not generally empirically based (Ricardo 1817, Marx, Moore et al. 1887, Jevons

1888, Keynes 1937, Walras 2010) as pointed out by Solerno[xi] on Rothbard and Keen (Keen 2011).

From Parlour on Credit Risk Transfer we can see how the values set and their measurement interact (Walras(Parlour and Plantin 2005)): (#10)

> *"Although the rise of a liquid CRT market is socially efficient ex post, it may not be socially desirable* ex ante. *Because the bank values liquid assets, its capital is more expensive than bond financing. Thus, in the firm's optimal contract, the bank's stake is the minimum one that preserves an incentive to monitor. However, once monitoring has taken place, bank capital is no longer "special," and thus the firm is indifferent as to the source of the financing. At this point it is socially efficient for the bank to sell its loan or transfer credit risk and recycle its capital"*

Here Parlour is identifying the relationships between buyers of credit products being influenced by a nested set of boundaries and values. The boundaries being the internal and external boundaries of the bank, the investors and the permittivity of data within these and the "market" as a whole.

Parlour, like Arthur (Arthur 2013), Mandeville (Mandeville 1723), Ormerod(Ormerod 1999), Minsky (Minsky 1999), Durlauf (Durlauf 1997) Keen(Keen 2011) and (Desai 2015), show that the parameters of broader systems do not necessarily follow those of the underlying, whilst the processes may be simpler the variables are different. This is critically important when assessing how different values are derived across system boundaries and why Classical Economics has competing strategies such as Complexity Economics (Arthur(Arthur 2013).

Chapter 2.1.1.5: ATPM: Defining Counter-parties

The next step is to define the counter-parties and the type of risks that surround them. From the above we saw that defining the parameters surrounding the risks involved is non-trivial as the causal framework is generally opaque. Gregory ((Gregory and Gregory 2012) Page 9) puts Counter-parties in its proper context by showing that a proper definition is the relationship between two or more parties in a transaction and not solely on a restricted relationship of derivative trading. His illustration is the demise of Lehman Brothers and the default of institutions like Bear Stearns, Fannie Mae and Freddie Mac in the 2008 Credit Crisis who were considered in “Too Big to Fail”(Sorkin 2009). By contrast PWC (PWC 2015) illustrates a more formal accounting approach to their definition. On page 10 Gregory identifies the core issue of just identifying Counter-party Risk by showing it is only manifest as a combination of credit risk with other risk types as described below:

- *Market risk;*
- *Operational risk;*
- *Liquidity risk; and*
- *Systemic risk.*

However, as we’ve seen above, the influence pattern is not a straightforward set of parties but a nested, or recursive, structure. This not only presents a problem when trying to determine the degree of influence certain parameters may have but is also compounded by any chain of ownership.

In the capital markets the underlying cross-dependency exhibited above can be illustrated by “(re)hypothecation” (Huertas et al(Huertas 2009, Calomiris and Herring 2011, Huertas 2011)) and/or (Gerathewohl et al“(re)insurance” (Werner 1964, Beard, Pentikäinen et al. 1969, Carter 1979, Gerathewohl 1980, Strain and College of Insurance (New York N.Y.) 1980, Stanard and Wacek , Banks 2005, Wuthrich 2011)), the former generally found in the equity/debt capital markets and the latter the derivatives/insurance markets.

How two or more parties exchange obligations to perform a particular strategy determines the uncertainties and risks they undertake. The price of assets and liabilities risks are procedurally driven by certain model processes (Asset/Liability Management Models) determined by qualitative and/or quantitative methods and offset to achieve the strategic financial outcome.

How we price risks therefore depends upon the endogenous/exogenous risks attendant to the processes embedded within the strategy at hand, contractual obligations, conditions and regulatory assumptions imposed. This process is applied to both assets and liabilities the value of the strategy being derived as a steady state between both and expressed as a relationship to the initial asset value.

Chapter 2.1.1.5.1: ATPMs - Acquiring Assets: A Process

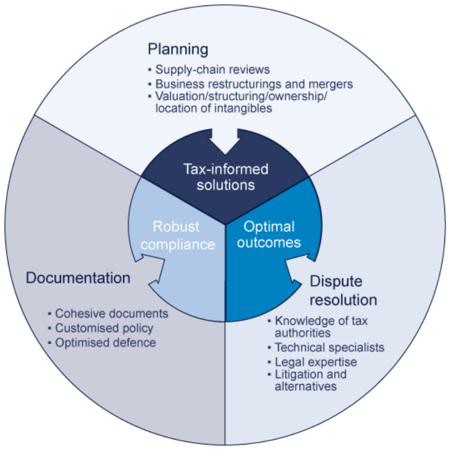


Figure 3: McKinsey on Transfer Pricing

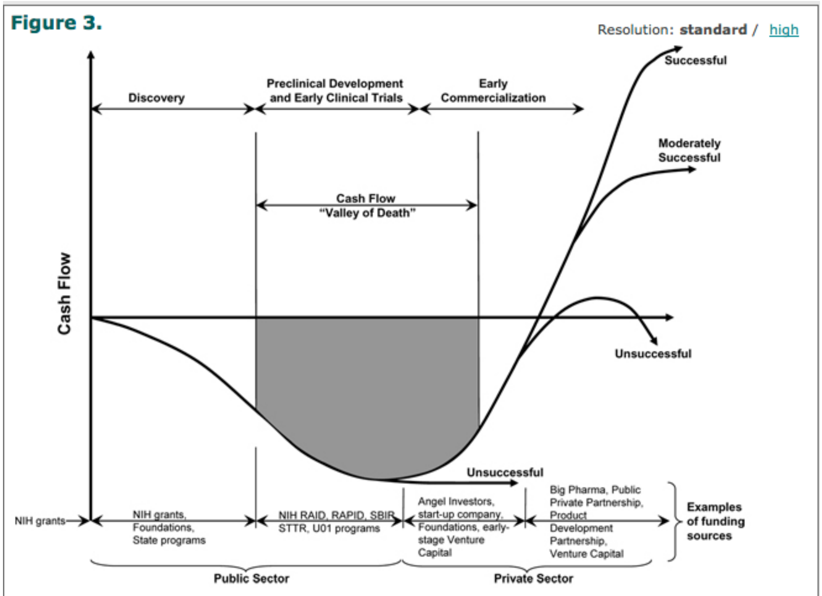
ATPMs are not simply about pricing then acquiring assets. Each element of the above is "in addition" to the standard pricing formulae that one must establish for the type of asset being identified and at each stage of a project's development there is a different type of asset that is generally accepted as suitable to finance the risks taken (see Figure 4-Author Unknown).

Business Development and Appropriate Funding Sources

Business Stage	Applied Research	Demonstration	Pre-Commercial	Early Markets	Growth Markets
Activities	Technology creation Proof of concept Team building	Prototype performance data Early market engagement	First customers/partners Product development	Grow customer base Licenses agreements Products sales	Established market Develop product portfolio
Type of finance	'Soft' funding	'Soft' funding Equity finance	Equity finance	Equity finance Debt finance	Equity finance Debt finance
Typical source of funding	**Grants R&D tax credits (Friends & Family)**	**Grants Angel investors Seed funds**	**Angel investors Seed funds Venture capital Corporate investors**	**Venture capital Corporate investors Loans**	**Venture capital Loans**
Typical sum raised	Less than £200k	£200k-£1m	£1-3m	£3-5m	£5m+
Years to exit	8-10 years	5-7 years	3-5 years	2-3 years	Less than 2 years

Figure 4: Business Development Funding - Asset Type

Failure to correctly assess the cash flow needs and its type at any of these points would not necessarily end in failure of the project depending upon whether available assets could become available. The cost to the original investors however would be great as Steinmetz (Steinmetz and Spack 2009) discusses in the development of neurological drugs and show the impact on cash flows as follows:



Cash flow 'Valley of Death' diagram. The cash flow 'Valley of Death' as a function of development stage (time) with typical funding sources at various stages (adapted from [12]). RAID, Rapid Access to Interventional Development; SBIR, Small Business Innovative Research; RAPID, Rapid Access to Preventive Intervention Development; STTR, Small Business Technology Transfer.

Steinmetz and Spack *BMC Neurology* 2009 **9**(Suppl 1):S2 doi:10.1186/1471-2377-9-S1-S2

Figure 5: Steinmetz Cash Flow - Valley of Death

Drug development is considered one of the more hazardous investment processes but extremely rewarding if executed correctly, from Klonowski (Klonowski 2007), figure 6, we can see a representation of the various stages and will be discussed in the Conceptual Framework chapter.

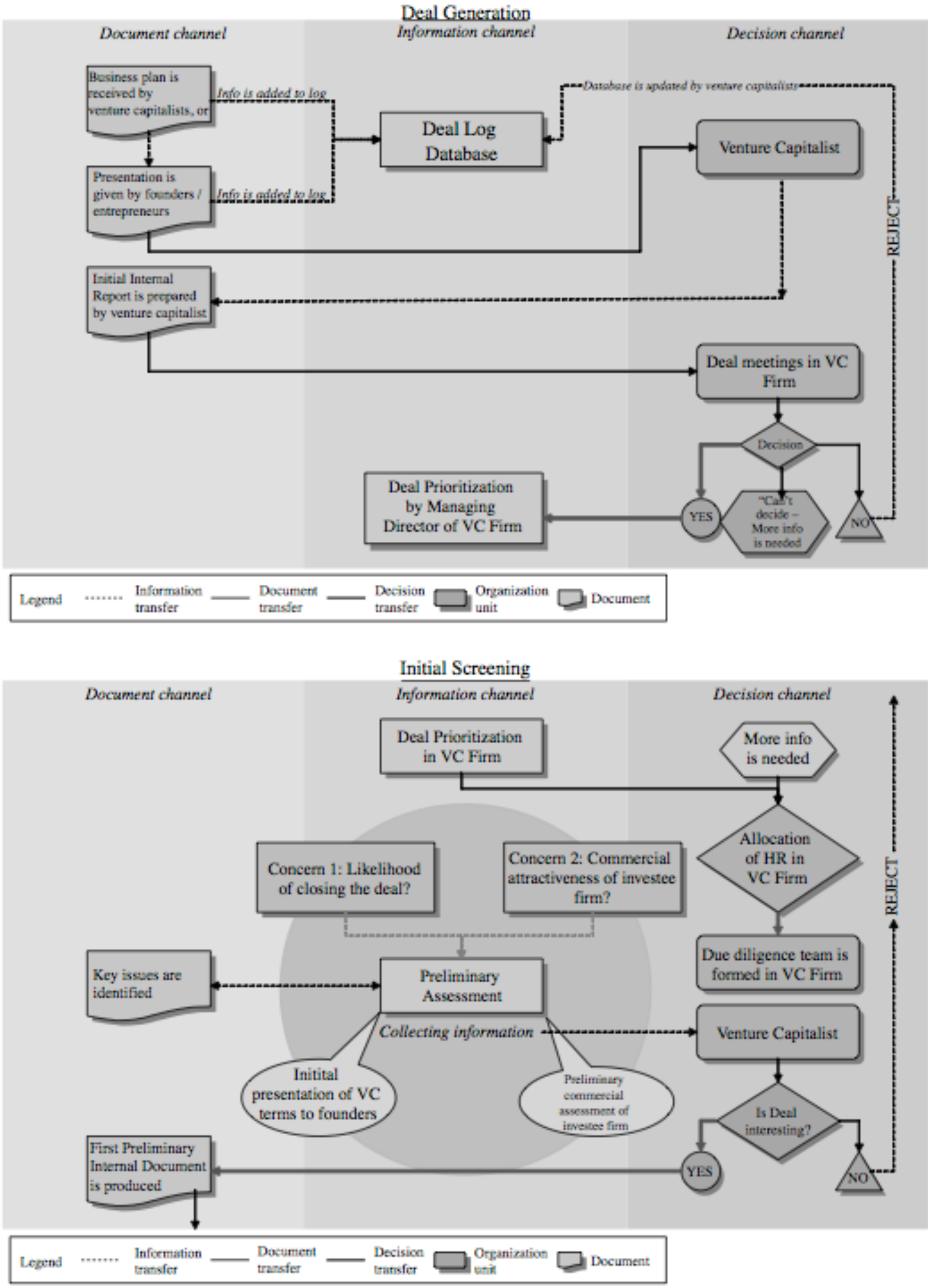


Figure 6: Initial Stages of Venture Capital Investment Process – Klonowski

Klonowski details much within the paper and it would be assumed that, after researching the exogenous and endogenous risks, along with probabilistic weighting, the due diligence would create a model balance sheet and accounts to estimate the performance of the plan.

Klonowski omitted the analysis of management structure however this is to be expected, as the research parameters did not include any systemic authors.

Chapter 2.1.1.5.2: When is an investment “Complete”?

It has been argued that the investment business is a “game” and as such would meet similar rules as Turing’s “Halting Method” where the processes take the place of the instructions Turing outlined: A halting process would not necessarily be bad if the results were a long enough time, and real rewards gained.

Arbitrarily though Klonowski points out that “exit” of the investment is synonymous with the “halting point” but this leaves the investor with the problem of what investment should be made or strategy pursued.

Chapter 2.1.1.5.3: Making Distinctions: The Firm, Market and ATPMs

George Spencer-Brown(Spencer-Brown 1972) is respected for designing a different form of calculus – The Laws of Form – and its first major statement is that we all make “distinctions” and that is how we view the Universe. Once accepted the process becomes quite straight forward and we start to compare each and the whole. Klonowski is effectively repeating the process but without the calculus.

Starting with Adam Smith(Smith 1776), though the concept precedes him, political economy started to develop the distinction between individual investor and “The Firm”, the former seemingly straightforward but the latter greatly debate in political economics since Smith as to its existence, boundaries, structure, strategies and evidence/metrics to prove its existence.

Shubik(Shubik and Smith 2009) adds Walras, Jevons, Arrow and Debreu to the list, the latter two developing general equilibrium theory in order to define a quantitative science they “*sought to define optimal resource allocations and exchange rates (prices), starting from assumed regularities in people’s preferences for one consumption profile relative to another*”(page 1). Shubik must make distinctions in order to use his approach and assume time exists in which to compare outcomes. He is identifying "econophysics[xii]" – a broad range of disciplines applied to economics – used as a proxy for prediction instead of neoclassical economic which fails just as easily when trying to search for emergent behaviour. (#14)

However in assuming that by only "*enlarging the sets of strategic possibilities available to agents*" and not allowing institutions to "foreclose" they are omitting work started by Simon (Simon 1979) where even there "bounded rationality" was shown limited and the behaviour of a firm relating its environment dynamic, not suitable for static aggregate equilibrium economics (Classical Economic Theory). At least Simon allowed the "agents" to change their environment freely, closing down strategies as new are made, or as Coase put it "*realistic in that it corresponds to what is meant by a firm in the real world*".

A different approach to Shubik, who predicates the roles of institutions to be stabilising forces, is given by Caccioli (Caccioli 2009, Caccioli and Marsili 2010) who focuses on the role of Arbitrage Pricing Theory (S Ross 1976(Ross 1976)) and the variety of financial instruments in the market as a guide to stability. His conclusion, in Beer's terms, is that external variety exceeds the internal ability to manage it (#15).

Sir Robert May was not only a party to the 1972 Nature article[xiii] but to another published with Andy Haldane, citing Caccioli in 2011(Haldane and May 2011) post the 2008 Credit Crisis wherein the emergence of instability from diverse instruments was discussed; Caccioli observes (#16): "*as no-arbitrage, perfect competition, market efficiency or completeness arise as emergent properties of the aggregate behavior, rather than being postulated from the outset.*"

Each is making distinctions about agents, firms as agents and markets as agents but with different strategies applied to each. However they are all placed on a two-dimensional topology upon which they are asked to act out their strategies. However May notes in his 1972 article, as does Beer in 1967, that Ashby clearly stated complex systems have inherent instability and we know that von Bertalanffy(Bertalanffy 1973) decried "*equifinal*" results for closed systems.

One of the main distinctions that none of the authors note is that the assets at the primary level of the economy are changing, indeed an ATPM's goal is to change one asset into another in either type or size. Equally the businesses invested constantly change shape and direction therefore distinctions used in a fixed theory would be prone to breakdown as new natural phenomena emerge.

Chapter 2.1.1.6: The Meaning of Value

Rostrow (Rostow 1990) reminds us of Keynes dictum (Keynes 1937, page 150):

> "*Students of economic growth concerned with its foundation in human motivation should never forget Keynes victim: 'if human nature felt no temptation to take a chance no satisfaction (profit apart) in constructing a factory, railway, mine of a farm, there might not be much investment merely as a result of cold calculation'*"

Keynes is saying that "cold calculation", the quantitative assessment of all material factor alone, cannot justify human actions and by conclusion that humans must see "value" in qualitative aspects of an enterprise in which "risk" is taken.

Rothbard (Rothbard 1995) shows us the development of economics[xiv] is a road from the Talmud, past the Greeks (Hesiod) to the Classicists: Hutcheson (Hutcheson 1747), Smith (Smith 1776, Smith and Haakonssen 2002), Ricardo (Ricardo 1817), the Mill's (Mill 1824) to Keen(Keen 2011). Rostrow(Rostow 1990) then takes Rothbard on an accelerated development as the Enlightenment's economic development "compounds (Rostow 1990, page 1)"

From Langholm (Langholm 1979) we can discern the following:

- Value or "just price" was shaped by the Romans and canon lawyers, the latter not creating an abstract theory preferring practical application.

- From the mid 13th century onwards, following Aristotle's Ethics translation his concept of Reciprocity, embodied in a quasi-mathematical model, proposed that 'exchange' could not take place without equalizing the 'value' of the goods exchanged. He considered money only as an artificial measure.

- It was Albert the Great (1280) that introduced labour and expenses but not labour-time/labour quantity though Aquinas (1274) reemphasising the Aristotelian " human want".

- Through this period the roman and Greek factors of labour and expenses to justify market price had always been present and it was these commentators that contributed to the construction of a theory of economic value thereby supporting Schumpeter's contention that scholastics was important in modern economic theories.

Debates on the value of money and utility have therefore occurred throughout the ages but identifying the components and understanding how the causal framework operated is recent development and still vaguely understood.

Nested within the processes of ATPMs are the concepts of Price and Value, which are not necessarily the same thing, that have exercised economists over the ages and their measure sometimes the source of great debate and false models.

One of the better contemporary reviews of the mid 20th-Century was Myrdal's "Political Elements in the Development of Economic Theory" (Myrdal 1990) and chosen here because it was written at a time of change in global politics, just after World War II and before the economic developments of the 1970's.

Myrdal addresses the derivation of utility and value in classical economics talking about Bentham's (Bentham 1823) distinguishing between real and fictitious entities, "rights, "obligations", "duty" are all fictitious in as much that the reality is choice but one where ignorance or deliberate avoidance will cause *pleasure* or *pain*. Yet Myrdal notes "utilitarianism" claims an "*objectivity*" to a moral philosophy like "natural-law" with "rights" and "duties" that create a political arithmetic by which strategy could be objectively determined. Though political philosophy moved away from such stringent views, as Myrdal notes on page 27, he, and his descendants, still held to a sense of *a priori* “natural-law” with its foundations in Roman jurisprudence and to Stoic/Epicurean philosophy that itself had “pre-Platonic though… that occasionally contains allusions to objective laws, held to be both necessary and rational, both natural and divine”(Myrdal 1990) page 29.

Chapter 2.1.1.7: Accounting and Risk

Chapter 2.1.1.7.1: Accounting

Alexander (Alexander 2002) gives a good history of Accounting as a profession not only from Pacioli’s modern construction but also from Mesopotamia in 3,500 B.C. to the present day.

With respect to financial accounts many changes have occurred in the last 50-years spearhead by regulatory reaction to: fraud such as the Kenilworth (Allen 1982); the introduction of banking regulation (Chorafas 2007, Blundell-Wignall and Atkinson 2010, Georg 2011, Settlements. 2015); and changes to how standard valuation for assets and liabilities were viewed (Financial Accounting Standards Board. 1985, Coase 1990, Lukka 1990, Biondi 2005, Gaffikin 2007, Jonas, Moehrle et al. 2010, Lukka 2010, Merchant 2010, Eve and Baker 2011, Ernst 2012, Irwin 2012, Moehrle, Jonas et al. 2012) through to the issue of IAS39 (IFRSBox 2015).

This is a complex and complicated field of activity led by an ever changing group of agencies such as the International Accounting Standards Board (“IASB”), the Federal Reserve Board/Securities and Exchange Commission (“SEC”) and the Bank of England to name a few. However whilst it is necessary to use the changing models these agencies create in an ATPM’s approach it is not the focus of this thesis, rather it is how they are implemented within a systemic model and what that model should be of interest.

Though now becoming a global set of standards they were not always so and commerce took advantage of a different set of rules to arbitrage for financial gain

(Goodhart 1985, Goodhart 1988). As a member of the London School of Economics Charles Goodhart has been influential in guiding the U.K. in its regulation formats possibly an architect in change U.K. regulation from a rules-based system to principles-based. The debate as to “rules-based” versus “principles-based” governance will continue until it is clear that Goodharts Law, a variation of Gödel’s Incompleteness Theorem, describes a continuing commercial reality that “rules” will be arbitraged for financial gain.

Chapter 2.1.1.7.2: Risk

ATPMs, in an attempt to reconcile a commercial proposal with the internal model of the investor, therefore deals with a variety of risks, events and their uncertainties. Frank Knight (and Langlois as reviewer) (Knight 1921, Langlois and Cosgel 1993, Knight 2012) eloquently reviewed the issue of the study in economics:

> “*as studies of perfect competition when none exist and universal laws drawn from a few premises*”.

Many have referred to Knight’s “Risk Uncertainty” post Credit Crisis, Guy Debelle of Australian Central Bank (Debelle 2014) and Andrew Haldane of the Bank of England(Haldane and Nelson 2012), but it was Haldane that put Knight’s thoughts in a historical perspective linking Knight’s (page 6) reflection on Mill’s need for reason and induction (Mill 1826):

> *“collate conclusions with fact, induction on the “too complex” and empirical laws deductively connected to general principles”*

Haldane takes us through “A Short History of Normality” (page 3) from Bernoulli’s “reversion to the mean” (1713), then Gauss, Laplace (1810), Galton (1877) on the “Normal Curve”, to Knight himself and the models of Markowitz (1952) and Arrow/Debreu (1954). This timeline begins to illustrate just how influential the Enlightenment had become in the formulation of modern ideas and models, especially their persistency in the face of economic adversity with little empirical support.

Chapter 2.1.1.7.3: Knightian Uncertainty

Post the 2008 Credit Crisis Knight (Knight 1921) has been quoted by a range of senior regulatory authorities such as the Bank of England, Royal Bank of Australia and the

Federal Reserve Bank of New York (see (Nakano and White 2006, England 2009, Kharroubi and Vidon 2009, Pritsker 2009, Turner 2009, Bronk 2010, Lopomo, Rigotti et al. 2011, Haldane and Nelson 2012, Anderson, Chappell et al. 2013, Blume, Easley et al. 2013, England 2013, Debelle 2014)) but Langlois and Cosgel 1993 (Langlois and Cosgel 1993) paper deserves mention as it highlights in its debate the contribution of his and Coase's work on defining the Firm as well as Knight's definition of "Uncertainty" as follows:

> *"We [Knight] shall accordingly restrict the term "uncertainty" to cases of the non-quantitive type. It is "true" uncertainty, and not risk, as has been argues, which forms the basis of a valid theory of profit and accounts for the divergence between actual and theoretical competition."*

When viewed from a Cybernetics perspective Langlois's paper is quite interesting but his conclusion, as follows, do not reflect this:

> *(1) Knight's distinction between risk and uncertainty is not solely a distinction between insurable and uninsurable risk;*
>
> *(2) Knight's explanation for the existence of firms does not reduce to a moral-hazard theory, except perhaps in the broadest and least-interesting sense; and*
>
> *(3) Knight's treatment of the problem of the separation of ownership from control is not as obviously wrong as commentators have made it out to be.*

Clearly from Knight's own definition anything that cannot be quantified is therefore "Uncertain" and lays at the outer most reaches of the risk spectrum when considered as insurance, but it is wrong to assume that all risk is insurance for that term has its own restrictions as to pricing as seen above. Knight reinforces the "*measurable-risk*" and "*unmeasurable –uncertainty*" throughout his book but he also makes it clear that the assumption of a static, perfectly formed economy (whether at a Firm Level or wider) is wrong and that everything is dynamic (see I.II.17-20) and therefore probabilistic. Langlois compares this to a very "Whig" interpretation by others; a criticism levelled by Pincus (Pincus 2009) on the MacCauley (Macaulay 1856) treatment of the English 1668 Revolution.

Langlois helpfully points out the consistent differentiation Knight makes between the "biological" and "mechanistic" treatment of the firm, again referencing the probabilistic and deterministic nature of these artefacts. Langois emphasises that, to understand Knight, one needs to "*understand the role of judgement in economic life*" by which he is referring not only to the Economy in general but the commercial activities of Firms.

Curiously Langlois does not introduce the issue of the observer in judgement making which would have been interesting because in 1993 Shannon's, Pask, von Foerster and Bohm's work had already been available. Had he done so perhaps another aspect would have arisen along the lines of information theory. However he does focus on the issue of competition (Page 4 & p 199) where Knight infers that equilibrium is not a required strategy because one has first to know which alternatives are possible hence: "*recognition of these two separate exercises of judgment, the formation of an estimate and the estimation of its value. We must, therefore, disagree with Professor Irving Fisher's contention that there is only one estimate, the subjective feeling of probability itself*"((Knight 1921), p.227).

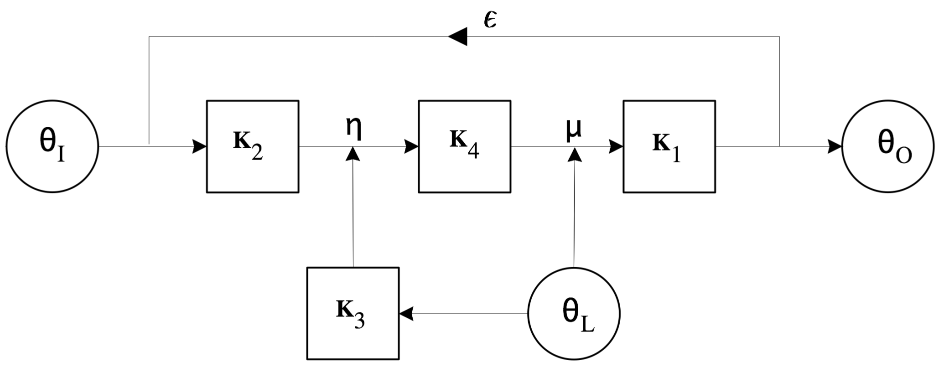
Langlois tackles "organisation" in Knightian terms and unlike the literature post Coase that focused on "*moral hazard and asymmetric information*" and "*the incomplete-contract theory of integration*" concluded that it is "*not insuring*" but that "*some agents receive a residual right and other a fixed claim*"[xv]. That knowledge and judgment is not contractible means that markets as a divisor of labour, rather than firm, is mistaken which leaves "responsibility and control" as an issue that Knight says cannot be separated.

Langlois resolves Knight's view as:

> *"The guarantors (shareholders) and the hired manager thus share the entrepreneurial function. Both have responsibility and control (as these cannot be contractually separated), but only one has the guaranteeing function (which can be contractually separated from other aspects of entrepreneurship)"*

In short that the act of residual claim, in whatever fashion, means that both the stockholder and the salaried managers have more "*guaranteeing responsibility*" (required control) than thought.

For one party if Uncertainty is the primary driver and Risk a relative value to the transaction then there is a feedback process that determines what level of reward can be charged. This has a boundary that, if it exceeds a certain level, the parties must determine a change in strategy. Conceptually this is the same process at work in any financial conversation so we could depict it using Beer's (Beer 1959) servomechanism diagram as follows:



Where:

θ_I Raw material *I*nput

θ_O Material *O*utput

θ_L *L*oad from order arrivals

K_1 Flow rate modifier - Load to Production

K_2 Flow rate modifier - Error to Planned

K_3 Flow rate modifier - Load to Planned

K_4 Flow rate modifier - Actual to Planned

ϵ *E*rror function: Diff. between Input/Output

η *I*nput *O*utput - Planned Rate

μ *I*nput *O*utput - Actual Rate

Figure 7: Cybernetics & Management 1967 Simplified Servo-Mechanism aka Simon

Chapter 2.1.1.7.4: Determining Comparative Value

"What matters about measurement is the ability of a metric to generate comparative data, given that certain conventions apply" (Stafford Beer (Beer 1966) p495).

Assessing comparative value for an investor has become a static singular event based upon out-of-date data. If the project is quoted on an exchange with ready markets trading occurs on a barter basis but there is various definitions of what is meant by Risks and Uncertainty leading to confusion in language.

Therefore value, of any sort, if it is quantitatively assessed must take especial care on the time frames that are used. Moreover all strategies are dynamic with respect to the parameters of the systems in which they are embedded. When taken together these considerations hint that structure of the project and its processes have more effect on the outcome than current valuation methods allow.

Chapter 2.1.1.7.5: Failings in 2008 Credit Crisis

Chief Executives may be focused on achieving annual profit targets will be biased towards the 'possibilities' of profit and not to the 'probabilities' of downside. The 'it can't possibly happen twice' is a blindness endemic in businesses where managers do not know the full extent of the risks and system they inhabit, especially one that exists in arguably the longest running inflationary period in modern history.

So McKinsey may be right in correcting the strategy and risk management of banks but it is all being done within a framework that is incomplete in at least one area, it does not monitor the contextual activity of the bank and how its business affects it.

One of the most pernicious aspects of the 2008 Credit Crisis was the use of "leverage" in financial transaction, whether in mortgages at a personal level or hedge-fund trading Lack(Lack 2012). We see in Sorkin, Bookstaber and Huertas the impact of both a lack of regulatory guidance and the inability to properly measure the underlying activities: e.g. '*the loss distribution cannot be known a priori with certainty*' (Tully 2010), p.133) but what can be done is to understand the prediction horizon in any system and build a heuristic model to manage performance within it.

Chapter 2.1.1.7.6: Leverage and leverage ratios

Leverage is derived from lever (from French lever, "to raise", c.f. a levant) and we are familiar when it is used in its physical form as a rigid object used with an appropriate fulcrum or pivot point to multiply the mechanical force (effort) that can be applied to another object (load): we are lifting a heavier load than we could normally. In finance, leverage is a general term for any technique to multiply gains and losses. For instance[xvi]:

- A public corporation may leverage its equity by borrowing money. The more it borrows the less equity capital it needs so any profits or losses are shared among a smaller base and are proportionately larger as a result;

- A business entity can leverage its revenue by buying fixed assets. This will increase the proportion of fixed, as opposed to variable, costs, meaning that a change in revenue will result in a larger change in operating income; and
- Hedge funds often leverage their assets by using derivatives. A fund might get any gains or losses on $20 million worth of crude oil by posting $1 million of cash as margin.

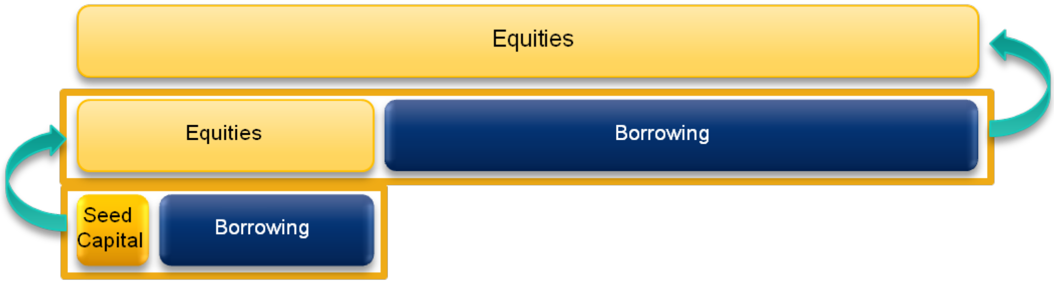


Figure 8: An illustration of financial leverage

The method to achieve financial leverage, whether on the asset or liability side, is essentially the same: there needs to be a feedback loop between the current and the next step in a process. If successive levels of feedback amplify this across several layers of economic recursion it can be catastrophic.

From Tully (Tully 2010) we are reminded that excessive leverage is not new in modern society, by which we refer to post 1800's. Starting with Galbraith's Great Crash (Galbraith 1955) and then Bookstaber (Bookstaber 2007) on the 1987 crash we can see that the successive application of a simple process of borrowing to invest in equities compounds the returns to initial investors. It is only when this compounding process reaches a tipping point as a percentage of the global economy that its requirement to exact returns by periodically liquidation becomes catastrophically dangerous.

Rogoff showed the volatility of the capital markets and that 1974 onwards was an inflating market that had run rampant; changes in capital and economic policy fuelled feedback loops that further expanded it across time frames enveloping generations of traders: It seemed impossible not to make money (Taleb 2007). Yield, whether crystallised or not, seemed to be magically made from thin air. In effect we are back to 'robbing Peter to pay Paul' or investors were taking equity risk at debt prices.

Both Tully (Tully 2010) and the OECD paper (OECD and Atkinson) extensively list the mistakes and oversights by the BIS that actually brought about the 2008 Credit Crisis . The OECD ((OECD and Atkinson), p.15) focuses upon the next mistake on using leverage as a backstop of capital whereas Tully presents the See-Through-Leverage index as a method of readjusting pricing, probability and loss default amount for all securitised products including historic portfolios. The latter is useful as a pathway to re-pricing risk but does not address the core issue: how the economy is coupled across the network. Recursive networks are about more than just correlation: It is asset activity in a portfolio.

Rating agencies and securitisation experts look at assets in a two-dimensional fashion, their correlations rarely looked beyond the manner in which assets respective industries are co-dependent on resources. Looking beyond asset comparison and into coupling at the next level of recursion would derive second order terms that are more useful in gauging network stability which, looking into the asset's management structure, would highlight resilience factors in crises. This is an aspect of asset organisation, (re) hypothecation and/or financial contract structures.

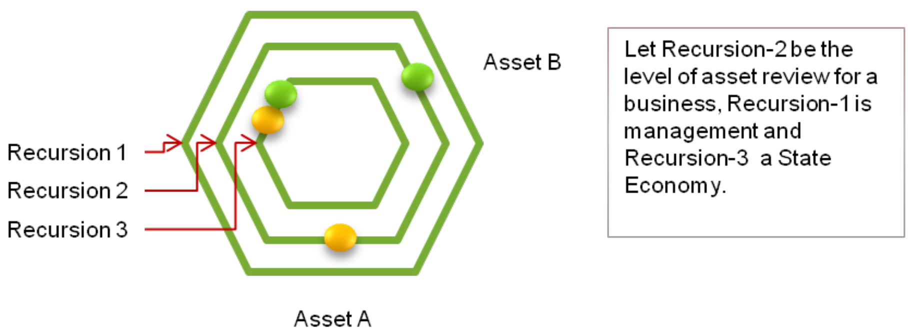


Figure 9: Defining Recursion levels for two assets

At a superficial level recursive structures may seem like correlation material but they go beyond the statistical approach and explain why events happen. The embedded feed-forward and feedback processes are lost to the statistical hunter as they are not always transparent. Just asking for output data will not explain the internal mechanism of economic "black boxes" and a fault See-Through-Leverage shares in common.

Though Smith, Ricardo, Jevons, Walras and Coase focused on the role of management within markets a good current example is Sterman & Beinhocker (Sterman, Henderson et al. 1995, John D. Sterman (1) 2007) wherein agents are analysed that are not "rational" but bounded in their rationality, have a capacity to delay actions and imperfect awareness of the local and global feedback loops. The results showed suboptimal result across the learning curve and highlighted the dangers of extrapolating from equilibrium models.

In 2006 Sterman et al(Sterman, Henderson et al. 2006) addresses the behavioural issues of markets and growth rates but before the 2008 Crisis this is a just warning. However all the indications so far point to a much more prosaic role for management, structure and the models they used.

Chapter 2.1.2: Organisational Dimension

The following from Gus Lubin of Business Insider[xvii] show various leadership and communication styles extant within the current commercial marketplace. Alongside is a 19th Century comparison and although illustrating knowledge of the internal connections of a firm or enterprise none link to a model managing the variety of exogenous and endogenous risks involved and how to manage them (an expanded view is contained in Appendix III):

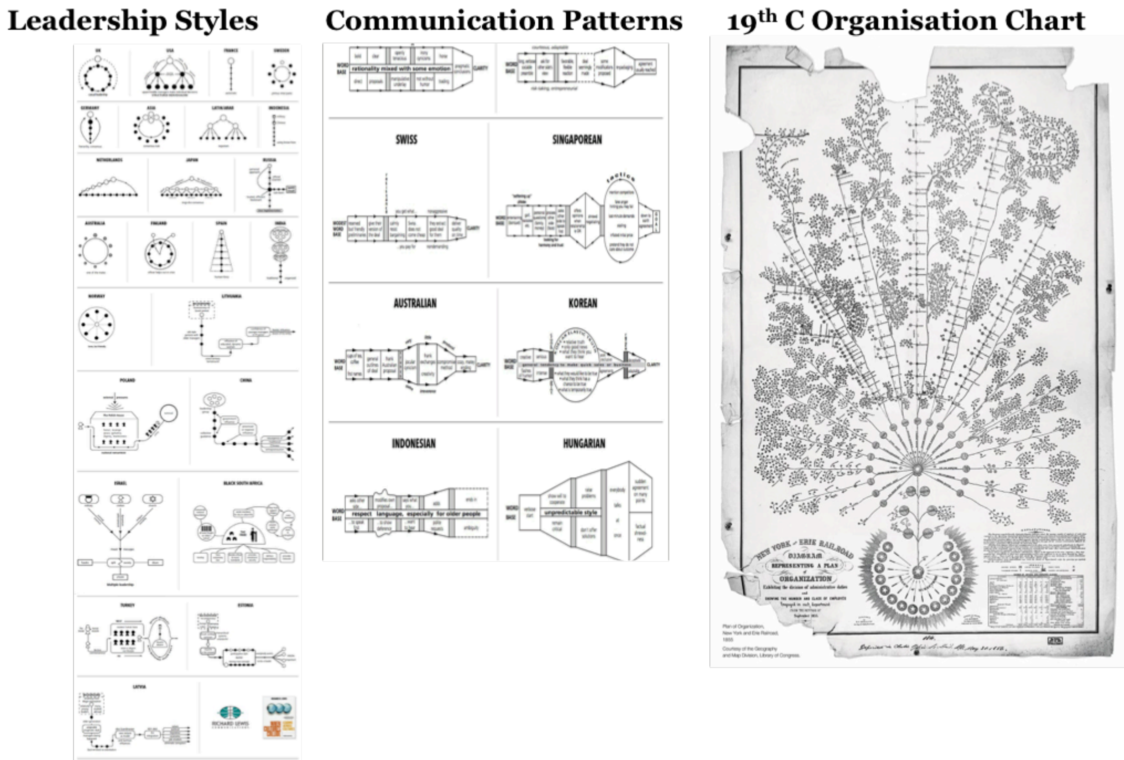


Figure 10: Various styles of Leadership and Communication Compared to a 19th Century Example

Defining the structure of a firm/enterprise/business is not therefore new and post Coase (Coase 1937) there has been an ever expanding literature on the subject that includes the behaviour of individuals and the entities themselves (Schumpeter 1983, Cyert and March 1992, March, Simon et al. 1993, Simon 1996, Simon 1997, Soros 2003, Penrose 2009, Pike, Neale et al. 2012) in addition to which could be added the numerous papers by consultants such as McKinsey.

Each of those listed above have individual views and compared by Kallay (Kállay 2012) concentrating on the "Contract Theory of the Firm". However whilst a contract may establish a relationship that usefully describes the networks established by its agents it does not reflect the full risks that expose the firm nor the activities of the agents.

Chapter 2.1.2.1: Models, Model Inertia and Eco-Systems

The Bank of England has been at the forefront of discussing how models failed within the global financial sector (Haldane 2009, Haldane and May 2011, Haldane 2011, Haldane 2011, Haldane 2012) as well as one of the founding authors of the capital markets models (Fama and French 2012). One of the critical factors criticised was the assumption that models live in "closed systems" and therefore mathematical/computational tractability could be enhance by making the model's core assumptions shorter. This assumes that the Universe itself is an "open system" and one opaque to us. However this may not be true and if we investigate the distribution of galaxies from recent research we find detailed structure that infers a model but one we have not fully resolved: see figure 11.

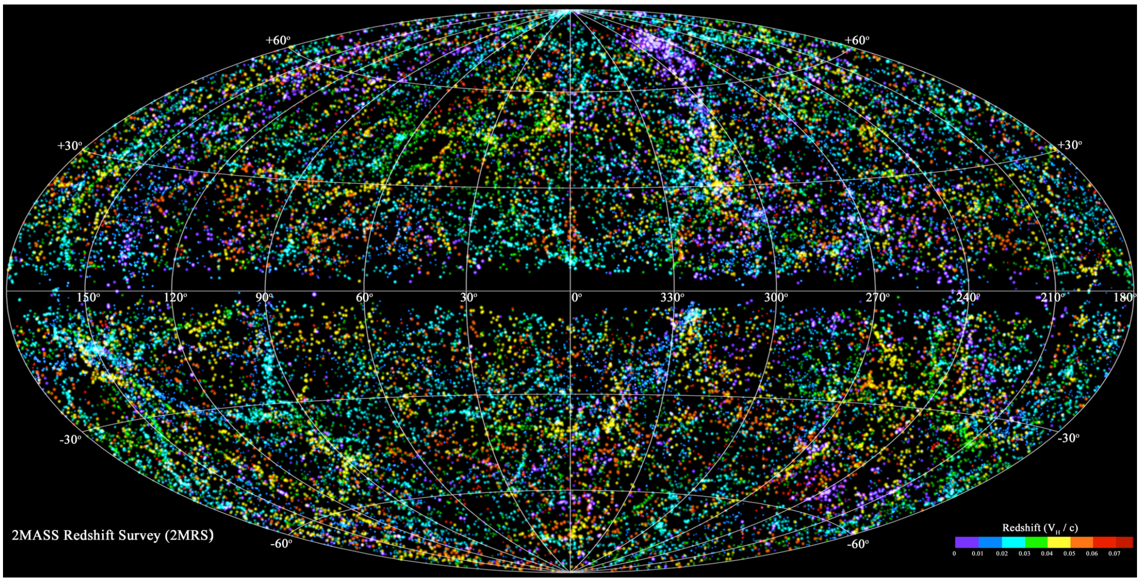
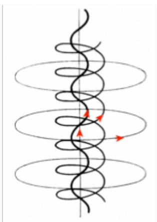


Figure 11: 2Mass Redshift Survey - Structure in the Universe

A possible solution to this is the existence of universal currents explained by Birkeland Currents (Scott and Ph 2012, Scott and Ee 2015) and figure 12:



The complex self-constricting magnetic field lines and current paths in a **Birkeland current** that may develop during Solar evolution (Hannes Alfvén/Gustaf Arrhenius[7])

Figure 12: Birkeland Currents

Ignoring the origination of these fields it infers that the exact operation of the Universe does have a model, though opaque; and as the universe is the most complex system we could think of this challenges us to investigate models and how to construct an appropriate one to describe the operations of ATPMs components, in order to assess the veracity of their outcomes.

From Schwaninger we can think of what models are and what they are used for (Espejo and Schwaninger 1993, Schwaninger 1994, Schwaninger 2006, Schwaninger 2009):

- “By model, we understand the representation of a real system. More exactly, a model is an abstract, conceptual system by which a concrete system is represented”;
- "To begin with, modelling in the context of management is about the construction of virtual realities in the minds of observers "; and
- "The argument that models are important for management has a scientific basis, which can be deduced from a fundamental law of cybernetics – the Conant-Ashby-Theorem".

It is also a common fault of many financial texts that a proper distinction is not made between data, information and models. Whilst information as a process is gained from one data input it is the output data to the strategy that is essential to understand in this iterative process and how it is managed.

Most of the current regulatory literature revolves around managing the models of the enterprises they control and yet within Basel II there is an incomplete or non-existent definition of a system. The consequence is a lack of understanding of the affects of timing and process on the result.

Models, whether economic or otherwise are useful if one can make empirical measurements and compare the outputs to expectations to attain some form of predictive ability. Examples of models underpinning practice that faltered and where the metrics used to assess value were either ill founded or changed their application (thereby invalidating the process (Morgan 1997)) can be found in Credit Default Swaps whose underlying model is to exchange the credit risk between parties in an efficient market but its pricing methodology and contractual foundations changed repeatedly becoming more opaque to the user.

Measuring performance presents another challenge when considering the effects structure. We know from Huxley & Tessier [see Noble] and the developing science of Allometry that scaling factors are related to environmental factors and from Noble (Noble 2008) that different biological structure creates different functional needs. Likewise the discussion on communications time lags impacts the outcomes.

The transfer of economic wealth depends as much upon expectation as it does an assessment of historic events; i.e. What is the expected return and what does history tell us? The interplay between functional parts of the economy and the processes that guide them create the cause and effect framework.

Each member or agent within the financial community therefore has their own ontological and epistemological frameworks that must be governed by a higher order of principles and rules if the system as a whole is to be maintained. If the Economy is broken then either the original individual models were incomplete and/or the overlying ontological framework was miss-understood, the picture so far begins to show both at error.

Chapter 2.1.2.2: Market Models and Governance Regimes

A significant growth in commercial activity ex-post Markowitz's Portfolio Pricing Theory and the Efficient Market Hypothesis ("EMH") was due to the Capital Adequacy Pricing Model ("CAPM") and Arbitrage Pricing Theory ("APT") that became the de-facto pricing models within Corporate Finance (Berk and DeMarzo 2014, Brealey, Myers et al. 2014, Berk, DeMarzo et al. 2015).

The common flaw in all three was to rely on assumptions that could not be tested or were blatantly wrong (Keen 2011, Fama and French 2012). However once the financial paradigm was established common usage took over and arbitrage prices that were initially wrong were amplified through repeated application of the process on the assets until the feedback loops in the markets fractured and losses were disproportional to the price of risk assumed. Attempts to govern the issues were largely rule based and only exacerbated the problem, as the metrics used did not recognise the underlying nature of the transactions or markets. As Beer might have noted, the governance language had collapsed and the system itself had become volatile, they had become “pro-cyclical” (Edmonds, Jarrett et al. 2010).

Chapter 2.1.2.3: Pro-Cyclicality in Financial Institutions and ATPMs

In October, 1999 Mr. Laurence Meyer, Member of the Board of Governors of the US Federal Reserve System, remarked to the International Finance Conference, Federal Reserve Bank of Chicago, about the impact of two systemically significant crises, the then Asian Crisis and the near bankruptcy of Long Term Capital Management. In it he addressed issues arising from the way financial institutions manage their portfolios over the short/long runs vs. market/risk-based capital concluding:

> *“Or, more generally, short runs have to be evaluated against the backdrop of long runs, regardless of Mr Keynes’s unfortunate observations about the latter” (Mayers 1998)*

Compare this with William R. White’s report summary to the Bank of International Settlements, Basle in 2002 on Hayekian liquidity/supply side responses:

> *“The US is set up at the structural level to ensure the kind of supply side response the Hayek School would have recommended. The various actors involved will ensure (through the courts if needs be) that the necessary supply side adjustments are made”*

Five-years later the 2008 Credit Crisis took hold and few had listened to the warning signs. Yet from 2007 to 2013 not only has the G20 implemented a regime that identifies significantly important financial groups and denies interconnected capital, but also brakes on the level of leverage available to all institutions including a plan to investigate the un-regulated institutions in the so-called “Shadow Banking” market. The following researchers have shown the different aspects of pro-cyclicality and its attempted regulation and include the above (Crouhy and Galai 1986, Aharony and Swary 1996, Durlauf 1998, Meyer 1999, Settlements 2002, White 2002, Committee 2009, Geanakoplos 2009, Sikka 2009, Turner 2009, Blanchard, Dell’Ariccia et al. 2010, Blundell-Wignall and Atkinson 2010, Blundell-Wignall and Slovik 2010, Adrian and Shin 2011, Pozsar and Singh 2011, Stability and Keynes 2011, Awrey 2012, Batten and Szilagyi 2012, Board 2013). Note especially Durlauf on Complexity, Blundell-Wignall on Basle-III & Stress Tests, Pozsar on the Nonbank-Bank and the Financial Stability Board’s recommendation on Oversight of Shadow Banking.

The common theme in all of the criticisms is “feedback loops”, or more accurately both “feedback & feed-forward loops”, between catastrophic financial events and new regulation to counter their repeat; for the following reason. Whilst feedback is temporally an immediate activity most of the financial tools criticised project the outcomes of commercial arrangements into the future either by individual contract construction or contracts that deliberately tamper with aggregate economic effects of system-wide regulatory parameters (regulatory arbitrage). The latter is more in keeping with “feed-forward” networks either at a single (contract to contract) or higher (aggregate exposure to a wider economic downturn) portfolio level.

Whilst there is a possible method to determine sustained changes in local market activity that in turn may aggregate and ultimately have systemic effects, regulatory systems throughout the 1990’s and 2000’s to-date do not evidence any method that can capture the data mainly because the definition of a system is not configured correctly, nor is the need to recognise recursive structures.

The source of the problem lies not in the confidence of the system but that all systems have the propensity to endogenous chaos, the continual creation of new products that strains the systems adaptability. More importantly the terms under which business transacts may transfer unknown risks from the market: The latter being related to Knight, Bohm and Beer’s rules/principles/languages debate on certainty.

Hence without a framework that recognises recursive structures and a methodology to anticipate rapid changes in economic state-space it is not surprising that “bubbles” occur more often (Reinhart and Rogoff 2009) and commercial forces avoid rule-based financial regulations designed to dampen the effects by creating the “Shadow-banking” (Sfadia, Filingeri et al. 2014) market.

Chapter 2.1.2.4: Information and Communication

Quote: *The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Claude Shannon* (Shannon and Weaver 1949)

Whether the preference is to believe in Descartes (Descartes and Heffernan 1992) rationalism of external but illusory things, or that the Universe is all a dream the practical matter is that, in order to buy bread, we must communicate.

To receive directions and compare objectives a priori knowledge in the form of internal models must be held by all participants to a conversation. These models use data to "inform" strategies that are then executed as strategies. To invest in any venture an exchange of assets is required and the capital markets have developed various methodologies by which data is presented to potential investors whether these are external or internal to the operational focus (Klonowski 2007).

In order to optimise the success of this process experts in presentational skills have developed their own methodologies to tutor presenters one of whom is Nancy Duarte (Duarte 2008, Duarte 2010) chosen because her underlying methodology shows distinct influences from Information Theory and the Shannon/Weaver (Shannon and Weaver 1949) seminal paper in communication. The following graphic is to be found on page 171 of "Resonate" but has one amendment:

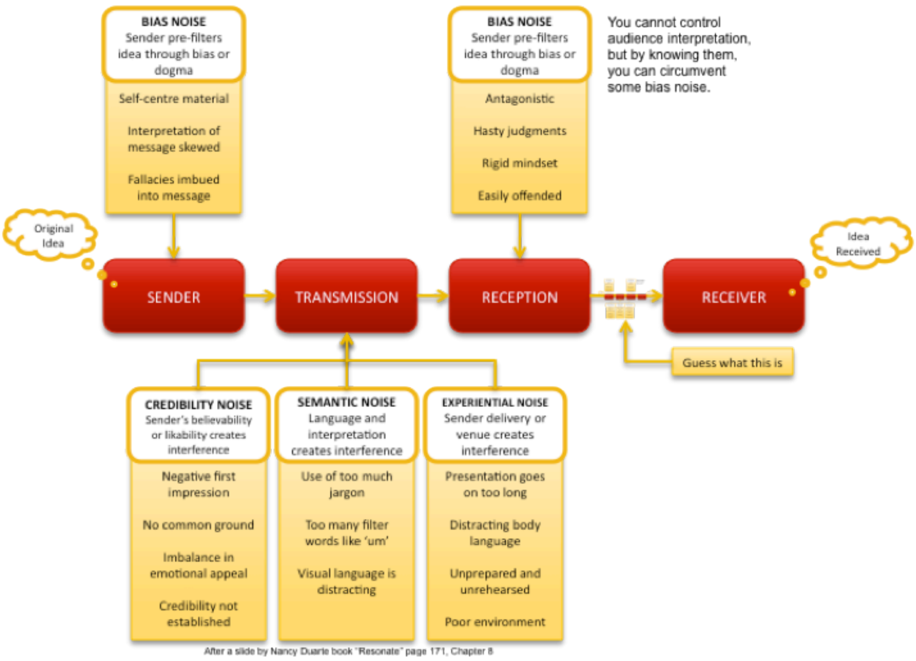


Figure 13: Example Presentational Methodology - Nancy Duarte

Comparing the above to its possible source we can see an illustration of a general communication system drawn by Claude Shannon (Shannon and Weaver 1949) as follows:

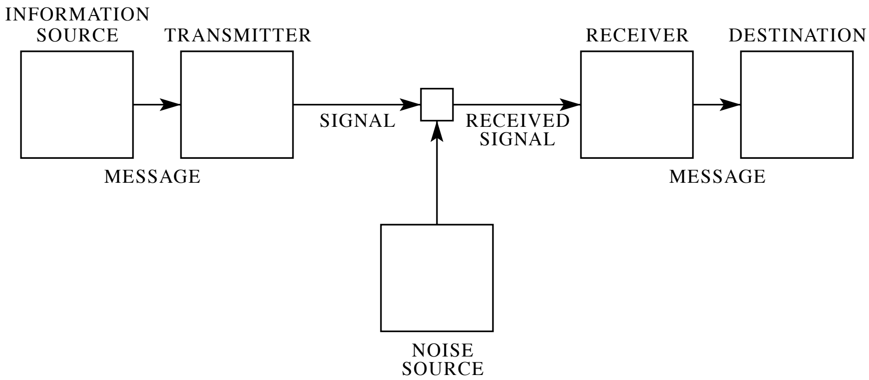


Figure 14: Page 7 "The Mathematical Theory of Communication" Shannon/Weaver

ATPMs require an exchange of data as a fundamental part of the process. The "noise" that Shannon refers to, and Duarte illustrates, can be simple or complex and why Communication Theory becomes important as part of the conversation – due diligence.

Information Theory expresses the communication of data in mathematical forms that can be used to identify efficient structures and explain counter-intuitive results and Ergodic Theory, the outcome of Information Theory, shows how probabilistic systems settle down over time given the right structure but the network structures must be inferred from a different framework such as Network Theory. ATPMs can be considered as transcription systems that pass assets from one place to another but need to parse the incoming data and component sub-structures in order to assess value before passing the data (assets) forward. Taking this approach it is not difficult to imagine Ergodic Theory explaining "bubbles" but the structure must encompass a recursive functional network – noise in this context interrupts the flow of data affecting all outcomes.

If considered in terms of translation one major aspect, apart from model construction, is language and semantics. In ATPM terms the unintended consequences of using common words that have syntactically and semantically different outcomes when used to present ideas is a common aspect of noise. One example is the word "mortgage" that carries with it meanings and models strikingly different between the U.S.A./U.K. and were at the heart of the 2008 Credit Crisis (Edmonds, Jarrett et al. 2010).

Chapter 2.1.2.5: Feedback, Feed-forward and Recursion

"Throughout the following a fundamental ontological issue is the construction of models and economic models fall with the extremely complex variety along with biological and social (Beer 1967)".

As Beer points out these models are defined by sets of complex process that have developed a scientific language of their own but one that leaked into common parlance.

Essential to any communication or language should be the explanation of the terms involved and in this regard as our objective centre around the governance or control of commercial enterprises we need to define these terms here as they will be mentioned in more than one set of circumstances.

Complex systems, of which management and social systems certainly belong, are described by their relationships, a network of processes that include time as a governance framework. We use the following terms regularly in management but what do 'feedback', 'feed-forward' and 'recursive' mechanisms mean?

Feedback has a mixed reputation and is largely misunderstood whilst feed-forward is generally not known at all. Feedback has both negative and positive connotations but one action: it takes a signal and loops it back to the source. Upon arrival pre-determined actions either amplify or attenuate (bring into alignment) current activity. Both can be considered positive or negative depending upon your point of view.

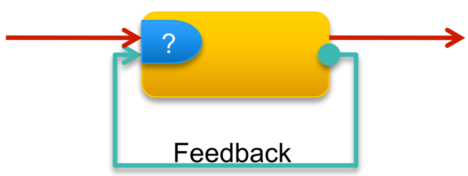


Figure 15: Illustration of a Feedback Process

Feed-forward on the other hand, whilst similar to feedback in some ways, essentially sends a signal into memory which along with certain rules creates a comparison process that occurs in the future. When a pre-determined trigger event is activated by data in the future those actions are carried out either looping back to the originating process or triggering others. The diagram below shows a general idea:

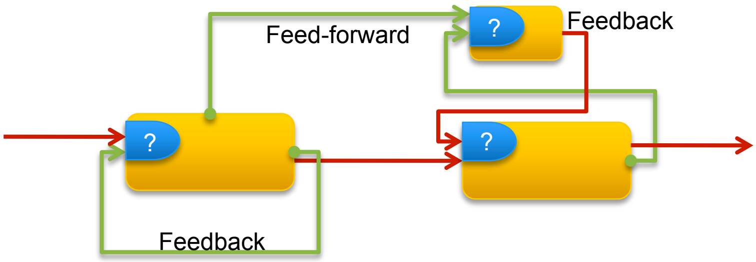


Figure 16: An Illustration of Feed-Forward Processes

The 'feed forward' loop above is a good example of a 'nested system'. Although the parameter comes from one set of processes it enters another that waits until its conditions are satisfied and then acts upon them. Here we also have the essential elements of governance so the figure above could be redrawn in figure 17:

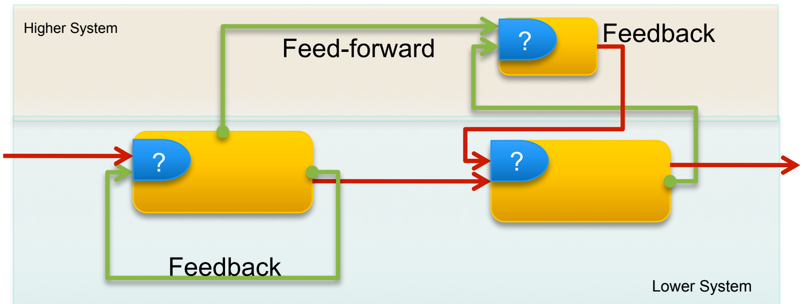


Figure 17: Illustration of Linking System Processes

The processes within these components could be quite complex but the essential functionality is all here. When the process within the lower level reach a certain state the information within it becomes the data for the next level (recursion) above which depending upon its own rules may start to govern the lower level by acting upon it.

If this were an electrical circuit then the lines would just be connections but in the real world processes are connected by individuals, or even groups, and therefore the connections have their own inner levels of interpretation built-in as follows:

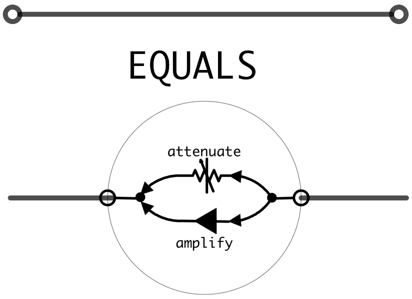


Figure 18: Illustrating the Internal Model of each Communicant (Beer Brain of the Firm)

Each individual within the group can intentionally, or unintentionally, amplify or attenuate the communication (attenuate = gradually reduce the intensity of flux through a medium) (Beer 1972). As the process becomes dynamically stable the whole reflects the activity of a 'homeostat' (Haeckel/Ross Ashby (Ashby 1956, Shannon, McCarthy et al. 1956, Ashby 1960)) however noise becomes an issue and hence the developments in Communication Theory e.g. whilst a manager may communicate one decision how that is carried out depends upon the actions of the receiving agent.

However businesses normally comprise hundreds of individuals, each with their own internal 'world-model' matched to the local business model within which they are embedded that in turn means the business model must be communicated effectively and then actively governed. How the business is operationally constructed is therefore vital otherwise communication will be misinterpreted or lost: the consequent result being improperly managed business. In this sense “improperly managed” could mean, “badly attenuated to shareholders requirements”. Capra illustrates a concept called Autopoiesis (Maturana and Varela 1980) within biological systems as follows but the same structure can be applied to business model and businesses themselves with consequent affects on ATPMs:

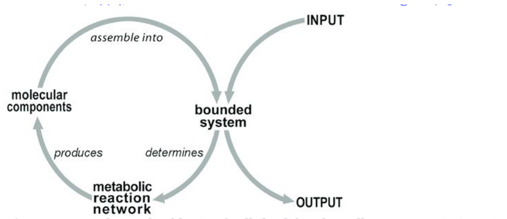


Figure 7.3 The cyclical logic of cellular life. The cell, an autopoietic unit, is an organized, bounded system that determines a network of reactions that produces molecular components that are assembled into the organized system that determines the reaction network that...and so on. The terms "input" and "output" – in observance of the fact that the cell is an open system – represent respectively the incoming of nutrients and energy from the outside, and the outgoing of waste products. The circularity illustrated in the figure corresponds to the notion of operational closure, giving rise to the broader notion of biological autonomy.

Figure 19: The Cell as an Autopoeitic System

To reduce complex problems to simpler components, or assess a general form in terms of what is clearly understood and that which is not, mathematicians and/or engineers refer to some elements as a 'black-box':

Figure 20: The Black Box - A Metaphor for the Unknown Process

The "Black Box" is a useful device when the exact process is unknown but the outputs are known from certain inputs. The modern concept of a 'Black-Box' seems to originate around 1945 but its formulation was around earlier in linear network synthesis of Wilhelm Cauer(Cauer 1897). At about that time several groups were working on how the mind worked and society managed itself. Norbert Weiner (Wiener 1948) recognised the Black-Box as a good way to express 'self-organisation'.

The problem in management and economic governance is that you cannot make such assumptions: the more complex the internal system the less reliable the correlation between successive data calibrations and Society is dynamic. In other words the 'model' in the box needs to be governed properly and understanding its structure is just as vital.

This is where the organisational research scientists from 1945 onwards started to recognise that Society does not follow a Random Walk even though the term was coined by Weiner to describe a stochastic process with a similar behaviour to Brownian motion.

However Weiner et al did not stop at describing a 'system' but went on to define how nested systems relate to each other to create eco-systems. The term “recursion” was given to each distinctly different, but self-contained, level of organisation created by the addition of new elements to a new whole. The term given to the new organising process was called “meta-systems” (Figure 21):

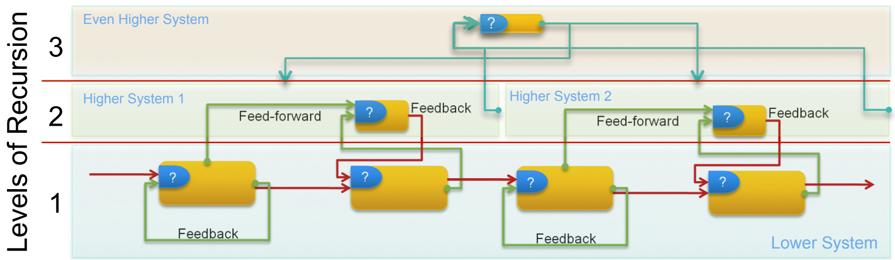


Figure 21: An Illustration of Recursion & Meta-Systems

Knowing about recursion levels/layers in an eco-system is important because it will assist us in building models with simple nested structures as well as identify those structures that may work well now but fail under stress conditions.

It is important to remember the scientists that came to define recursive processes thought in complete systems and not just isolated sections with a few variables. Many were biologists and it is obvious to think that understanding one cell does not explain how the body works. They were collectively studying dynamic systems and applied their research to other areas as data sets became available; such is the enquiring mind of the scientist (See (Pickering 2010, Capra and Luisi 2014)).

For instance though Mandelbrot originally believed market forces could be likened to his work on Nature's Fractals (Mandelbrot 1983) he later looked harder at the seemingly organised but unpredictable Economy and withdrew earlier assumptions (Mandelbrot and Hudson 2008). Like the work by W. Brian Arthur on the Economy as a complex system of agents (W. Brian Arthur 1989, Arthur 1995, Arthur, Durlauf et al.

1997, W. Brian Arthur 1997, Arthur 1999, Arthur 1999, Arthur 2000, Arthur 2005) discontinuities kept appearing because the 'Black-Box' used did not account for the internal structural complexity.

However others like Stafford Beer (Beer 1959, Beer 1966, Beer 1972, Beer 1979, Beer 1985), Frederic Vester (Vester 2007, Vester 2009), and Maturana/Varela (Maturana and Varela 1980, Maturana Romesín 2012) had spotted that structure mattered. Certain organisation structures seemed more durable to dynamic events relating to the manner in which the communication network operated in conjunction with their function. This allowed models to be created to test the current structures as to likely compared to actual outcomes.

Collectively therefore Feedback, Feed-forward and Recursion become fundamental to the construction of a complex system. The models that try to describe these systems must therefore take into account these aspects (Capra and Luisi 2014).

If we reflect upon Beer's Cybernetics and Management we may now see that he was indeed leading us to a better differentiation of how systems work but to use one of his devices we should iterate again that Cybernetics deals with "probabilistic" and not "deterministic" systems: Many can make the mistake that feedback systems can be considered deterministic.

Chapter 2.1.2.6: Models and Model Persistence

"*One of the principal difficulties associated with attempts at mathematically modelling social and economic phenomena has been the natural tendency of modelling too slavishly, in fact to almost religiously adhere to the modelling apparatus which has served so well in physics and engineering*"(Beer and Casti 1975).

We build models to try and understand our world in order to avert possible disaster but in using a reductionist approach suitable for very local conditions we miss the larger implications of processes at boundaries with other systems. By ignoring the effects networks of 'feedback' and 'feed-forward' loops have on the whole we are in fact ignorant of the whole systems true properties.

In economic philosophy we came across the concept of emergence where the result of dynamic activity of many agents using one set of objectives and parameters create another whose own objectives and boundaries differ (Mandeville 1723). The feedback process (Cristelli, Pietronero et al. 2011, Hector and Jean-Paul 2011, Helbing, Yu et al. 2011) that ensues from trying to maintain the benefits of the wider activity by adjusting the actions of individual components will arise more than once in the forthcoming review. In the rest of this thesis it will be seen that errors in understanding the dynamics and the application of inappropriate models explain many of the problems arising from the Credit Crisis 2008 (United States. Congress. House. Committee on Financial Services. 2011) and also why Agent-Based Models, hailed as a solution to complex dynamic economic agent activity (W. Brian Arthur 1989, Arthur 1994, Arthur 1999, Arthur 2005), failed (Durlauf 1997, W. Brian Arthur 1997, Squazzoni 2010).

As discussed above Communication, Measurement and Models are intricately coupled and without the former models such as ATPMs lose useful meaning. However with the concept of emergence models that try to explain reality are destined to break down if they are based upon a set of properties that suddenly change or if the model is miss applied to seemingly similar markets but have completely different underlying structures (Bookstaber 2007).

The point here is to reinforce the fact that a model is just that a representation of reality or an idea. Schwaninger identifies the serial applications of models from strict formal to images or mental the former allow computer simulation whilst the latter allow insights to be tested against real events.

With respect to management he notes an important aspect of using simulation with respect to models and governance that has been proven – “"Every good regulator of a system must be a model of that system" (Conant and Ashby, 1981)”.

Finally he raises the point of viability of a system governed by models that may seem obvious: if a model is useful then it is valid – insight alone is not enough.

The tension between types of models is generally split between those that try to explain from the ground up and those that are top-down. Newton and Descartes started a powerful revolution modelling with a calculus that reduced to ever-smaller parts that could be well defined assuming that when they were added together the whole was miraculously explained?

The counterpoint is holism or a 'holarchy' as defined by Arthur Koestler (Koestler 1972, Koestler and Smythies 1972), which effectively says 'the whole is greater than the sum of its parts'. The problem being that, before 1945, no real attempt had been made to show how one model became the other, or indeed whether they were capable of doing so. This mirrors the debate between classical Newtonian, Relativity and Quantum.

The whole area of complexity theory has grown up in the attempt to fill in this void. Yet with the assistance of a Matryoshka Doll and Information Theory (Shannon , Shannon and Weaver 1949, Kelly Jr 1956, Ash 1965, Shannon and Weaver 1998, Piotrowski and Schroeder 2007, Vannini 2007) we can build a definition of Systems from a set of functional processes, feedback/feed-forward loops and the idea of recursive levels where systems become functional components of bigger systems that emulate eco-systems.

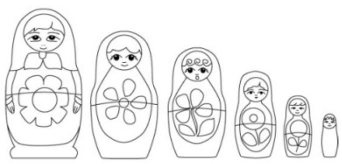


Figure 22: Nest Maytoshka Doll

Türke (Ralf-Eckhard 2008) lists the general requirement for all actor interactions, following in Gordon Pask's footsteps who illustrated it in his actor theory (Pask and Scott , Pask 1961, Pask 1975, Pickering 2010), and state:

> "*Models are the means through which actors reconcile their mutual activities and implement their social purposes. Obviously, the question of the role and contribution of model to governing*

refers to the use of formalized, prescribed and standardized models derived from scientific theory or experience..."

The staple requirement here is that this must be a 'complete' model, the basis of strategy and the implementation of this heuristic must be made in real-time. However how does one man's model become a society's paradigm?

Chapter 2.1.2.7: Paradigms

Perhaps we could consider the reason why paradigms (Kuhn 1962) exist and persist in terms of the energy requirement needed to create and then change them? First let us draw a picture of how Paradigms, being a shared model, may exist in the world (figure 23):

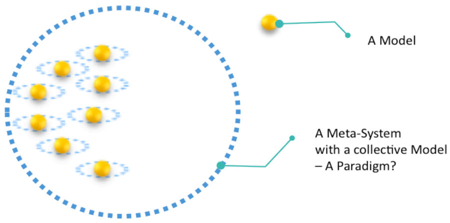


Figure 23: An illustration of a Paradigm

Each 'system' could be considered a person, bank or business that shares a common model, let us call them agents. Each agent is in a shared space but that is not a “meta-system” as it is only topographically related and equally other agents may have different models in the same space (figure 24):

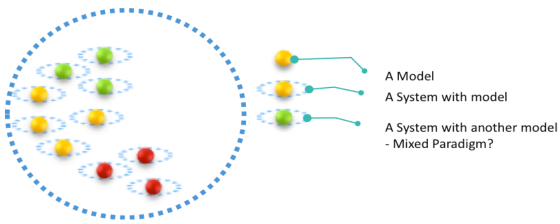


Figure 24: An illustration of a "mixed paradigm"

The more commonly accepted the model the more engrained and dominant it will be in the Meta-system. This could be represented by the cumulative energy required for the Meta-system to acquire it (Figure 25):

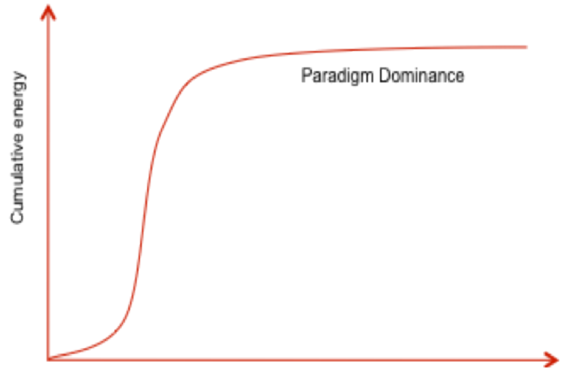


Figure 25: Representing the energy required to acquire model dominance

Figure 26 is the comparison of the utility of the model in the market place compared to the amount of energy expended. Utility increases as the market recognises the worth of a model – its time has come they would say. However as the model's utility wanes efforts to make it work increase until it fails:

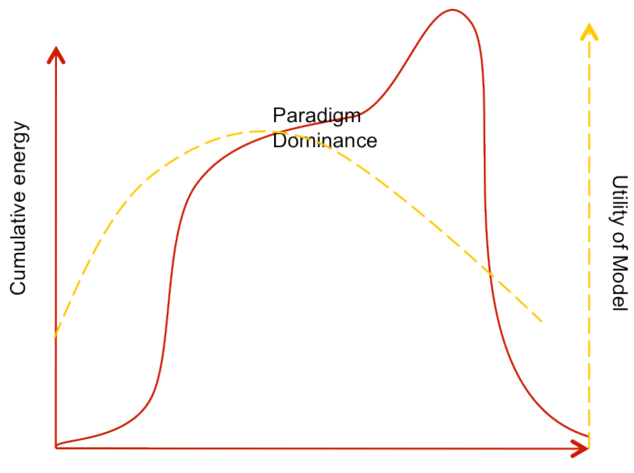


Figure 26: Paradigm Energy Applied vs Utility

The frequency with which paradigms have changed has increased over the last 70-years as technology and its consequences on Society have developed (Arbesman 2012). Defending the old paradigm is energy inefficient but we only do so as a matter of course because its failure is not readily apparent to all, it could be said that the Paradigm has its own inertia.

The energy required to enter a new model competes with the resistance of the established order, itself consuming energy to do so. Change only comes when data, proofs and verification of the new show better predictive results (Bohr 1948). Achieving these is difficult if the agents of the established paradigm control the resources. As Planck noted in Kuhn's seminal work (Kuhn 1962)p.151 *'a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it*'.

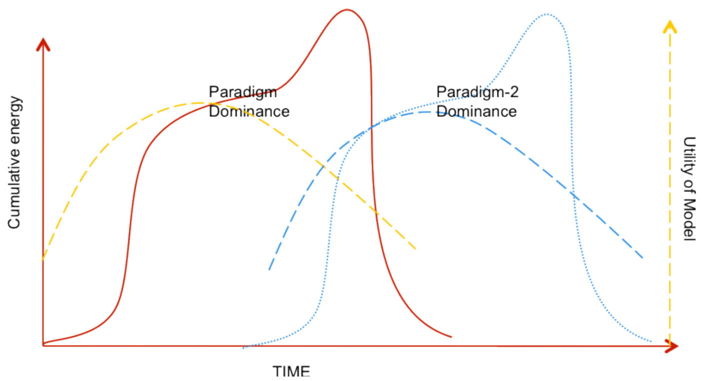


Figure 27: Representing the competition between paradigms

Chapter 2.1.2.8: Causal Frameworks and Governance

Noble(Noble 2006) sought to understand how the heart functioned by analysing the causal pathways and their order of interaction to make the heart work and understand the system's operational framework. In the same way we can analyse how the same type of causal framework may apply to a socio-economic structure

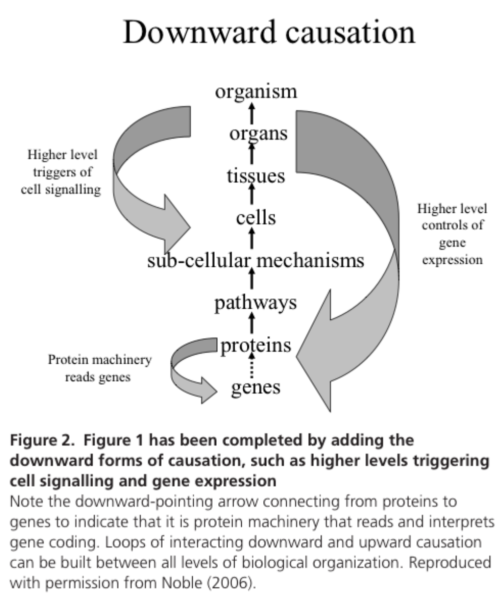


Figure 28: Nobel's Music of Life Causal Framework (Referencing in image is Noble's)

Causation is a deeply philosophical subject (covered in Conceptual Methodology) but Beebee (Beebee, Hitchcock et al. 2009) gives us many methods to approach causation. From the tight lens of commercial ATPMs the "cause-event" proposition prevails and influences the accounting, social (chapter 36), legal (chapter 37), insurance and information (see also Pawlowski(Pawlowski, Paterek et al. 2010)) aspects of ATPMs. Using Noble's causal framework as a guide we may draw the figure 29:

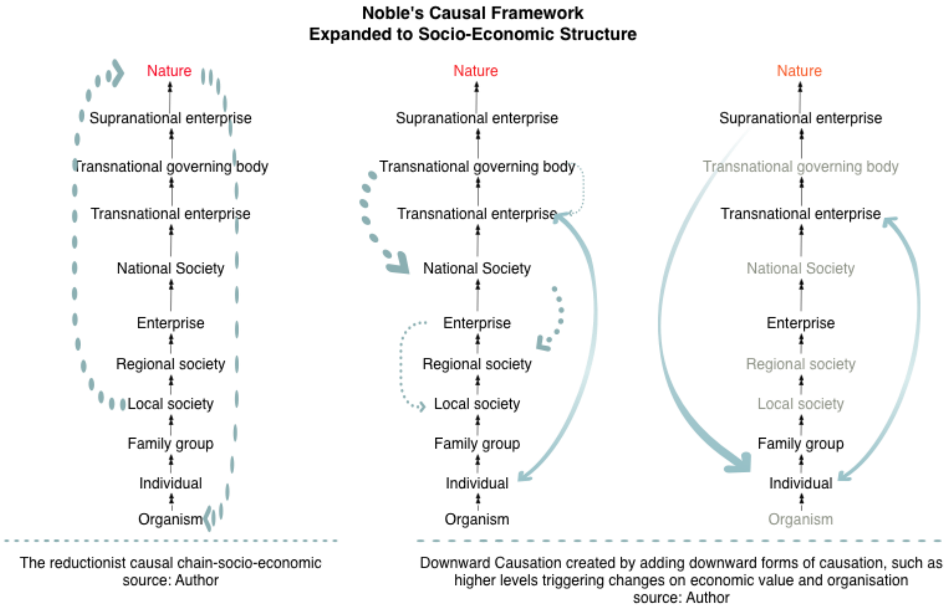


Figure 29: Adapting Noble's Causal Framework for Economic Recursion

On a broader note, and only choosing two, Menger (from page 55) and Keynes (pages 22, 32, 34) themselves regard "causation" as an integral concept in economics and as ATPMs are embedded within this socio-economic system they cannot escape the core issues surrounding them. When it comes to organisational cybernetics and time causation becomes process dependent and the influence of institutionalised models versus individual opinions on what constitutes "an event" will raise complex and even combative issues in employment, competition/co-operation and insurance.

Chapter 2.1.2.9: A. Stafford Beer and the Viable System Model

Like Edward Abbott (Abbott 1885), then Ian Stewart (Stewart 2001, Stewart 2008) after him, Beer quickly discriminates between different types of systems however in Beer's case the issue was not Abbott's "dimensionality" but a world in need of some sort of governance, a world *""beset by regulators" and a "world of regulations" but lacking a "status of the "reguland""*(Beer 1957, Beer and Casti 1975) Perhaps "reguland" is an homage to Abbott but Beer's purpose was to show how systems, each with unique narrow limits of operation, develop concepts of control to regulate their own existence, must then fit together under some form of higher control function that in turn keeps the larger “eco-system” within its own, but different, boundaries of operation.

The result of Beer’s review of the operations for United Steel (Beer 1957) was a model that sought to optimise the commercial performance of the business plan. A pictorial summary of Beer’s operational review can be seen in figure 30 and was quickly followed in 1959 by “Cybernetics and Management (Beer 1959)” then later, as a result of his work in Chile, the Viable System Model (Beer 1966, Beer 1972, Beer 1974, Beer 1975, Beer and Casti 1975, Beer 1979, Beer 1985, Beer 1989). The latter considered the wider implications of management cybernetics on Society.

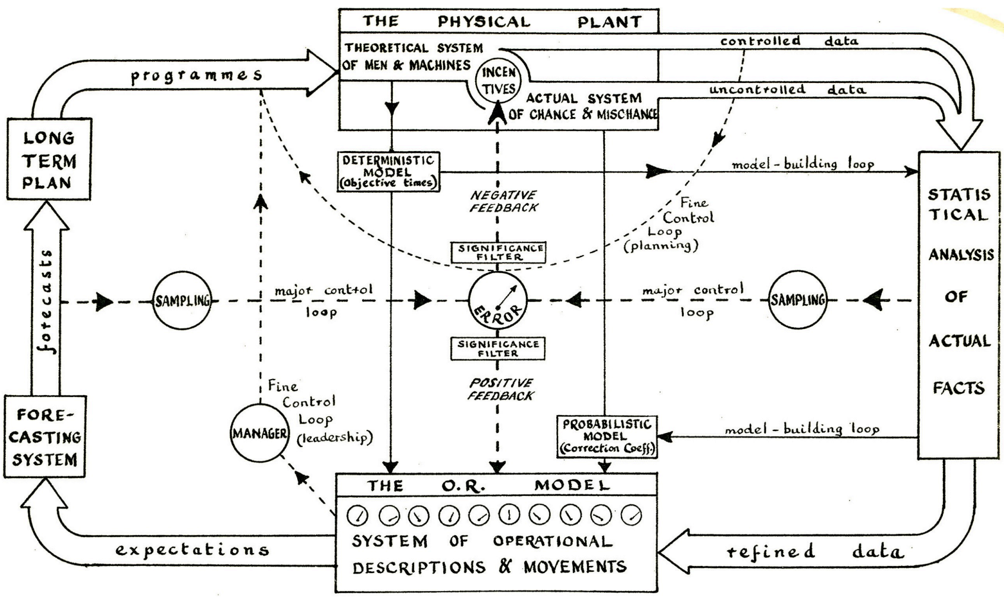


Figure 30: Beer's Pictorial Summary of United Steel Co. Report on Operational Research 1957

Here Beer is describing a process, or model, by which United Steel may reasonable forecast a strategic outcome based upon the dynamics of the environment within which it is set. If we are to suppose that United Steel’s objective was to set a strategy by which, an investment in expertise, physical plant and raw resources, could develop a profitable return then Beer’s forecasting model embodies most of the criteria ATPMs would require to dynamically manage the outcomes of investments to meet the initial investment strategy.

Within “The Brain of the Firm”(Beer 1972) Beer formally introduces the concept of recursion and feedback/feed-forward mechanisms to optimise the performance of the system. He is employing insights from: Cybernetics developed by Norbert Weiner (Wiener and Massachusetts Institute of Technology. 1949); the psychiatrist Ross Ashby's - Law of Requisite Variety(Ashby 1956, Ashby 1960); and electronic engineer and cryptographer Claude Shannon's Information Theory (Shannon and Weaver 1949).

Beer's axiom's, principals and laws developed within "The Brain of the Firm" and latterly in "The Heart of The Enterprise"(Beer 1979) start to define a model by which an investor could employ as an ATPM to assess and then optimise the dynamic outcomes from the transfer of assets to a strategic investment (Morlidge 2009, Morlidge 2010, Morlidge and Player 2010). However not all target organisations operate within Beer's concept of a "viable" system. It is therefore important to investigate Beer's model and what insights it provides.

Beer produced a wealth of material but for the purposes herein a selection of his works has been reviewed in Table 3:

Table 3: A Stafford Beer's Materials Reviewed

	Title	Published		
	Sole Author	**First**	**Last**	**Selected**
1	Cybernetics and Management	1957	1967	X
2	Decision & Control – The Meaning of Operational Research and Management Cybernetics (Beer 1966)	1966	1994	X
3	Brain of the Firm (Beer 1972)	1972	1994	X
4	Designing Freedom (Beer 1974)	1974	1994	
5	Platform for Change (Beer 1975)	1975	1994	
6	Heart of the Enterprise (Beer 1979)	1979	1994	X
7	Diagnosing the System (for Organisations) (Beer 1985)	1985	1993	X
8	Beyond Dispute – The Invention of Team Syntegrity (Beer 1994)	1994		
	With Others			
9	Internal Report for United Steel: The development of our work on control systems (Various)(Beer 1957)	1957		X
10	Investment Against Disaster in Large Corporations (Beer/Casti)(Beer 1975)	1975		X

11	Pebbles to Computers(Blohm, Beer et al. 1986)			X
12	The Viable System Model – Interpretation & Application of Stafford Beer's VSM (Espejo/Harnden) (Espejo and Harnden 1989)	1989		X
13	How Many Grapes Went Into The Wine – Stafford Beer on the Art and Science of Holistic Management (Harnden/Leonard) (Harnden and Leonard 1994)		1994	X

A major contributor to the social science and recognised as the founder of Organisational Cybernetics Beer's work in the late 1960's (Beer 1966) and early 1970's drew upon practical experience in developing management systems in a variety of organisations from steel companies (Beer 1972) to whole countries (Beer 1979). The main corpus of his work revolves around the development of "The Viable System Model" ('VSM') of which the focus of its application herein will be its relevance to ATPMs as it supplies a topographical framework upon which to investigate the activities of agents and the networks they create.

Considered the founder (Medina 2011) of Management Cybernetics the provenance of the VSM can be found in 13 above page 11. With a background in philosophy and psychology Beer developed Operational Research into a holistic science. Though 4, 5, 8 and 11 do not directly concern the main body of the VSM they bring insight to the science of recursive management and systems when applied to wider social issues.

Chapter 2.1.2.9.1: Ten Important Years: 1957 – 1967

In 1959 following his United Steel report Beer first published "Cybernetics and Management" (Beer 1959) credited as the first cohesive application of cybernetics to the social science of management. Though in many respects the United Steel report was ahead of its time in as much that: it recognised what Keynes ((Keynes 1937), page 8) had said about economic performance, organisation materially impacts outcomes, to further abstract the insights to a general theory was as Beer admits, "*a set-theoretic model of the brain onto a company producing steel rods*" was "*to prove difficult to understand*" (Espejo and Harnden 1989). Therefore swapping mathematics for neurophysiologic terminology he wrote the Brain of the Firm(Beer 1972) followed quickly by the "Heart of the Enterprise" (Beer 1979) which he believed proved "*the* *necessary conditions for viability in an enterprise had been established*": Viability in this sense being the ability of an enterprise to be aware of and continually maintain its existence accounting for the variety of states it may encounter.

Though not generally available the United Steel report is important as a good record of Cybernetics as a tool for operational management and sets the scene for Beer's "Cybernetics & Management"(Beer 1959).

Whilst generally Beer's work does not provide a general commercial model for ATPMs it does provide a framework under which such operations can be transacted. By including financial considerations along with the inclusion of recursive structures (Beer 1985, Harnden and Leonard 1994) (incorporating Conant/Ashby and Maturana/Varela's works). As a probabilistic framework Beer also anticipated certain conditions required for Complexity Economics, as define by W Brian Arthur.

Where the United Steel Report introduced Cybernetics "Cybernetics & Management" begins to define the organisation of a Company by first declaring, (as does Arthur) it is a good example of an "*exceedingly complex probabilistic problem*" (page 16 and page 1 respectively) and then therefore "*the set of 'exceedingly complex deterministic systems' is empty*" (page 16). Beer is making the distinction between it and existing commercial models. Most importantly by introducing the concept of "self-regulation" or "homeostasis"(Beer 1959) Beer begins to draw analogies between the biological world of Bernard and the operational processes of a Company.

Chapter 2.1.2.9.2: Beer's Cybernetics & Management

Cybernetics and Management is in four parts, the basic notions, the logical theory of cybernetics, the biophysical theory of cybernetics and the analogue theory of cybernetics. The following will review the "Basic Notions" and summarise the remaining only as they relate to elements of ATPMs.

Beer is emphatic that we are "discussing exceedingly complex, and probabilistic, systems of a homeostatic character" (para 2, page 23) and much as Arthur describes "dynamic systems" Beer introduces dynamics along with "entropy" as an ordering system (page 26) with its ability to change a system's level of complexity (becoming less probabilistic but not more deterministic).

In Chapter IV Beer introduces "feedback" and the works of von Foerster (American Society for Cybernetics. and Von Foerster 1969, Foerster 1979, 1995) indeed on page 33 Beer notes how Keynes "General Theory " expresses the relationship of dependences between the different factors but steps into Keynes error by assuming that the economy is in general homeostatic or self regulating without satisfactorily identifying how this self-regulation is arranged. Keen (Keen 2011) and Arthur both show that this is unlikely in a classical sense.

Chapter V introduces purposive systems and information exposing the work of W. Ross Ashby(Ashby 1956, Ashby 1960) and Claude Shannon to define how the relationship between two machines can create effective regulators and actually illustrating the "scientific process" in the following terms "the model building by which science proceeds to study nature is an activity proceeds to study nature is an activity devoted to the construction of isomorphic machines" (page 42, Para. 2).

Accommodating homomorphism's completes the "one to many" and "many to one" types of regulatory structures that Beer shows Ashby (Ashby 1956, Ashby 1960) stipulates as the necessary "requisite variety" to embraced a model of Nature. However too much variety reduces the ability to control the system and so Beer introduces Shannon & Weaver's (Shannon and Weaver 1949) Information Theory to show that it is Information (the average information-content or entropy develops) and how it can be managed probabilistically through ergodic theory (the manner in which "probabilistic systems settle to certain predictable forms" page 44) that can be used to regulate variety. One aspect of this theory is that they settle independently to the temporal conditions in which they inhabit. This is an aspect Arthur raises on pages 9, 11 and 12 highlighting the fact that different processes exist in differing temporal environments.

Purposive systems therefore are essentially those systems exhibiting functional direction and Beer indicates that the level of entropy and their ergodic nature can measure the performance, or state, of these systems. Beer tells us that "*if there is a tendency for the entropy of a system to rise, the machine is 'running down' – becoming less differentiated*" (page 46) is true for both thermodynamic and cybernetic machines.

Paradoxically this infers that any purposive system that can "*adjust its probabilities*" (page 47), in order to become more predictable, necessarily increases its entropy (chaotic in the Information Theory sense). To counter this tendency within a Company the need to inject more information increases the variety of which will need to be managed. Beer notes that the level of complexity needed to manage this variety leads to another measure of performance – redundancy. He concludes this chapter with an insight on how this is useful to the Company: "*This does not mean that they are becoming more rich in information, for they are not adding to their structure. They are losing information by becoming less and less differentiated*" (page 48).

Beer completes the first section with the subject of "the black box", a device created to handle extreme complexity in cybernetic systems that are themselves in turn deemed as indefinable. Modelling such systems by means of simplifying it to a set of inputs and outputs with no detail of its internal operational structure improves tractability of the whole by transforming the many-to-one renders it "homomorphic" to the cybernetic system.

Drawing upon Ashby's Law of Requisite Variety Beer points out that by estimating the possible states of the system and countering them with a regulator with at least equal or better variety the system can be controlled. In risk terms the ATPM needs to model the possible positions the project may find itself in order to then gauge the relative value of the initial investment.

Beer outlines this technique for handling extremely complex systems described as "input-manipulation, output-classification" and not "cause-and-effect" analysis (page 52). Beer makes an important observation on page 56:

"the blackbox must be designed to operate that procedure effectively……… it intends to behave homeostatically between the variety of the problem and the criteria of survival, by imposing a higher-entropy controller fed with requisite variety for trans for transforming the states of the system experimentally."

Beer immediately compares this whole process to that of the human brain and nervous system, a subject that he will take to some logical limits when devising the Viable System Model in the successor book "the Brain of the Firm".

Sections Two to Five start with tracing the idea of cybernetics and justifying it as a science from the logic of Plato and Aristotle to Norbert Weiner and von Neumann. He emphasises that cybernetics deals in information and uses Zeno's paradox to introduce Gödel's Incompleteness Theorem and how it is applied to the blackbox technique. He introduces us to the theory of automata (Conway(Conway 1971), Holland(Holland 1992, Holland 1999), Wolfram(Wolfram 1994, Wolfram 2002), Tesfatsion(Tesfatsion 2002), Arthur(W. Brian Arthur 1989, Arthur 1994, Arthur 1995, Arthur, Durlauf et al. 1997, Arthur 2000, Arthur 2005), Squazzioni(Squazzoni 2010) and Viglen(Vidgen and Padget)), machines which imitate the behaviour of others machines notably biological systems. On page 77 Beer refers to the United Steel report and links "Black Box Theory" to the title of that chapter "Completion from Without" and the work of the Bourbaki School of France and Kleene in America on set-theory and Gödel/Hilbert on meta-mathematics – the theory of proof.

Curiously Beer does not include Network Theory developed from Euler/Hamilton that would become a major science in its own right from the works of Atkin(Atkin 1972), Braess(Braess 1968), Granovetter(Granovetter 1978), Murata, Kauffman(Kauffman 1993), Strogatz(Strogatz 1994, Strogatz 2003), Barabasi(Barabási 2003, Barabási 2003, Barabasi and Oltvai 2004) and Watts(Watts 1999, Watts 2002, Watts 2002, Watts 2003). This is not surprising considering that, as Beer wrote in "Pebbles to Computers"(Blohm, Beer et al. 1986), "*the facility afforded by computers to retain and manipulated data was fast developing and at the time were only just taking advantage of transistor technology*". Most of the authors here developed their theories post 1995 and Beer developed the VSM, based upon existing network knowledge, but did not research further their implications to the VSM[xviii].

One of the few graphics in the book illustrates the relationship between control mechanism and real life. The text from Page 79 – 81 is quite important in describing how the internal control mechanism must be strong enough in variety to manage real life otherwise, and citing Gödel's Incompleteness Theorem, the system must be controlled from outside by a higher, or meta-language, that can.

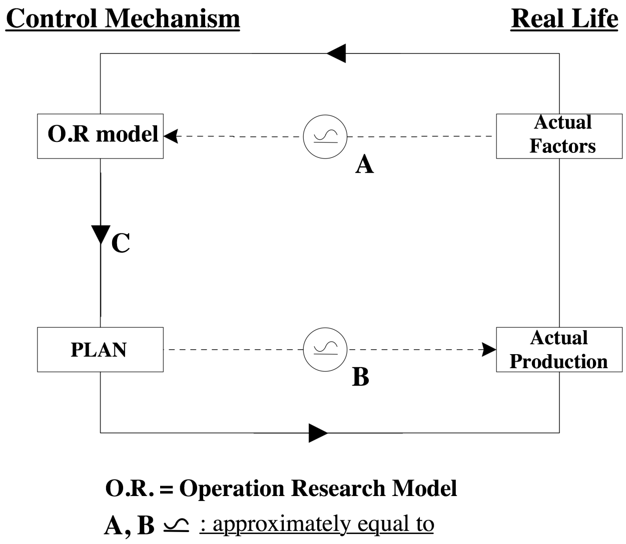


Figure 31: Figure 2, Page 80 Cybernetics and Management: Stafford Beer 1959

In figure 31 Beer is describing the "feed back" process between "Real Life" and the "Plan" generated by the "O.R. model". The effective measurement process is the correlation between A and B, being the mathematical representation of the system, indicating that the control language is effective in describing the system. As the control language "within" the O.R. model is inflexible another feedback process is introduced to modify the generated plan based upon a "meta-language" "*external to the enclosed system*" that modifies the diagram as follows:

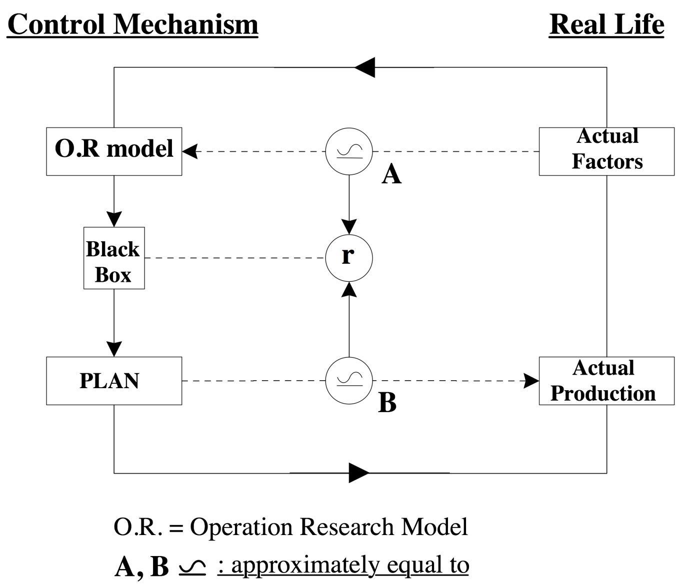


Figure 32: Cybernetics and Management Figure 1 page 77 - Stafford Beer 1959

In figure 32 the “Black Box” is the meta-language that affects the control system and “r” is the measure of it. Beer’s focus on “variety” is embedded in the language used in the formulae of A and B. Here, using Ashby’s Law, he shows us that the successful use of variety in A and B will lead to a level of equivalence between the Control Mechanism and evidence from Real Life (Ashby 1956). At all times Beer refers to the “state of the system” not an outcome.

It is at this point that ATPMs become an important factor of the discussion and one that Beer also raises in another paper (with John Casti) in 1975 “Investment Against Disaster in Large Corporations”-“IAD”(Beer and Casti 1975), at what point should all stakeholders take into account the adequacy of: the correlation between A and B; the variances in r; and the construction of the Black Box? Though not mentioning ATPMs as such Beer is addressing the issue of commercial outcomes from “plans” in both C&M and the previous United Steel Report: he labels them “strategies” in IAD.

The commercial outcomes Beer is concerned with are predicated upon a plan that he suggests is constantly modified according to the dynamics of its economic and physical context. In both he is introducing us to the types of models needed to take into account the variables required to meet the shareholders commercial objectives.

In concluding Section I using Beer's words:

> *"In the same way, Completion From Without, admits the facts of industrial life to the incomplete control language which describes it. But in this case we must expect the new element itself to be incapable of detailed definition: We must expect it to be a Black Box"(Beer 1967)page 81"*.

Beer has used Gödel's Incompleteness Theorem to illustrate that the models used within commercial control systems are in fact a language that are inadequate to the task of defining the whole and that an external "meta-language" is needed to solve this but even this language has its own indecisiveness. When reviewing Arthur's Complexity paper we also see that systems can produce chaos (non-defined) endogenously ((Arthur 2013), page 5), that foils a managers or investors choice of path, however Arthur is referring to the Economy for which there is Knightian Uncertainty(Knight 1921) and Technological Innovation whereas Beer is concerned with the control language requisite to manage the system. Disequilibrium in commercial terms could therefore be compared to Beer's view of the Incompleteness Theorem in control mechanisms: the lack of internal definition in control terms leads to wrong outcomes so the language of control must impute better definition by being a meta-language outside the current control mechanism. From this platform Beer is leading us to the concept of "recursiveness" reviewed later that becomes essential to the Viable System Model in "The Brain of the Firm".

Section II – The Logical Theory of Cybernetics took the reader through its origins, the design of a meta-language to control the commercial system in the real world, the computability of numbers and Turing's Halting Problem through to the Theory of Automata, machines that seem to act intelligently and to a purpose. Collectively Beer is setting the reader on a course to understand not only the mathematical parameters needed to encompass the control mechanism but also that the internal language of a system may be insufficient to control it along a specific strategy and an external reference point is required, with all its own deficiencies.

In Section III – The Biophysical Theory of Cybernetics - Beer brings us from the abstract to the Real World with the analogy of the machine as a biological entity and vice versa. Discussing not only the degree of complexity required to cope with Real World events in a control system for commercial planners but also introducing Von Neumann's ideas he introduces the Homeostat of Ross Ashby (Ashby 1956, Ashby 1960) that "*a well-controlled system acts like a homeostat*" (page 117). When the control system is imbued with sufficient variety and the homeostats operate efficiently Beer brings us to Ashby's concept of "Ultrastability" from his Law of Requisite Variety where it can be "*achieved only by a cybernetic machine empowered to meet the random information conveyed to an environment of high variety with internally generated random information of equal variety*"(page 118).

Beer's description of Ashby's Homeostat lays the groundwork for all that comes next as follows: "*the homeostat first adjust itself to the external situation; it turns itself into a machine for dealing with that hitherto unspecified problem, and then solves the search for orthodox stability*". This is a reflection of the System described above which Beer credits Ashby with the ability to "*to isolate the mathematical principle behind adaptive behaviour in general*". The parallel between biological and commercial systems begins to be made by Beer as we move toward two machines that can learn and teach introducing the works of Uttley(Uttley 1979), George(George 1965) and Gordon Pask(Pask and Scott , Pask 1961, Pask 1975, Pask, de Zeeuw et al. 1992).

Although Beer gives us a sketch of the Cybernetic Factory in Section III (see Figure 6), which we will see as a pre-cursor to the Viable System Model, he then moves on to actually gives us an insight into the cybernetics of commercial incentives and something core to ATPMs.

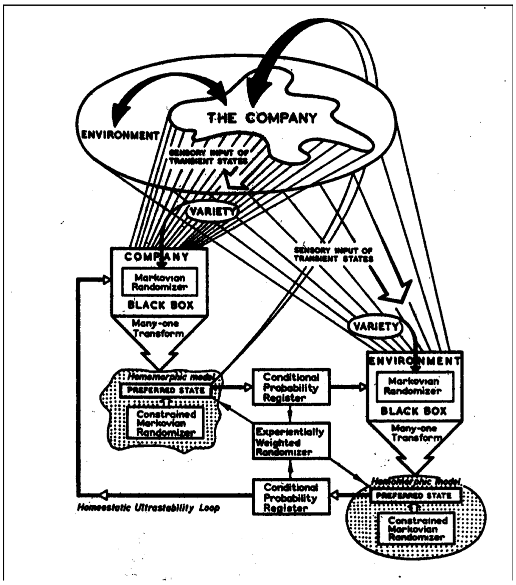


Figure 33: The Cybrnetic Factory: A Stafford Beer, Cybernetics and Management 1967

Figure 34 outlines the process Beer takes to analyse this:

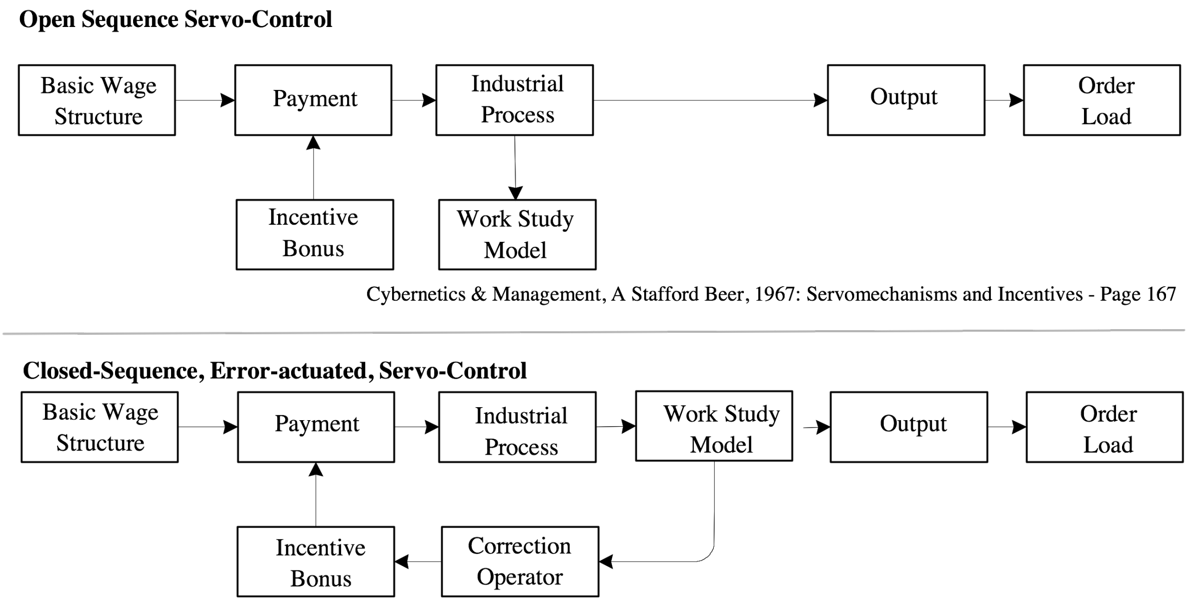
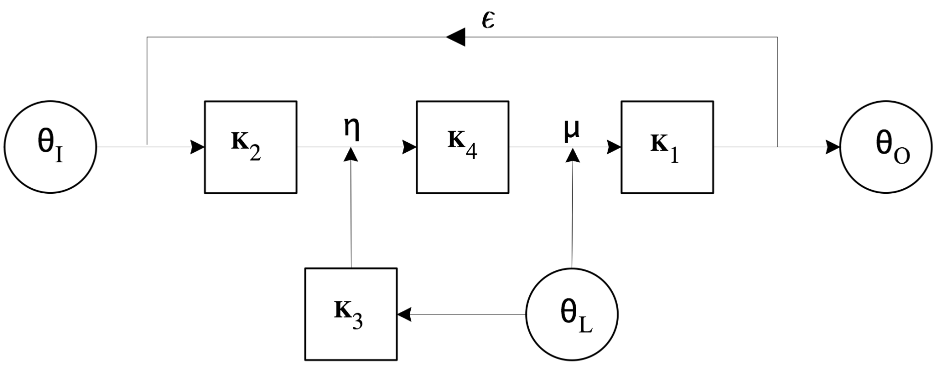


Figure 34: Beer's Incentives Management Scheme – C&M p168

The upper part describes an ideal situation using a servomechanism approach (Beer physically demonstrates in a video[xix]) of Porter's steam turbine. It is ideal because in real life the loads and pressure vary making the process unstable. Trying to counter this problem in a closed system approach is proposed in the lower half effectively stopping the "run away" system problem introduced by varying loads and the open-system trying to compensate (this is an adequate description of Arthur's endogenous chaos or instability). However Beer equally notes von Bertalanffy's(Bertalanffy 1973) proof that trying to seek a route to "Ultrastability" (or as Arthur would put it "equilibrium") in a closed-system is not possible: "equifinality" being all routes lead to the same result is not possible in closed systems (page 169): and so Beer brings us back to the discussion of a meta-language required to resolve the paradox of achieving a decidable outcome from a commercial process using a closed-system approach.

Between pages 170 and 181 Beer discusses the work of Simon (Simon 1957, Simon 1957) in trying to apply a full mathematical servomechanism approach to industrial product and proposes a simplified model in figure 35:



Where:

θ_I	Raw material *I*nput	K_1	Flow rate modifier - Load to Production	ϵ	*E*rror function: Diff. between Input/Output
θ_O	Material *O*utput	K_2	Flow rate modifier - Error to Planned	η	*I*nput *O*utput - Planned Rate
θ_L	*L*oad from order arrivals	K_3	Flow rate modifier - Load to Planned	μ	*I*nput *O*utput - Actual Rate
		K_4	Flow rate modifier - Actual to Planned		

Figure 35: Beer's C&M Equations for Incentives p171

Beer introduces us to the equations, whether linear or non-linear algebraic, that can use the Laplace transform, (Pierre-Simon Laplace (1749-1827)) who progressed the work of Euler and others. However it is important to note Beer constantly reminds us that Cybernetics deals with "probabilistic" not "deterministic" systems and that the language used to determine commercial systems cannot be "closed-form" and is always itself "indeterminate".

Contrast this to the deterministic methods of early Political Economics (Ricardo, Malthus and Mills), the exact assumptions required to price portfolios of stocks

(Markowitz(Markowitz 1959)), finally the assumptions of Fama (Fama 1991) and Black-Scholes(Black , Black and Scholes 1973) that exact prices can be predicted and equilibrium (Ultrastability) maintained.

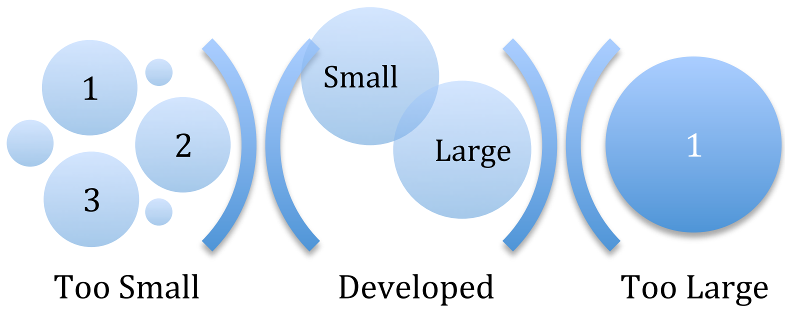


Figure 36: Types of Company

Beer has introduced us to the company as a cybernetics machine. Whilst there are issues that persist throughout the review of the VSM, and addressed later, he shows us that when handling economic information the company needs to optimise its organisation of components to ensure that not only do they manage the level of entropy within the system but also the shape of the organisation itself has to its ergodic tendencies.

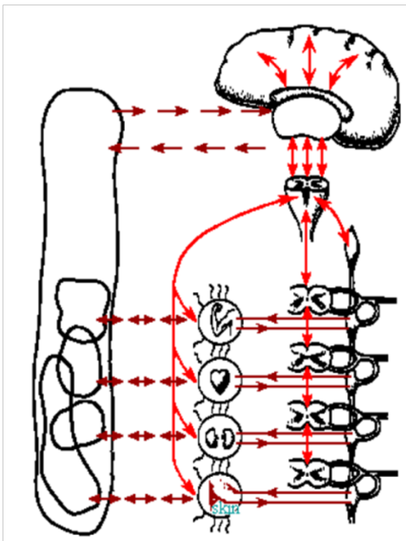
This infers that there is a complexity component to organisations (see Figure 9) that Arthur and Watts would recognise: the former as to very large systems tendency to create dis-equilibrium endogenously; and the latter to the implications of Small World Networks(Watts 1999).

Having laid out the basics of cybernetics and management Beer then moved to address issues that Coase (Coase 1934) would recognise in defining the Company or firm: its boundaries; what makes an efficient information management process; and what isomorphic/homomorphic structure is necessary if the entire company is to remain viable. All throughout his work, time is deemed to be variable and system dependent.

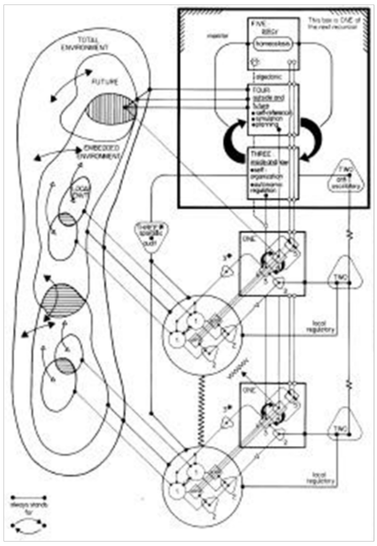
Beer shows us that it is wrong to assume that a business is too small to be viable, inferring that it would not have sufficient complexity to manage the variety of information required, although scale is important. Equally not to assume a company can be too large whereby it loses differentiation as it leaks information required to control itself, although there are certain limits. This shows us that cybernetics can frame a model that allows the company to adapt and learn to sustain its identity if it follows certain criteria. In the next 10 years Beer then develops the VSM to illustrate just how this can be accomplished.

Chapter 2.1.2.9.3: Developing the Viable System Model

Effectively Beer had separated the process from the knowledge of any enterprise and found a common, scalable approach that shared resources automatically without a central command structure leaving that function to implement strategy. Having identified the semi-autonomic processes (interlocking homeostats) within the human body that allowed distributed command Beer now needed to be prove it could be applied at scales higher than an individual corporation. His chance came when Chile needed help in bringing its economy into the 21st century.



Comparison to the Human Body



The Final Model

Figure 37: the Brain of the Firm: Beer's Mapping of the Human Nervous & Para-Sympathetic Systems

Beer recognises that a commercial entity is coupled to a competitive environment (Beer 1985) where a constant stream of data informs models the outcome of which need to be communicated effectively to implement strategy. By separating and optimising this process from any knowledge base Beer gives us a template for viability that has been applied to a variety of systems from Hurricane management in Hawaii to Military Strategy (Harnden and Leonard 1994)xx.

Indeed the latter may also assist in understanding its derivation as Beer spent time in India and Operational Research for the U.K. Army (Espejo and Harnden 1989) where Group commanders must acquire, interpret, decide outcomes and implement any strategy using local commanders and troops in the field. Beer's differentiation of data, models and communication channels speaks to Shannon's Information Theory that is intrinsic to the VSM in using a clear central strategy communicated across a network sharing resources and data by commanders who know their local topography to effect its outcome.

Beer's abstraction of a biological management process to social organisation might be applied in most governance situations and it is therefore not surprising that Sun Tsu's Art of War (Tzu 2007) or Myamoto Musashi's Go Rin No Sho (Book of Five Rings) (Miyamoto and Harris 1974), being primarily military philosophy, mirror this approach by using metaphors in the business management environment.

Chapter 2.1.2.9.4: Beer, The VSM and Causality

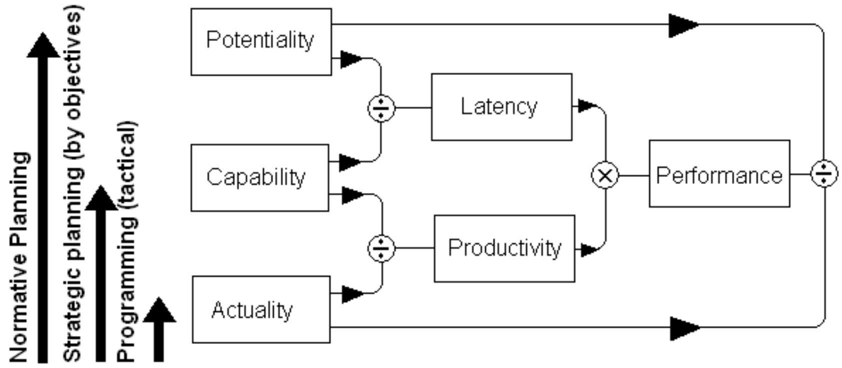
Cybernetics and Management Beer states that Cybernetics is a tool for managing "*probabilistic" system and not "deterministic*" or "*cause and effect*" chains. However he describes feedback systems involving incentive plans, steam engines and biological systems that can learn, indeed teach. In some way then Beer has a concept of causality in the traditional sense but in a control sense he is quite explicit in The Heart of the Enterprise (page 290 – 292)(Beer 1979) that "*causality*" when it comes to the management of large systems is not an appropriate methodology.

Drawing on Hume's (1711 – 1776) view of causality [xxi] Beer questions existing management's approach to finding the "cause and effect" of events. As Beer points out on Page 290 large systems fail because they are potentially unstable "*No unique event is the cause….*" and "*even when the event is intrinsically disastrous of itself, it is not possible to isolate it from its systemic milieu*". An analogy could be the act of walking, or running, viewed as a "constantly falling over" at a young age a toddler recognises that standing is achieved by a constant set of muscles counter-acting the desire of the body to fall by adjusting the centre of gravity back to an upright position. However changing the centre of gravity to a forward position and increasing the range of actions of lower limb placement affects the act of walking. This is a complex set of feedback mechanisms based upon experience of a heterarchy not hierarchy of muscles and not unlike the complexity found in a large organisation.

Beer's solution to causality in the system is simple – ignore the unique cause approach and concentrate on the "Am I alright" loop that assess the relationship between "the Actual", "the Potential" and "the Capable" nature of the system. Much like a child assesses that they "are alright because they are not hurt" knowing where they actually are compared to what potentially could have happened and, upon reflection, what they were capable of doing. Beer is opening the discussion to performance metrics of a Viable System and the Cyber-Filter on Page 293 of the Heart of the Enterprise.

Chapter 2.1.2.9.5: The VSM's Performance Metrics – The CyberFilter & Variety Management

The CyberFilter seems to be a simple set of performance metrics set at each level of the recursive structure of the system in focus and is usually depicted in the following form:



actuality: "What we *are* managing to do now, with existing resources, under existing constraints."
capability: "This is what we *could* be doing (still right now) with existing resources, under existing constraints, if we really worked at it."
potentiality: "This is what we ought to be doing by developing our resources and removing constraints, although still operating within the bounds of what is already known to be feasible."
Beer adds "It would help a lot to fix these definitions clearly in the mind." System 4's job is essentially to realize potential.
He then defines ***productivity:*** is the ratio of actuality and capability;
latency: is the ratio of capability and potentiality;
performance: is the ratio of actuality and potentiality, and also the product of latency and productivity.

Figure 38 Replicated from "Brain of the Firm 2nd edition" by author

The value of the orthogonal sum of recursion levels would equate to market capacity for the product. However it is more than just a simple capacity issue.

Beer gives us a complete analysis of “measurement” within the VSM from “variety indices” to “business performance”. The introduction of the CyberFilter in the Brain of the Firm (Beer 1972), page 171, coincides with his explanation of the regulatory function (System 2). However a fuller description in the Heart of the Enterprise (Beer 1979), pages 499-509, start with the discussion on “real-time” data as it stood in 1979 where he gives us the following outline of a reporting system:

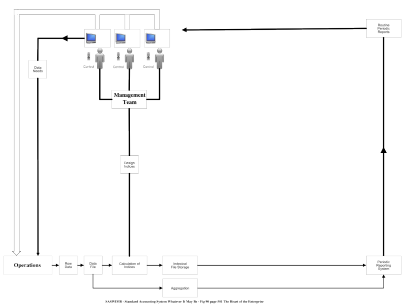


Figure 39: Redrawing of Fig.92 Heart of the Enterprise

Beer anticipates the development of computational ability, which we now take for granted at a desktop level, but Beer's systems were "main frame" and the time delay critical due to acquisition and reporting design (HoE page 500). Beer's observation on reporting is that not only are reports hopelessly out-of-date but that the instabilities responsible for causing a disaster would not necessarily be observable immediately even though the brain is good at pattern recognition, he introduces the Bayesian statistical theory of Harrison-Stevens at this point, something he experiences in Chile when creating the first fully fledge application of the VSM.

Beer has moved the focus of management away from traditional "forecasting" to "filtration" of insipient instabilities in the present (Chapter 11 of the HoE, "Measurement") and page 502 he develops the introduction to the CyberFilter. Beer's contention in 1979 was that current accounting systems were not constructed to address continuous streams of data (HoE page 503 bottom) but periodic reporting which remains the case today (Morlidge 2010, Morlidge and Player 2010).

A cursory review of the CyberFilter would conclude it to be a similar set of performance metrics, which because they are assessed from a recursive business model are at best complementary to existing metrics like profit, Return on Investment etc. This would be a grave mistake as Beer points out existing performance metrics lack requisite variety ((Beer 1979),Chapter 11). What Beer is driving toward is the active identification and management of instabilities than the passive acceptance of adverse results blamed on the market or bad management.

Beer's faith in the Harrison-Steven's method was its ability to increase sensitivity in analysis in response to adverse movements in time-series data. To achieve this Beer created a model universe wherein normal data indices created by management are updated continuously with new input, updated but stored in a companion file from which comparisons can be made. Beer calls the matched time stream in this model universe "Bogus Real Time" in allusion to the assertion that in doing so the statistical method had created a data stream from which his "instabilities" could be measured. The complete diagram, page 505 of HoE, is figure 40:

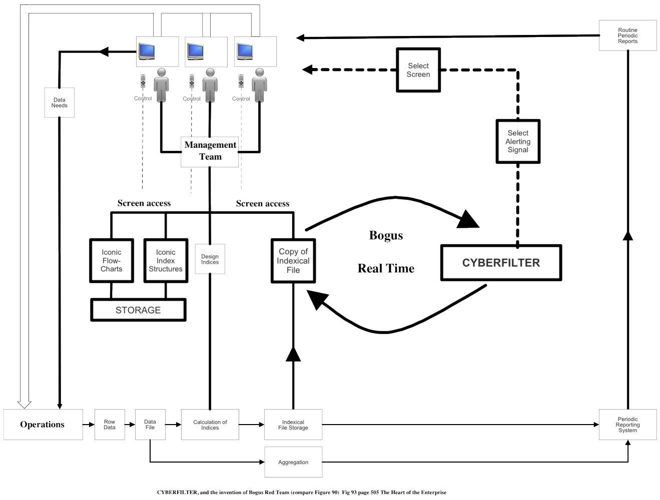


Figure 40: Redrawing of Fig 93 on page 505 of HoE

Beer expounds the theory behind his metrics more fully in HoE than BoF giving examples of cybernetic intervention but in BoF Beer walks us through a territory more familiar to financial officers and treasurers, the faults inherent in existing reports and how they should be amended.

Beer opens with the simple observation of the corporate model in System 4 (BoF page 183) presented to “businessmen by their advisers”:

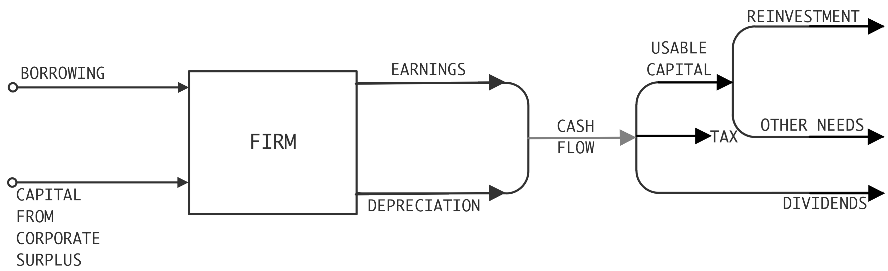


Figure 41: Fig 34 - Time unfolds left to right

The continual redrawing of this figure to take account of reinvestment is ineffectual to Beer who considers it lacking in its representation of a firms dynamics. By considering the firm as an adaptive system Beer starts us on the path to analysing performance in terms of feedback loops and continuous adaption by altering the above see figure 42:

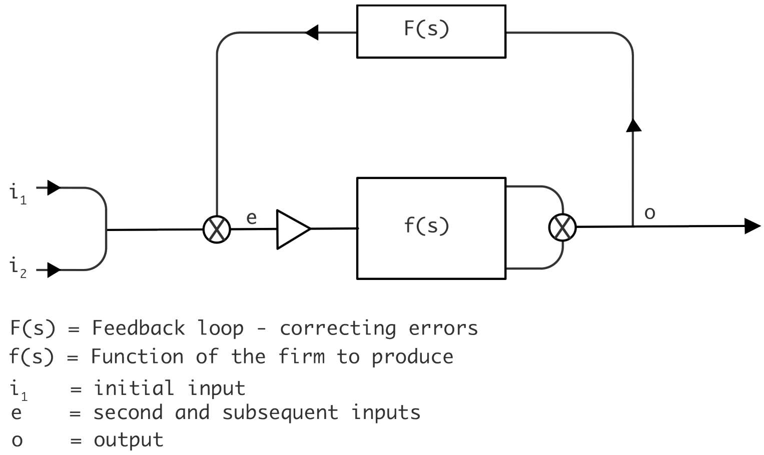


Figure 42: System 4 Corporate Model as continuously adapted

In conjunction with R. H. Anderton, Beer expanded this model to take into account the development of improve upon and innovate new products including the market variables "Y" for the cost of capital in the marketplace (figure 43).

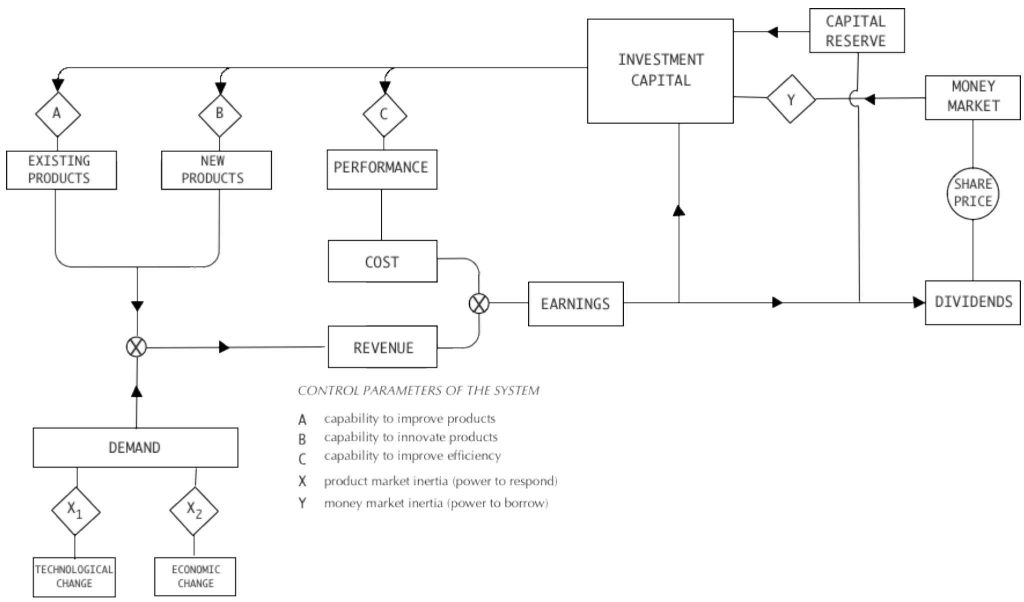


Figure 43 Replicate from "Brain of the Firm 2nd Edition" by author

These parameters are arranged in the model as control settings and feed the various model scenarios that are stored and compared to reality in a feed-forward process. The result of this comparison is the feedback loop that adjusts the parameters. Here we see "i" again as the initial input unfettered by adjustment but "e" is the second and further iterations adjusted by reality and the model scenarios f(s), f1(s) and F(s).

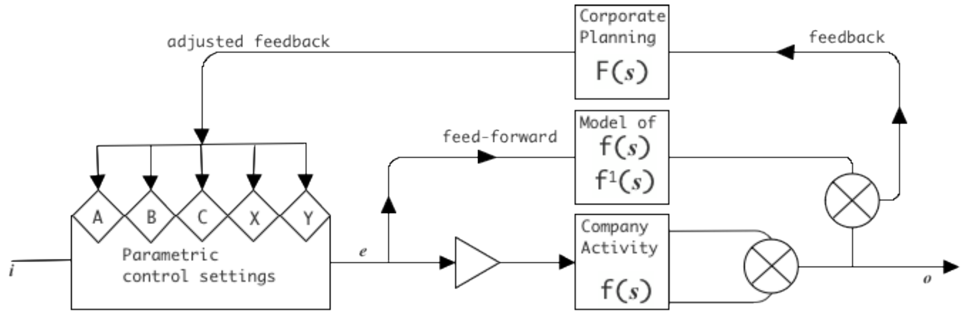


Figure 44: Fig 37 from Brain of Firm

Beer goes further to help us arrange these in a manner that allows us to combine difference divisions into one condensed diagram [see figure 46].

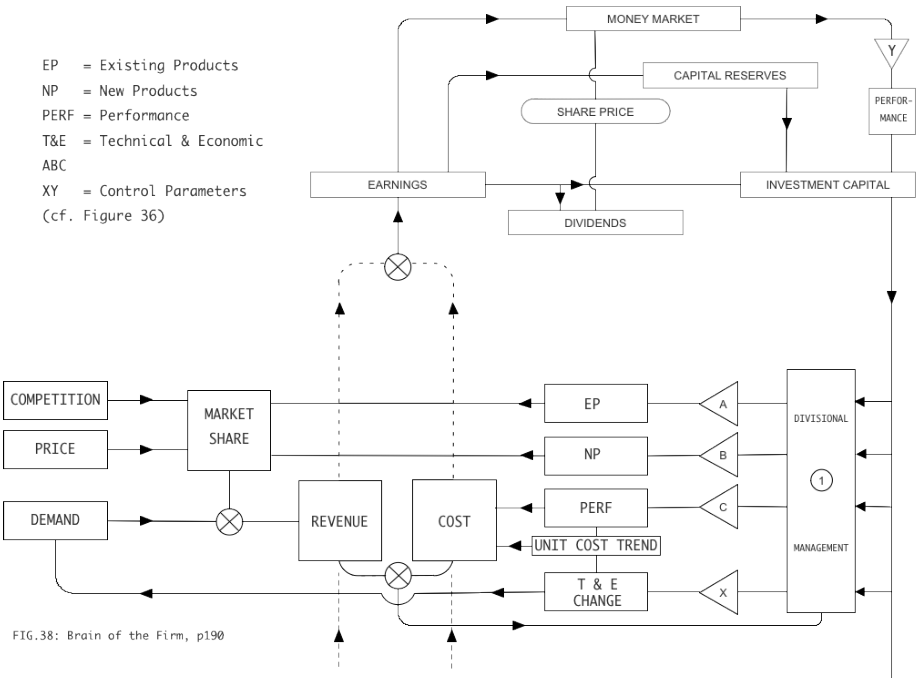


Figure 45: Brain of the Firm Fig 38

It is figure 46 that will be used to show where GHOST's basic proposals operate and how the model braids with Beer's work.

Beer's attitude was that it is "better to dissolve a problem than solve it" (Beer 1966) and to stop using solutions that fail and pose the problem in a soluble fashion. To this end the VSM is more about variety management than new metrics; and his abstraction of the nervous system as a form of biological governance into an organisational model for business starts to take form.

To Beer standard management metrics lacked “requisite variety” but the paradigm of “return on investment” persisted and remains at the heart of ATPMs. In order to supplant this approach we need to show how Beer viewed ATPM’s as embedded within the VSM; this starts with a single recursion diagram (Figure 45).

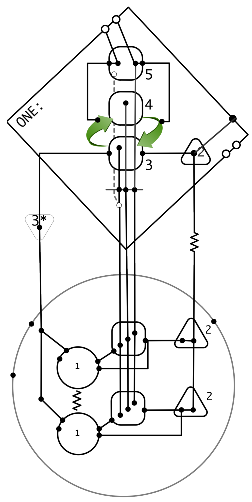


Figure 46: One Recursion VSM

A fuller explanation of the “six” Systems 1 – 5 is best found in Morlidge (Morlidge 2010) but in the following Figure it is the green arrows that are of interest, for whilst they are usually depicted in many illustrations without explanation, Beer goes to some length to show how System 5 influences management in System 4 and the twin coupling that exists between System 4 and System 3 (Figure 47).

Beer notes in the left hand diagram that a variety amplifier and attenuator could exist between S4 and S5 but that as S5 would not have sufficient variety it would devolve into an autocracy. Beer solves this issue by leaving S5 as a general monitor but with the power to influence outcomes leaving the management at S4 to control capital flows down through the system. This is Beer putting differential meta-languages to work.

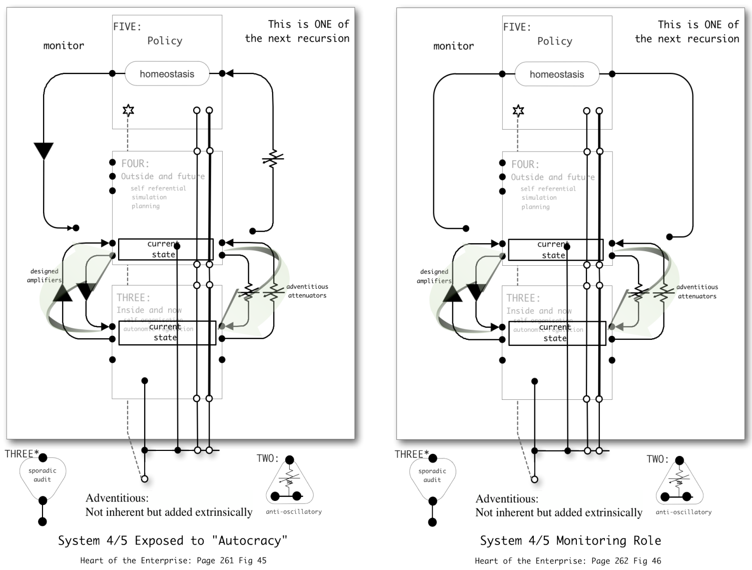


Figure 47: Systems 4/5 - Autocracy or Monitoring?

The reflected green arrows are in fact two-sets of amplifier/attenuator systems that continually monitor and manage the variety status of the business using the tools he devised with Anderton. The relationship between S4 and S3 has become known as the "capital jostle" which aptly describes its role within the firm as it relates to the investment capital at hand and where the ATPM model operates.

Variety management can essentially be described as the coupling between two sets of oscillators: external; and internal. The internal oscillator's role is to be tuned such that it goes into or out of phase with external events thereby either amplifying or attenuating them: building the internal oscillator to match the variety of frequencies external events present can extend this metaphor. This coupling process can be broken down further and exposes an element of system science seldom considered in conjunction with the VSM – Systems Dynamics.

Chapter 2.1.2.9.7: The Viable Systems Model and Systems Dynamics

Continuing our metaphor of coupled oscillators removing the ability to tune according to phase and frequency would leave either an amplifier or attenuator depending upon the separation stage. Referring to our discussion above on Systems Dynamics we can see that the VSM could be arranged such to parallel the simple "reinforcing and balancing loop" structure we found in System Dynamics.

This occurs in two places within the VSM: at each Recursion Level and within the communication lines themselves. The following two graphics highlight how these can be shown in figure 48.

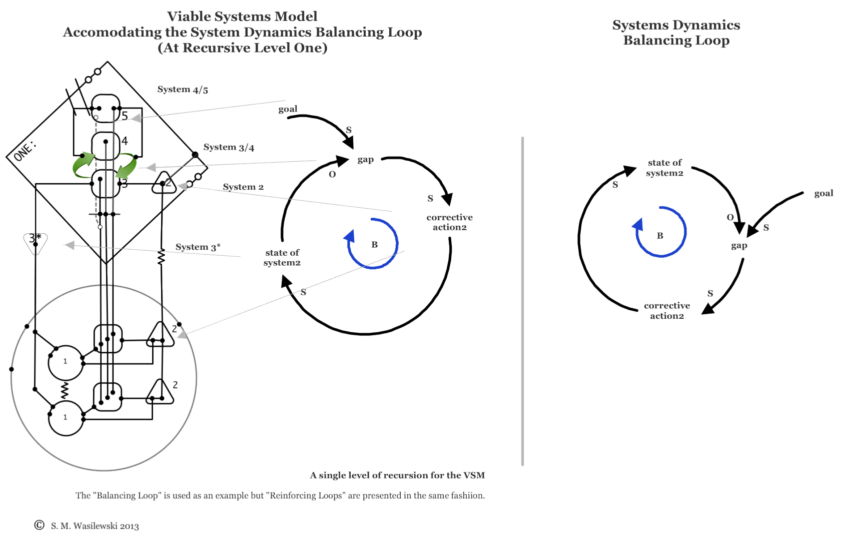


Figure 48: Illustrating the VSM and Balancing Loops of Systems Dynamics (Recursion Level)

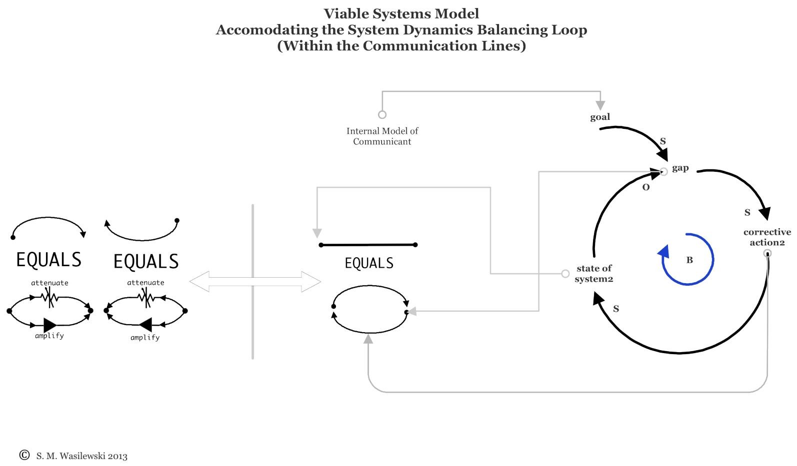


Figure 49: Illustrating the VSM and Balancing Loop of Systems Dynamics (Communication Lines)

It may not be readily apparent in the second example how the "goal" enters the scene compared to a Recursion Level. It is clear in the latter that the "state of the system" is supplied by System 3*'s audit process that is passed to Systems 3 and 4 and at the same time, to System 2 if it needs to act. Systems 4 and 5 maintain the "Goal" from whence it is passed to System 2 and local Systems 2, 3 & 4 to ensure it is processed.

In the case of the communication lines the internal model of the participants in communication supplies the roles of Systems 3, 4 & 5. Their understanding of strategy should be a sympathetic model to that of the enterprise itself. Their ability to "attenuate" or "amplify" actions resonates with the "balancing" and "reinforcing" loop processes found in Systems Dynamics.

The ability to embody recursive structures to System Dynamics processes is a major step forward and brings a new level of complexity. Though only the "balancing loop" is illustrated above the "reinforcing loop" is straightforward to imagine. See Schwaninger (Schwaninger and Ríos 2008, Schwaninger 2009, Schwaninger 2009)

Expanding the process to two-recursion level is illustrated (Figure 50):

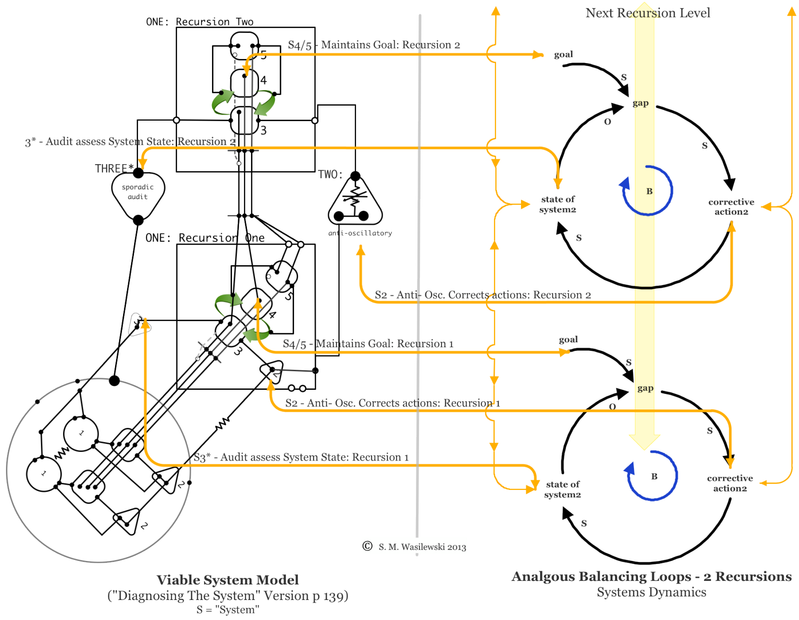


Figure 50: Two-Recursion Level Balancing Loop versus VSM

In terms of performance, keeping to objective, a guide is the degree of connectivity between the different operational parts. A useful metaphor could be the regularity of a multi-pivoted pendulum where the degree of connection, or communication of objective, between the goal strategists and operational management is reflected in the pivot links of a pendulum, an illustration in figure 51:

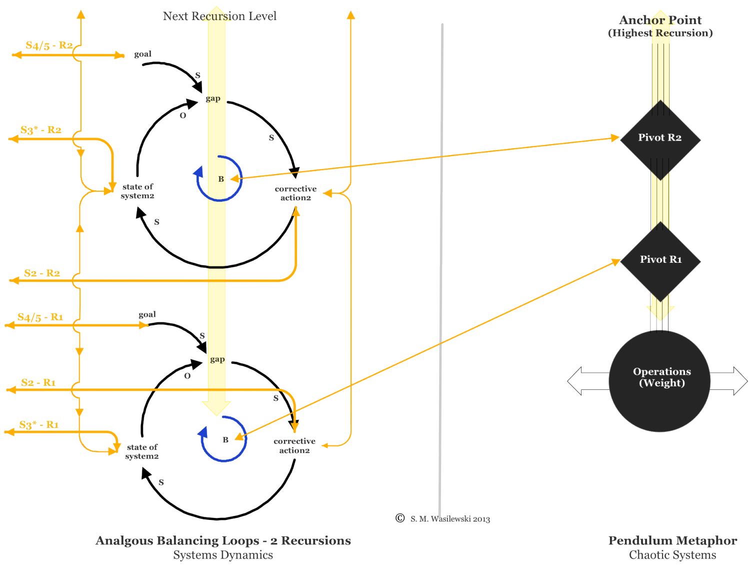


Figure 51: Using the Two-Pivot Pendulum as a Metaphor

Here the anchor point of the pendulum is the origin of the strategy, the goal setter. In terms of the VSM, the strength of the communication chain between the Systems 4/5 of the top most level of recursion, the data-gathers (System 3*s) and those responsible for effect the instructions (System 2s), will determine whether the production team (here representing the weight of the pendulum) keep to the strategy. Any weakness at the junctions, the pendulum pivots, and the regular frequency of the pendulum will turn into chaotic movements until no predictable pattern is discernable[xxii].

In this metaphor, where successive driving and dampening forces stimulate a pendulum, the production unit is driven out of control if management cannot affect control of the enterprise through the exchange of data and control mechanisms: production will wander its own course.

If we reintroduce the discussion on meta-language and causality from C&M then we can see that the Systems Dynamics approach becomes a fixed language and prone to its own instability and we revert to the problem Beer wished to overcome and the need to reintroduce a meta-language to the control systems else complexity will increase along with the potential instability.

Chapter 2.1.2.9.8: Memory and the VSM

Curiously there are only two specific listed references to memory in Beer's books: C&M page 35; and Brain of the Firm page 96. However the role of memory is critical and can be inferred from the C&M discussion as to how it manifests itself.

Under the heading "Feedback in a Psychological Context" Beer refers to the "electronic computer" memory storage unit as a naïve metaphor. The principle reason being that as a metaphor for the analogue human memory is infers long-term storage but omits the need to "forget" – "*surely, is something which stores – but stores selectively, Moreover, it does not store indefinitely: it also forgets*". Whilst Beer is not allocating a location for memory (Atkinson and Shiffrin (Atkinson and Shiffrin 1968) will publish on that subject the next year – 1968) he allocates in the final picture of United Steel's model and within the Cybernetic Factory's "Black boxes" registers to store the parameters for feed-forward processes.

When Beer expands his thinking to encompass the VSM, whether you take the final diagram in "Diagnosing the System"(Beer 1985) or the initial one in "Brain of the Firm", it is apparent from C&M that: feed-forward mechanisms must store parameters; and recursive organisational models must store either whole models or just individual parameters in some form of memory for different periods of time dependent upon their functional use or level of recursion. As this is a socio-economic venture the analogue (as Beer puts it) is the human memory and the digital/servomechanism the machine complement.

When discussing Feedback and Feed-forward processes memory is tightly coupled to processes of all sorts, however within the VSM the role of memory within personal models requiring human storage capacity infers that complexity will arise even in the best regulated structures. As the variety of abilities and constant changes in personnel volatility increases in the connections and amplify the probability of "forgetting", or indeed over-riding, the required functional process of the business with personal ideas. Repeated in figure 52 is the graphic for each line in the VSM representing one or more human "analogue" connections that must manage the exchanges according to local task and overall process.

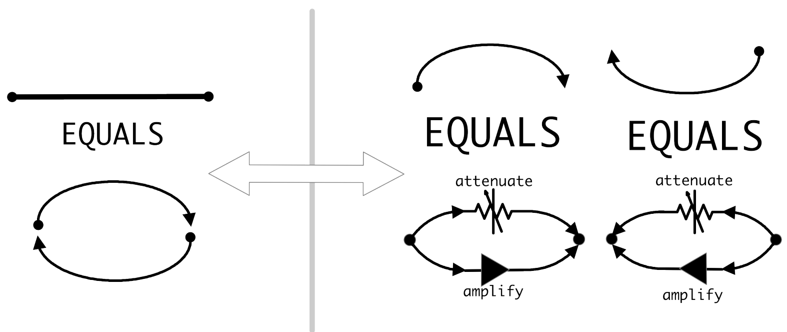


Figure 52: Author expansion of Beer's "Brain of the Firm" VSM sub-diagram

To the designer of ATPMs the VSM may seem a complex model dynamically interacting with its environment over different time periods. However this complexity compensates for the lack of variety management and "closed system methods" in current ATPMs where their absence under-prices risk.

Chapter 2.1.2.10: Criticism of the VSM

Beer is exhaustive in his analysis of business process and systems in general but there are distinct drawback in writing style. Beer's information content is dense and his style detracts from the message.

Including much about the development in Chile throughout is contextually useful but tends to over elaborate. Similarly with the juxtaposition of metaphor "at the bar" and the idiosyncratic diagrams found throughout. There is also the subtle introduction of System 3* between the construction of the VSM in "Heart of the Enterprise" and "Diagnosing the System" that makes all the difference in defining recursion and self-consistency in systems.

Of the depth of knowledge there is no doubt but a more, and clearer, account of the communication lines would assist in understanding where amplification and attenuation of data influences pathology. In this regard a chapter on Shannon and Weaver's Information Theory would have explained transduction, channel bandwidth issues and entropy. Equally an acknowledgement that each line is in fact "dual direction" is mute if the point is omitted that participants in a communication have their own internal model and adds to the complexity of an organisation.

Time, market behaviour and the acquisition of data are addressed but scattered across four books and within other subjects. This is particularly important with respect to "time" as it is an important aspect of any communication system, a core element of information theory and vital to the performance metrics not only within the CyberFilter but also in commercial market where it is a constant division but does not take into account management, process or organisational dependency.

Causality is addressed as a definite subject only in the Heart of the Enterprise, page 291, but referred to in many parts of other works. Its emphasis on moving away from the existing paradigm of single events and blame to circular systemic and instability is well taken, but the search for heterarchy could have been made more clear: Bohm had already written a seminal piece, Causality and Modern Physics (Bohm 1984, Bohm and

Hiley 1993, Bohm 2002), clearly highlighting the fallacious nature upon which we build causal assumptions and then models of our world.

In the CyberFilter explanation in Heart of the Enterprise Beer gives us the development of the Harrison-Stevens statistical method (Richardson, Gordon et al. 2007) used to create indices and eventually embedded within the CyberFilter Accounting process. This method is a Bayesian-Kalman Filter approach that re-uses data in a particular fashion to reduce computational complexity which, if illustrated better, would have shown the role time takes in computing the indices. Equally the data used in the Chile example does not take into account the differentiation of parameters between individual and group behaviour characteristics.

Though Beer is exhaustive in his description of components the distinction between the objective of the VSM as a variety management process and old style performance metrics could have been made clearer. It could also be said that the VSM as drawn only works in a command economy as it illustrates a defined set of recursion levels that, when extrapolated to an ultimate government level, closes the whole system and becomes more like a Systems Dynamics approach. This is disfavours the VSM and has already been addressed above as to-date System Dynamics archetypes alone do not offer recursion as a solution. However the question remains: How can the VSM be adapted to manage variety in an open, emergent, socio-economic system?

Finally one would ask, “How do organisations create viability?” to which one anonymous author kindly supplied the following as a graphical guide:

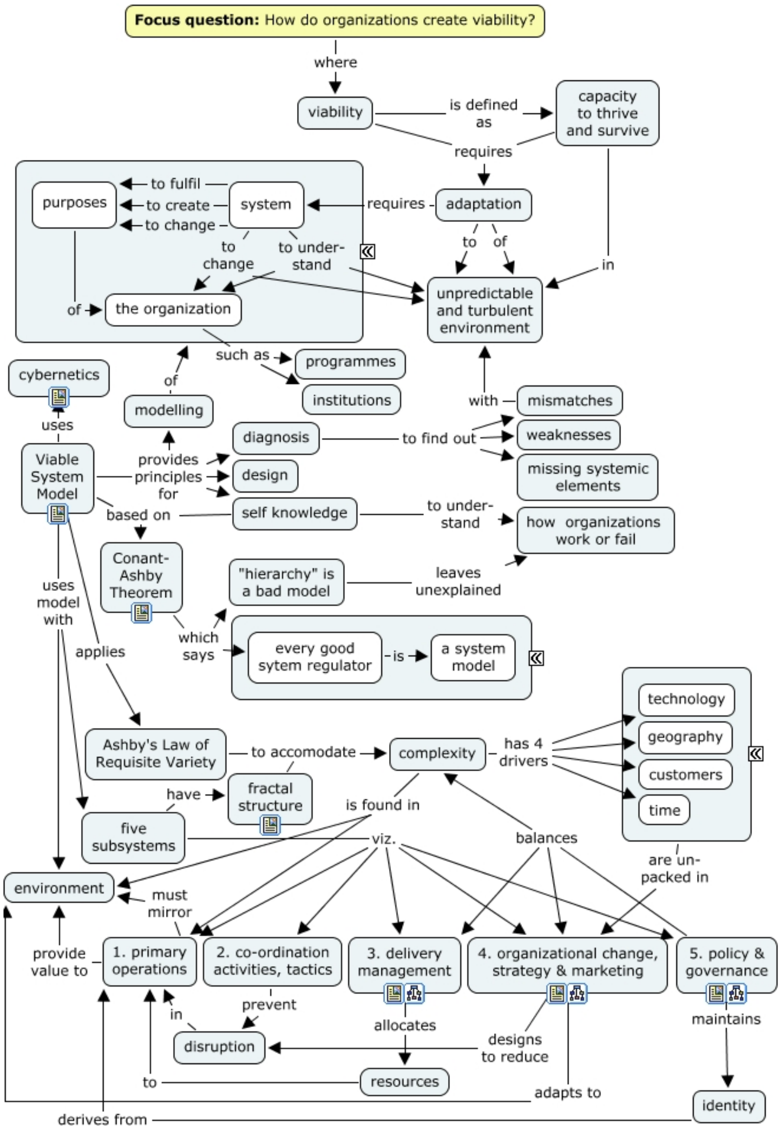


Figure 53: Author unknown - Original file name "VSM-CLS4D ConceptMap.jpg

Chapter 2.1.3: Complementary Systems Models

"*Increasingly we are aware that the large systems we attempt to manage show signs of disastrous breakdown. For purposes of this discussion, we define disaster as the passage of some important systemic variable beyond a threshold of acceptability. Thus in managing the ecosystem, we may find that pollutants have killed all the fish;...........a firm may go bankrupt*."(Stafford Beer/John Casti: Investment Against Disaster in Large Corporations(Beer and Casti 1975))

From Janskengard we saw that cash flow risk is a difficult metric to gauge and the threat to the on-going nature of the firm related to the processes as well as the financial structure at any one time. The risk of default is not therefore just a financial consideration but determined upon how well the governance of projects is executed. In Jankensgard case the example was Norsk Hydro's ("NH") balance sheet, its current and future debt load before and after disposal of assets.

It can be considered that if disposals did not meet the targeted returns or NH retains residual business risks, such as environmental liabilities, then ex-post sale liabilities may not be stable which, in turn, will damage their liquidity standby.

During his development of the Viable System Model Beer absorbed much of R. Buckminster Fuller's work on Synergetics (Fuller and Applewhite 1975) a philosophy within which resided 'tensegrity'- tensional integrity- (an architectural system in which structures stabilize themselves by balancing the counteracting forces of compression and tension giving shape strength in both natural and artificial forms). Fuller himself was heavily influence by Loeb's "Space Structures" that dealt with space, its geometrical constraints and a quantitative method to express them.

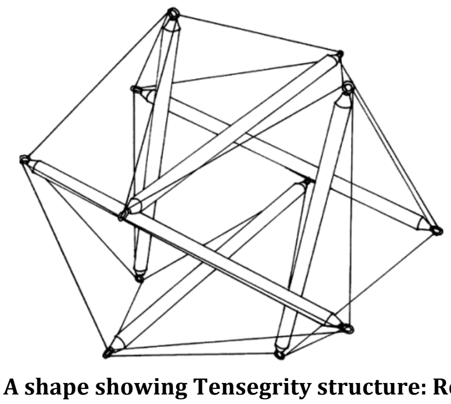


Figure 54: A shape showing Tensegrity structure: Rod and Line

By substituting the structure of the firm and noting mean communication times for the lines and rods, Tensegrity could provide a framework to show how systems can be measured in terms of their networks relative communication performance: effectively the forces that need to flow across the system are data and transcription time.

Beer, as well as Pask and Vester, developed these models to explain an enterprises' component functions, how learning was achieved and what metrics really counted in order to then build a model. Time in this essence became integral to the system and process dependent.

Time for dynamic systems is therefore characterised by the relationships between the execution of multiple variables expressed in geometric form as a surface or topology. As a model the VSM links the essential functions of a business, vision/ethics, planning/control, audit/learning and production so that it can be used to interrogate any enterprise and as all businesses are embedded in a dynamic and conditional environment, dynamic system theory would therefore sensibly describe its activities.

Systems whether physical, chemical or management emerge in different forms and can be nested alongside or within other systems. It is the pattern of construction of the feedback and feed-forward communication lines plus the quality of materials used that is crucial to whether the business is successful in the long term.

“Time lags”, derived from imperfections in communications highlight the flaws within the structure, show up when a range of external perturbations affect outcomes by amplifying internal problems.

Beer used icosahedrons as the optimum example of communication structure within a business because of its unique ability to distribute force efficiently thereby taking more load. However Buckminster Fuller showed that other structures can be built using the same tension theory but their resilience was related to critical dependences.

The “rod and line” example above is self-adjusting as the forces within it move dynamically to compensate to local changes. However the picture below shows an arch, a sculpture by Kenneth Snelson[xxiii] (figure 55), using the same methodology but anchored to the ground at two points. The metaphor describing a business would be that of depending upon two important anchors the demise of either of which would collapse the whole.

Figure 55: Tensegrity Arch by Kenneth Snelson

The performance, and timing, of the system will therefore depend upon how the structure is connected, the geometry of the pattern and the strength of its communication links. It changes shape but not functionality to meet changes in the landscape it must operate within: an illustration of this can be found in Donald Ingber's 'The Architecture of Life' published in Scientific American January 1998. Ingber (figure 56) identified the structure of a cell then 'connected the dots'. How it reacted to a changing external landscape is explained in the accompanying text.

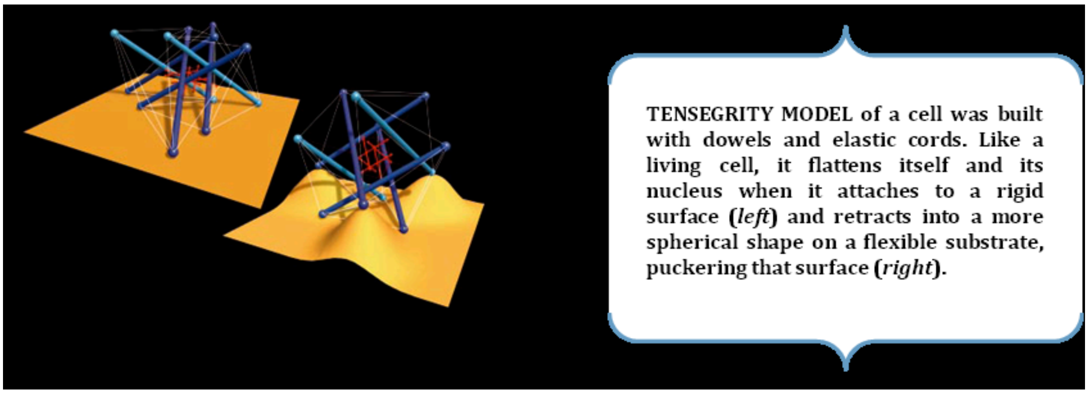


Figure 56: Same Structure Different Shape

Visually the shape of the cell model has changed to accommodate the changing landscape. If the model is not complete or dependent upon components that cannot adapt then the range and magnitude of perturbations to the systems can adapt to shrinks.

In management terms one should say 'only internal the variety of talent within the right communication network can manage the variety of external problems affecting the businesses' and we are back to Beer's use of Ashby's Law of Requisite Variety not only to optimise the viability of a business but also to affect the timing of its processes.

Chapter 2.1.4: A Sense of Time

Vannini (Vannini 2006), Time as a Variable, gives us an insight into how Time has been treated historically and that the "concept of time and the concept of causality" has been central to science. From Galileo and Newton's "mechanical causality" with its Arrow of Time pointed to the unknown future to special relativity's dual solution and "quantum mechanics" complementary waves of past>future, future >past and from 1916 absolute time was abandoned in physics.

Superficially "Time" would seem to be a simple constant against which commercial performance is measured. However "Time" is more complicate and can take on characteristics usually seen in physics (Bird and Einstein 1921, Davies 2005) and biology (Noble 2006, Noble 2008, Maccone 2009, Noble 2010).

For the purposes here it will suffice to state that the concept known as Time commonly used throughout commercial transactions is a convention that we knowingly or subconsciously accept as a constant (Merton 1973, Price 1996, Prigogine 1996, Gollier 2001, Smith and Haakonssen 2002, Prigogine 2003, Stacey 2003, Vannini 2007, Vazquez, R√¯° cz et al. 2007, Weinberger 2007, Mills and Markellos 2008, Noble 2008, James, Mahoney et al. 2010, Marvel, Kleinberg et al. 2011, Wang, Sha et al. 2011) but that commercially "real-time" should be "*to know the trajectory of the system quickly enough to be able to take corrective action before catastrophe overtakes you…"real-time"…is therefore always (in this framework) relative to what you are trying to do*"[xxiv].

We noted in C&M that Time was relative to the functionality of the system and therefore process dependent. As all systems are different this would infer that "time span" within which process must occur are different and comparative measure become a variable required to adjust internal system processes to an external common timescale.

Whether scale is invariant is not the issue it is whether there is a scaling factor available along the lines of biological allometry (see (Stevens 1946, Stevens 1968, Platt and Silvert 1981, Max-Neef, Elizalde et al. 1991, Shingleton 2010, MacKay 2011)) considering the constant parallels drawn by Knight, Langlois and Beer herein.

The effect of continuous change on Tenor/Time Horizon is a central aspect of finance. It affects the calculation of the complete range of investment products: return on equity, internal rate of return on bonds and most fundamentally its effects on statistical metrics. The problem is time is not linear when it comes to dynamics and that is why probabilistic outcomes are considered as a viable method of managing risk: a process responds to change independent of linear time.

Herein lies a problem: Investors need to know the likely default probability or failure rate of equity in order to know whether to invest. Measuring economic change at a country level does not give the type of granularity required to effectively pick a good portfolio and too granular an approach make portfolio analysis computationally unwieldy.

A critical path is something well known to project financiers as well as the critical inflexion points of a business development plan (figure 57). It could be said that ATPMs also manage a critical path, mindful of these inflexion points and the adverse liquidity strains events they may put upon them.

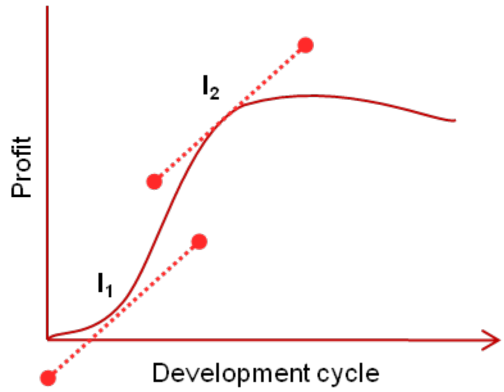


Figure 57: Capturing the second inflection point I2

Processes that assume an infinite time horizon, complete integrability, intensity functions and stochastic stopping points have underlying assumptions that generally do not fit real-world dynamic portfolio in analysis. How risk is managed and the proper application of its financial tools prompted Robert A. Jarrow to write in 2010 specific papers reviewing the application of risk models before the Crisis of 2007 (Turnbull, Crouhy et al. 2008, Jarrow 2010).

Analysing individual client risk using a recursive Jarrow model would yield interesting iterative changes to its model assumptions. How a recursive Jarrow model copes with portfolio assumptions without recognising systemic coupling is at the heart of the discussion here.

Specifically ATPMs seek to understand the performance of assets not only in the past but also in the future. From a historical point of view ATPMs have priced commercial assets based on times series and correlation statistics assuming that the future is a reflection of the past.

Holling, Ryan, Crutchfield and Shubik will tell you different perspectives of the financial worlds view of time’s arrow and Basu (Basu 1997) will show you that human response to good or bad financial results can be counter-intuitive when regulatory accounting is at issue, time and causality have been financial bedfellows.

However if the assets reviewed within ATPMs are a function of the dynamic systems that create them, and those systems in turn are topologically influenced, then how can a true understanding of time be made available for surely errors in calculating time affect every financial calculation whether it is directly through simple discounting or indirectly through an arbitrary division of times metric when employing the Poisson Process? Beer first offers a solution in C&M and then builds upon it with the VSM's performance metric.

Chapter 2.1.4: Entropy

Surely one of the next issues in dealing with Risk measure is to show how a system behaves over time and we know that there is a significant difference between open and closed systems – called entropy. Though Fuller and Beer systems look "closed" they are in fact built to adapt to exogenous forces.

Entropy has multiple meanings and a great deal of confusion surrounds the relative application (Pierce 1980). The following is a brief list of the meanings of entropy as applied to ATPMs:

Table 4: Entropy Definitions Used In Different Systems Models

Entropy in:	Citation	Brief Description
Etymology		Greek: en-, *in*; see, + Greek trop, *transformation*
Information Theory	(Pierce 1980) p23, (Shannon and Weaver 1949)	In communication theory it is a measure of the uncertainty of the information in a message conveyed from its source. Information in this sense is *not* "knowledge", as popularly considered, but the resolution of uncertainty.
Dynamic Systems	Online[xxv]	
Physics	Online[xxvi] (Schrödinger 1962, Penrose 1989, Beck and Schlögl 1993)	**en·tro·pies** **1.** *Symbol* **S** For a closed thermodynamic system, a quantitative measure of the amount of thermal energy not available to do work. **2.** A measure of the disorder or randomness in a closed system. **3.** A measure of the loss of information in a transmitted message. **4.** The tendency for all matter and energy in the universe to evolve toward a state of inert uniformity. **5.** Inevitable and steady deterioration of a system or society.
Viable System Model -	(Beer 1966)	Classical description (p346). Negentropy, a system gaining in

1	p 345	entropy is losing information, is therefore a measure of information (p 347). A discussion on coupled sub-systems within one system and the organisation of information regarding Negentropy (para 3 p 347).
Viable System Model - 2	(Beer 1966) p491-495	With reference to decision-making: The measure of uncertainty that will be applied to the decision process. When H=0 entropy has disappeared and the decision has been taken (p491). "Now it is possible for the OR scientist to ensure that entropy of each remaining choice is appropriately reduced as the consequence of each choice already made (p493)".

The definitions used here all refer to the First and Second Law of Thermodynamics that they stipulate a closed system. However the definition of the boundary within which a distinction is made again becomes the main concern (see Measurement) and at all levels of recursion from the atomic (Bohm 1981, Bohm 1984), biological (Noble 2006, Vannini 2007, Noble 2010), communication (Shannon and Weaver 1949, Pierce 1980, Ash 1990, Johnson 2001) and organisational management (Beer 1959, Beer 1966, Beer 1972, Beer 1979) it is seen that noise as an external force or dissolves the boundaries under consideration or new research indicates that Maxwell's Demon (Mandal and Jarzynski , Bailey 2008, Crutchfield and Ellison 2010, Young 2011, Barato and Seifert 2013) is seriously under consideration and therefore entropy a convenient local calculation.

The ability to measure entropy in a system is useful to identify the inertia or chaos in decisions within an enterprise, the establishment and changes in agent behaviour, but the cost of measurement itself should be take into account (Bohm and Hiley 1993).

Chapter 2.1.5: From Ising to Cellular Potts

From Cipra (Cipra 1987), Beaudin (Beaudin 2007) and Scianna (Scianna and Preziosi 2013) the development and application of the Cellular Potts Model ("CPM") from its beginnings with the Ising Model offers an insight to why the CPM may be a useful tool for ATPMs. At its core lies the Hamiltonian framework upon which the activities of agents under mathematical guidance transact. It is by replacing the biological approach with the recursive framework of the VSM that ATPMs may observe changes and emergent behaviour when the CPM's Hamiltonian is constructed from observed interaction and network construction. Both the CPM and VSM embrace a probabilistic model of events with outcomes as vectors for strategies.

Chapter 2.2: Conceptual Framework

Chapter 2.2.1: Introduction

Asset Transfer Pricing Mechanisms ("ATPMs") deal with a tightly focused part of the world's commercial activities, the exchange of assets prior to, or the maintenance of, business processes. Whether this is the investment into a factory, housing complex or simply a loaf of bread, it is the internal model of each participant that will govern the transaction. Following the 2008 Credit Crisis the major of the major world economies populace were reminded that, in a highly connected environment, the cumulative actions of a few unregulated agents can have both advantageous and disastrous effects.

ATPMs were introduced here as "Models that are descriptions of the endogenous, exogenous and orthogonal risks/uncertainties that surround a potential exchange of assets associated with which is a process of called "due diligence [xxvii]" - "*A comprehensive appraisal of a business undertaken by a prospective buyer, especially to establish its assets and liabilities and evaluate its commercial potential*".

The description of the "Models" resides in the concept of a worldview but the "due diligence" is a methodology by which the necessary data is acquired and transported to the model (Duarte 2008, Duarte 2010). The proposal is to augment current ATPMs by identifying a general form of this duality, a *meta*-ATPM or *m*-ATPM, which suggests parameters that are currently missing and/or incorrectly calibrated and identifies a similarly augmented methodology with which to acquire the new data. The conceptual framework will be describe in the following sections and the augmented "*due diligence process*" in the Methodology Chapter.

One year after the U.K. Chancellor announced support for Northern Rock and the precipitation of the 2008 Credit Crisis, Paul Tucker (Bank of England) (Tucker 2008) Tucker starts his speech as follows:

> *"As many people have said, this is a challenging time for policymakers. But the real challenge is for households and firms in the real world who are having to navigate the fallout from the*

extraordinary combination of financial and commodity shocks rippling through the world economy"

In the notes the term "Procyclicality" appears that would become the centre of attention for global regulators and defined by Nanto (Nanto 2009) as follows:

> "*Procyclicality: The tendency for market players to take actions over a business cycle that increase the boom-and-bust effects, e.g. borrowing extensively during upturns and deleveraging during downturns. Changing regulations to dampen procyclical effects would be extremely challenging*"

The "*actions*" these "*market players*" take are predicated or sustained by financial models – ATPMs. The "*challenging*" regulations have been discussed over a long period:

- From 1986 where Crouhy(Crouhy and Galai 1986) discussed Banking Capital Requirements just before the 1987 Crash(Reinhart and Rogoff 2009) through;
- Aharony(Aharony and Swary 1996), Durlauf(Durlauf 1998), Meyer(Meyer 1999) following the 1998 demise of Long Term Capital Management(Lowenstein 2000);
- The Bank of International Settlements ("BIS")(Settlements 2002) and William R White(White 2002) (BIS/Bank of Dallas) prior to the 2007 Crash;
- BIS (again)(Committee 2009), Geanakoplos(The Leverage Cycle)(Geanakoplos 2009) and The Turner Report(Turner 2009) and various other regulatory papers up to 2012(Sikka 2009, Blanchard, Dell'Ariccia et al. 2010, Blundell-Wignall and Atkinson 2010, Blundell-Wignall and Slovik 2010, Adrian and Shin 2011, Stability and Keynes 2011, Batten and Szilagyi 2012); and
- Pzsar, Awrey and the Financial Stability Board in 2012/13 including the issue of a "Shadow Banking Market" (Pozsar and Singh 2011, Awrey 2012, Board 2013).

Superficially ATPMs would seem, to the broader populace, rooted in a simple mechanism of barter between two or more parties with the aim of either: acquiring some assets to develop an investment plan; or invest assets to meet a particular financial. However it is when asked to consider the meaning of price, value, risk and time that complexity starts to emerge and to amplify this complexity most risk models use time as a constant without correlation to the processes embedded within.

ATPMs, being so embedded within the socio-economic network, events arising therefrom may not be directly perceived in the wider economy yet their indirect consequences certainly have been and so in order to assess the conceptual framework involved it is felt necessary first to examine some of the issues that arise from the subject matter before commenting upon whether one philosophical sort or another best frames the approach taken.

From Chan(Chan 2006), O'Brien(O'Brien and O'Brien 2004), Rothbard(Rothbard 1988, Rothbard 1995, Rothbard 2002, Rothbard and Rothbard 2004), Myrdal(Myrdal 1953) and Hayek(Hayek and Shenoy 1972, Hayek and Shenoy 1979) we are given a perspective of Political Economy in the 20th and 21st Centuries that addresses some of these issues but they tend to be macro economic and expect the reader to have developed a good background in the core philosophies of Smith(Smith 1759, Smith 1776), Ricardo(Ricardo 1817), Walras(Walras 2010) and the major macro-economic philosophers. All looked at the issues and what lay behind commerce comparing their "modern" thoughts against those of the Greek(Langholm 1979, Langholm 1983, Langholm 1984) and, on occasion, Arabic(Nasr 2006) philosophers.

As ATPMs largely concern the possible exchange of assets within an economic environment closely tied to human society it would be natural to assume that there would be a sociological bias featuring the views of Marx(Marx, Moore et al. 1887), Weber(Weber and Shils 1949) and Durkheim (Durkheim and Lukes 1982). Although there is some empirical foundation due Marx (Marx, Moore et al. 1887, Smith, Engels et al. 2008), in economic analysis of the Credit Crisis(Mulgan 2009), much to the consternation of some Western Governments, the remainder of his work is deeply flawed (see Scott Simon on Weber's view of Marx(Simon)p17) and tainted by misinterpretation.

Mark Granovetter(Granovetter 2002) in his "Theoretical Agenda for Economic Sociology" gives us a deeper appreciation of sociology's development in the 19th & 20th Centuries from a kind of Newtonian philosophical framework to a more Quantum Mechanics and Network-based approach that builds upon Simmel's (Nakano and White 2006, Shubik and Smith 2009) focus on the connections and dynamics between individuals and the societies they create, both religious and commercial.

Scott Simon sums the comparison between Marx, Weber and Durkheim:

> “*While differing in many respects, these founding classical sociologists all share insights that have proven relevant to current times. Capitalism, the division of labor, class struggles, religious ideologies, and productive forces are all still with us today. And the struggle to gain understanding of the relationship between the economy and society has been greatly aided by their substantial theories*”

Within this piece we see the inertia of classical economics and its sociological influences that Granovetter starts to dissemble from the “block” allocation of society from either a religious or commercial background into a network theoretic approach where the tensions of individuals and groups differ not only in their propensity to either compete or cooperate (see also (Morgan 1975, Ward 1993, Bingham, Eisenhardt et al. 2007, Dresher 2007, Rumelt 2011, Dylan 2012)) but the direction of influences: see Keynes at Bretton Woods comment on Hayek in Nasar(Nasar 2011) on planning and totalitarian states.

Any current comparison between the old and new players would not be complete without adding Smelser(Smelser 1976) 2013 version, Epstein(Epstein 1999, Epstein 2006, Epstein 2008), Hale(Halé 1995), Davies(Davies and Gregersen 2010), Kauffman(Kauffman 1993, Kauffman 1995, Kauffman, Maguire et al. 1999, Kauffman 2000, Kauffman 2008, Kauffman 2012, Vattay, Kauffman et al. 2012), Barabasi(Barabási 2003, Vázquez, Dobrin et al. 2004, Vazquez, Rácz et al. 2007, Barabási 2010, Karsai, Kivelä et al. 2011, Onnela, Arbesman et al. 2011) and of course Ashby(Ashby 1956, Ashby 1960), Maturana/Varela(Maturana and Matríztica , Maturana and Varela 1980, Maturana Romesín 2012), Foerster(American Society for Cybernetics. and Von Foerster 1969, Foerster 1972, Foerster 1979, 1995, Von Foerster 2003, Von Foerster, Müller et al. 2014), Pask(Pask and Scott , Pask 1962, Pask 1975, Pask, de Zeeuw et al. 1992) and Beer(Beer 1957, Beer 1959, Beer 1966, Beer 1974, Blohm, Beer et al. 1986, Beer 1994, Beer 1994, Beer 1998) to Granovettor’s. Whilst there are many more and all connected to the development of a network theory of interaction and communication these have been selected to extract the core principles involved.

Before proceeding to detail why these may assist perhaps now is a place to provide a sketch of the conceptual framework surrounding the augmentation of the Viable System Model and its application to ATPMs.

The overall framework sympathises with the view gaining ground over recent years that the Economy is much like an ecosystem[xxviii](Haldane and May 2011) and that the methods used to investigate biological systems can be applied to the organisation and dependencies that create the Economy.

In order to remain consistent I have augmented the definition of 'Economics[1]' to reflect a 'living relationship' between 'agent(s)' that themselves could be 'ecosystems' in a recursive[1] process. A possible metaphor might be - a forest within whose boundary trees, insects, and animals are coupled within/to the whole; communicate and act out a dance of cooperation or competition. Here businesses within the Economy could correspond to a complex of components, say within an animal, that achieve a cooperative arrangement with its endogenous and exogenous networks and collectively be considered as an "ecosystem" (Fuller 1971, Lovelock 1987, Kauffman 1993, Noble 2006).

The metaphor may a priori be understood but it would be useful to have a definition of "recursion" as it is a vital concept within System-Biology, organisational cybernetics, eco-system and model construction. Its origin in the late 18th century where it was in the general sense comes from late Latin "*recurs*- 'returned' (from the verb *recurrere* 'run back')" + -ive. Specific uses have arisen in the 20th century particularly in economics where George Soros(Soros 2008, Arthur 2013) has developed his own approach.

There are two current definitions in the Oxford and World dictionaries that most aptly describe how they will be applied herein:

> *Mathematics* & *Linguistics* relating to or involving the repeated application of a rule, definition, or procedure to successive results:

- e.g. "*A class of mathematical problems is called recursive if there is an algorithm for finding the answer in each individual case*"

  Computing relating to or involving a program or routine of which a part requires the application of the whole, so that its explicit interpretation requires in general many successive executions:

- e.g. "*Self-regulated learners engage recursively in a cycle of cognitive activities as they work through a given task*"

In organisational cybernetics and particularly relating to the VSM we have:

Angela Espinosa gives us Beer's:

- "*the Law of Recursive Viable Systems:"* in a recursive organisational structure, any viable system contains and is contained in, a viable system'. ((Espinosa 2010)p118).

Stephen Morlidge (Morlidge 2010)

- Recursivity is a feature of hierarchically organised systems, whereby the same structural features are replicated at different levels, thereby demonstrating the parsimony of natural invariance (Beer, 1979). Recursive systems demonstrate fractal geometry

Where there is general agreement conceptually between Espinosa and Morlidge's definitions and that applied herein there are two areas of dissonance as follows:

- The use of *hierarchy* and *fractal* by Morlidge:
  The Oxford Dictionaries define "hierarchy" as "*a system in which members of an organization or society are ranked according to relative status or authority*" by which the implication is a rigid embedding structure of like agents. As both Morlidge and Espinosa are referring to Beer's *Law of Recursive Viable Systems* where the "agents" are "viable systems" it is possibly true but in the real world, and certainly in Systems-Biology(Noble 2006, Vannini 2007, Noble 2008, Noble 2010, Noble 2011, Noble 2012), this is a very restrictive case as emergent functional viable entities may make use of any component from any other "recursive level" even sub-components of other functional entities if those components are synergistic[xxix] and a higher level of functionality is obtained. The same applies to "fractal" where again Morlidge is applying the term to Beer's Law but topologically a fractal structure would exhibit the same properties at each level whereas we shall see that different functional objective have different operating

parameters at different levels of recursion, especially as to processing speed (Time frames) as the higher the level of recursion the longer the timeframe due to transduction through multiple pathways.

- The use of “and is contained in” by Espinosa:

  Here Espinosa is specially talking about Beer’s Law but in reality there may be emergent “viable systems” that exist within a context that of itself is not, but if the relative timeframe of the latter is so exceptionally long and provides the raw materials for the latter where is the boundary and distinctions to be made. This strikes at the heart of the Enlightenment/Romantics debate between holism and reductionist philosophies both metaphysically and physically is there one system or many, are we doomed to the “heat death” of entropy?

As it seems the above is applied to ‘recursive viable systems’ the contention here is that:

> At some level of organisation there are emergent agents who are become viable over one timespan but not over longer horizons as resources in a dynamic environment allow other emergent agents to arise. The issue therefore is – What timeframe and boundaries conditions are required to define viable systems?

The hypothesis requires that in order to remain viable their boundary conditions and operating parameters must be common in *each reference frame*. Beyond this organisations may emerge temporarily but doomed to wither unless the conditions for Autopoiesis become available: i.e. become closed and aware of their ability to sustain themselves.

The treatment of time is therefore vital as *temporal conditions for each organisation are different for each reference frame and predictability has a time horizon (Vester 2007)*. This distinction of temporal viability and viable system is important when it comes to ATPMs as the investment horizon must be within a viable economy or one where the components are readily available to allow emergent structures to appear.

Biologically, and economically, the description posited here is one of a heterarchical and dynamic set of processes and emergent recursive agents that exist within a common set of core resources.

The temptation at this point is to set a new definition but Maturana and Varela (Maturana and Varela 1980) offer a conceptual insight to overcome what Beer, Gödel and Goodhart (Goodhart 1985, Goodhart 1988) discussed as the limitation of closed systems and Foerster (Foerster 1979, 1995) saw as “negentropy”.

Maturana/Varela introduced the concept of Autopoeisis – effectively the biological process of self-sustaining chemistry that has moved across to Luhmann’s(Luhmann 1993, Luhmann 1995) Social Systems Theory and included in Beer’s own VSM. Being self-replicatory and not “allopoietic”, where one system is designed to construct something other than itself, the proposition embodies the observer-observed conundrum similar to Descartes “*Cogito ergo sum*” – “*I think therefore I am*” and yet there must be two languages operating in tandem, one to sustain the building of the entity and the other to manage the boundary conditions.

Noble (Noble 2006) describes the chemistry of the heart in terms of a single element seemingly dormant until an electrical imbalance is reached at which point it acts as a catalyst returning the whole chemistry to the start and maintaining the whole – the beat of a heart. Could we define this as Autopoiesis or homeostasis?

On the other hand we know that Beer applied Gödel’s logic of closed language systems to overcome a management control issue(Beer 1959, Beer 1972), Goodhart applied Gödel to show why rule-based regulation leads to arbitrage, and Foerster generalised the whole to create “second-order cybernetics”, describing the process of meta-languages controlling lower-level processes as the observer-observed problem.

The concept here is that self-replicatory, or self-sustaining, systems have been rigorously described. In economic terms Keynes General Theory (Keynes 1937) notes Mandeville's Fable of the Bees(Mandeville 1723) – Private Vices, Publik Virtues - where the collective actions of agents (the Private) sustains a larger system. This is effectively a complex feed-forward, feedback process the parameters of which are different at each of the levels replicating the two-languages creating feedback loops to sustain the whole - albeit imperfectly.

One could therefore image layers of economic agents cooperating across whole industries the result of which is an emergent commercial entity with sector, national and/or transnational boundaries. However in order for the collective agents to form a coherent pattern/system, and therefore layers of recursion, the conditions for autopoeisis[xxx] must be met such that the successive language(s), and parameters they use, create the same effect Beer applied in creating his Viable System Model.

Finally layers of recursion need not consist of agent(s)/components whose identity is the same across all layers, but according to Beer's VSM their functional forms must be.

One could now start to build a definition of "recursion" that also allows the braiding of the operating processes involved within a commercial context that may be a more accurate model for ATPMs. It is necessary because ATPMs must be cognisant of the endogenous operating structures of its target investment and the exogenous markets that comprise its context; especially with regard to both of their abilities to communicate within and between each other. We shall use the following definition from here onwards and expand the focus to ATPMs other component issues:

> **Recursion:**
>
> Is a dynamic, conditional process whereby a nested, each within another, set of self-similar *functiona*l forms emerge within a broader contextual set of resources.
>
> It is dynamic because each emergent level of recursion:

- Exists in a probabilistic environment from two main risks:
  - Must compete with other agents to maintain topological structure for both endogenous components and exogenous resources; and
  - The impact from environmental changes.

It is conditional upon:

- The continued existence of resources within which they are all embedded;
- Upon the availability of a stable set of functional components that fulfil the same functional whole, independent of strategic objective;
- Functional components must meet the conditions of Homeostasis and/or Autopoiesis; and
- Its topographical structure enables and maintains transduction across the whole.

It will likely exhibit the following properties:

- Self-similar variety management processes within functional forms;
- Allometric scaling factors of its topographical structures and transduction timescales

Recursion – a shorthand description:

- A set of dynamic systems formed like "matroyshka dolls" dependent upon a broader contextual set of resources. Its temporal existence is scaled relative to the embedding context and topographical structure

It was important to take the effort to define recursion in this context because it will allow the comparison of conceptual frameworks used in other organisational systems and taxonomy for ATPMs.

Let us analyse ATPMs in terms of a meta-model(Foerster 1979, 1995) using the recursive definition, compare it to how Beer developed his Viable System Model and try to identify any differences. First a restatement of:

Asset Transfer Pricing Models:

ATPMs are those dynamic, conditional models used to gauge the value of a prospective use, and current employment, of assets.

They are dynamic due to:

- The nature and volatility of global and local physical conditions
- Changes in local and global regulatory and governance structures;
- Changes in exogenously driven financial parameters; and
- The availability of data to support initial and ongoing strategies.

They are conditional upon:

- The construction of the internal and external performance indicators and models;
- The types of risks specific to each use of the assets in the targets, including but not limited to:
    - The nature and volatility of global and local physical conditions
    - Changes in local and global regulatory and governance structures;
    - Changes in exogenously driven financial parameters;
    - The physical and control processes employed within the project;
    - The maturity of the technology and ability of those to employ it according to the operating parameters required;
    - The construction of the internal and external performance indicators and models;
    - The production, management and governance structures within the target required to meet the objectives stated;
    - The ability of the target to acquire, disseminate and inform the governance structures;
    - The ability of the target to disseminate strategy effectively to adjust direction if required; and
    - The ability of the target to identify market availability and changes in behaviour of its own, and other, agents.
- The maintenance of the internal processing capability;
- The physical and control processes employed within the business;
- The maturity of the technology and ability of those to employ it according to the operating parameters required;
- The production, management and governance structures within the business required to meet the objectives stated;
- The ability of the business to acquire, disseminate and inform its governance structures;
- The ability of the business to disseminate strategy effectively to adjust direction if required; and
- The ability of the business to identify market availability and changes in behaviour of its own, and other, agents.

The risk parameters of the investor (the business) and the issuer (the target) are, in effect, the same but viewed from different lenses: they are self-similar structures reminiscent of recursion symbiotic and co-dependent.

Equally important is its level of abstraction as a model from the target investment as a few examples may elucidate using an anecdotal scale (author's) for importance and references where available:

Importance scale: 0 - 10: Low - High

Table 5: Anecdotal Importance Scale of Parameter Change

Criteria	Example Type			
	Purchase bread	A technology project[xxxi]	A financial product[xxxii]	Islamic &/or other religious criteria[xxxiii]
The nature and volatility of global and local physical conditions	3	5	8	8
Changes in local and global regulatory and governance structures;	2	5	10	10
Changes in exogenously driven financial parameters;	4	8	10	10
The physical and control processes employed within the project;	1	9	9	9
The maturity of the technology and ability of those to employ it according to the operating parameters required;	2	9	9	9
The construction of the internal and external performance indicators and models;	0	8	8	8
The production, management and governance structures within the target required to meet the objectives stated;	0	8	8	8
The ability of the target to acquire, disseminate and inform the governance structures;	0	9	9	9
The ability of the target to disseminate strategy effectively to adjust direction if required; and	0	9	9	9
The ability of the target to identify market availability and changes in behaviour of its own, and other, agents.	0	9	9	9

Notes:

Bread: We normally would not care about the ability of the baker to manage the shop if purchased before but we may be concerned about the future of crops and it effect on price.

Technology: In contrast though physical and regulatory changes may affect outcomes of a technology investment but they can usually be insured or compensated for respectfully in the business model. Whereas the remainders are vital if the managers are to implement and sustain the business.

Financial: As we will see in the case study physical conditions can materially affect a portfolio of risks especially if the product supports a financial institution, itself a leverage entity. However changes in accounting, legal and regulatory structures will materially affect both the current assets and liabilities of the institution as well as the future performance of their customers. Under Basle BIS Sound Capital Planning Process: Fundamental Elements(Committee 2014) the fundamental components are listed as: Internal control and governance, Capital policy and risk capture, Forward-looking view, and Management framework for preserving capital.

Islamic etc: A predicate of most faith-based investments is a set of conditions that filter acceptable investments. In the case of Islamic Law, and most Torah-based systems, this filtering system applies not only to the type of potential investment but also to the manner in which the arrangement is constructed. The best-known Islamic/Judaic rule being the prohibition of usury but interpreted as “interest” labelled “haram” meaning “sinful or forbidden” in the former. This however does not obviate the application of all the other aspects of ATPMs as they apply to apply to the proper execution of these and the other entire requirement necessary to execute and sustain the “promised return”.

As a reprise it should be noted that, within ATPMS, the desired successful outcome of an investment is not the initial investment but the completion of the strategy and receipt of the objective returns. It is therefore important for the investor to understand how the target operates within its milieu, not for the last 5-years, but for the length of time the investment will be outstanding. In addition dynamic, conditional environments require dynamic management(Beer 1959, Beer 1966, Beer 1972) that is sustained throughout this term.

Chapter 2.2.1.1: How, and why, Beer Used Recursion

Some of the best articulations of Beer’s use of recursion comes from Espinosa(Espinosa 2010), Harnden(Harnden and Leonard 1994) and Morlidge(Morlidge 2010) but the best is in his own words from “On the Nature of Models: Let us now praise famous men and women, too”:

> "The model of the brain that I developed throughout the 1950s, is a closed system"………. "This closed model was neurophysiological. I used the yo-yo model as far as ever I could, and tested other biological systems against it. The conclusion was that I could never find anything that was inconsistent with what the neurophysiology was saying about regulation -- in particular what was newly becoming known of ecological systems was supportive. But this was a weak outcome in terms of the inductive power of the yo-yo. It worried me deeply that other major systems of the body's regulatory processes could not successfully be mapped, especially the endocrine system. To a holist, it was self-evidently reductive to be modelling even so large a system as the neural brain in isolation, when there were so many biochemical pointers left unaccounted for. This was surely because too little was known about the internal interactions of the definable components. I knew about neurons and their nervous processes. As to the rest -- even at the cytological level there were mysteries. To this day, I feel convinced that too little is known about the glial cells for instance"……. "In Brain of the Firm (1972) I expounded what I had earned from the VSM in terms that the manager might understand. First of all, there was closure. And in order to re-open that bounded concept, I had drawn on mathematics again. Number theory supplied definition by recursion: the bounded system could be re-opened by including recursive models of itself inside itself. The image of *Russian dolls* was helpful so the diagram of the VSM contained icons of itself. Next, using the yo-yo methodology, the VSM was shorn of its neurophysiological connotations."…."However, it was not until *Diagnosing the System for Organizations* (1985) was written that I finally solved the problem of diagrammatic recursion with a degree of elegance." (The author has deleted asides deemed irrelevant and highlighted in italics his own relevancies)(Beer 1998)p78/79.

Yolles (Maurice 2004) reviewed recursion in "The implications of Beer's Ontological System/Meta-System" but Pickering(Pickering 2010) in "The Cybernetic Brain" extends this review to show what he calls "a performative ontology" exists in most cyberneticians but most importantly Pickering identifies an insight to Beer's ontology as put forward as """entailed a faith in agency of matter:….some chunk of nature probably already exists that can help us along the way" and "perhaps we don't need to make the trek (to design the computer)"p236 and on p248 a summary description of the VSM including Beer's own words again on the use of the mathematical application of recursion in describing models of nature that ascribe the benefits of minimal processing power but maximum utility of outcomes.

Beer solved the model of a firm by stepping outside closed-system thinking and using a recursive set of *governance processes* to create commercial viable systems.

Ontologically it is important to make the point that these *governance processes may* have completely different strategic goals, equally they are unlikely to emerge unless strategic synergies between two or more sets of production facilities provide either enhanced returns or solve one or more risks probabilities that may be threatening existing yields. At this point it may be useful to review the conceptual structure of the Viable System Model to ground why this may be valid.

Chapter 2.2.1.2: The Viable System Model: An Ontological Discovery

In the discussion on recursion Beer introduced his approach to modeling real-world structures – the Yo-Yo Model – that emerged from his experiences in business especially United Steel(Beer 1957) and Chile(Beer 1972, Beer 1974, Beer 1979, Beer 1994, Harnden and Leonard 1994, Medina 2006). The following graphic describes the processes:

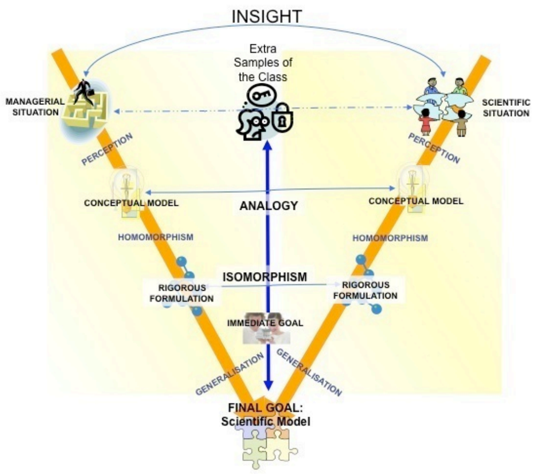


Figure 58: Stafford Beer's "Yo-Yo" modeling process

Though Pickering observed that Beer's "Cybernetic Brain" did not take the logical steps here, Beer himself describes the development of the VSM, as above, by using the model to enquire of Nature, then develop an ontological structure or model that may then be verified independently. In Beer's case he wanted to focus on organisations as viable systems. Schwaninger reviewed is follows:

- *Focus on viability*. The VSM is a framework for the structuring of organizations as viable systems, which deal with complexity adaptively and recursively. This focus on viability does not preclude other theories of management, but it does complement the many approaches which focus on partial aspects of design and control with an integrative view;

- *High level of generality*. The VSM is not concerned with a particular structure, but with a system's essential organization—with what defines the system and enables the maintenance of its identity; and
- *Theoretical propositions.* The main theoretical proposition stipulated by the VSM is that an organization is viable if and only if it has a set of management functions and their interrelationships as specified by the theory. To our knowledge, this proposition is stronger than those of any other theory of organization design. The second proposition is that any deficiencies in this system, such as missing functions, insufficient capacity of the functions or communication channels, or faulty interaction between the functions, impair or endanger the viability of the organization. The third proposition is that the viability, cohesion and self-organization of an enterprise depend upon these functions being recursively operative at all levels of the organization. A recursive structure comprises autonomous units within other autonomous units. Moreover, a viable organization is made up of viable units and itself forms a part of other, more comprehensive viable units.(Schwaninger and Ríos 2008)

These remarks resonate with the comparison in the Literature Review between Systems Dynamics and the Viable System Model, indeed come from Schwaninger's own analysis on that subject as he describes in the introduction:

> *"The purpose of this paper is to show why and how SD and OC are complementary. Both disciplines are rooted in the systems approach, and therewith have bred methodologies for dealing with complexity. Both originate from a common theoretical basis: general system theory and information theory. But each one also has additional roots in disciplines or theories which are specific to it, in particular, neurophysiology and set theory for managerial cybernetics, and engineering and control theory for SD".*

Schwaninger echoes the roots of Beer's work in neurophysiology/set theory, the recursive structure of the approach, its focus on functional organisation and not structure, and the emphasis that communication within a complete set of functional systems must be maintained if the whole is to be self-sustaining. He also gives another definition of recursive structures as:

> *"A recursive structure comprises autonomous units within other autonomous units. Moreover, a viable organization is made up of viable units and itself forms a part of other, more comprehensive viable units".*

The concept then is that Beer focused on viable systems that he ultimately defined in "Diagnosing the System for Organisation(Beer 1985) " comprised of 6-parts although curiously numbered 1 – 5, the sixth being 3*. Along with his functional structure Beer proposed a set of axioms, rules and propositions required to be at all times the proper description of a viable system.

First we should respectively define "viable" and "laws of viability for complex organisations" as Beer did:

- Viable: able to maintain its own existence
  (Oxford English Dictionary)
- Laws of viability: "the laws of viability in complex organisms are not merely, or even primarily, concerned with that energy (like the metabolism of money) that propels them, but with the dynamic structure that determines the adaptive connectivity of their parts. Can the organisation actually survive – assuming that the financial constraints on met?"(Beer 1985)p xi

We have seen from the analysis of Cybernetics and Management that in order to maintain viability Beer says that there must be two forms of language, the primary and the meta-languages in order to overcome the concept of a "closed-system".

The best description of the construction Beer's VSM comes from Morlidge (Morlidge 2010) however Beer's addition of the Algedonic Loop (from the Greek "pleasure" and/or "pain") is of note to ATPMs.

Chapter 2.2.1.3: Formal Closure: The Algedonic Loop

Beer added a small but vital aspect of Viable systems in the form of its requirement for closure as Morlidge put it: "*The role of System 5 is to administer organisational closure by taking responsibility for all those things that lie outside the logical calculus of regulation. Such undecidable propositions can only be resolved by value judgements, like those involved in making trade-offs between investment in maintaining present or creating new capabilities*". These statements and judgments, whether ethical or investment related, are decisive in creating the variety required throughout the organisation and in order to create closure in the communication process Beer recognised it in the form of the Algedonic Signal (from the Greek “pleasure”/”pain”). This feed-forward/feedback loop runs from the “shop floor” to the “Main board” informing the Chairman.

In recent times the Algedonic loop has be given prominence but under the title “whistleblower” an epithet that has denigrated its importance in ensuring that intermediary levels of recursive governance have not collapsed or taken on roles they were not designed. Algedonic signals are important variety feedback signals and should be encouraged from a behavioural standpoint for all participants: Consider that the internal models for each communicant requires the same form of closure, the absence of an external rule in the language of governance creates the opportunity to arbitrage the system Goodhart observed, although in this case it may be for personal aggrandisement.

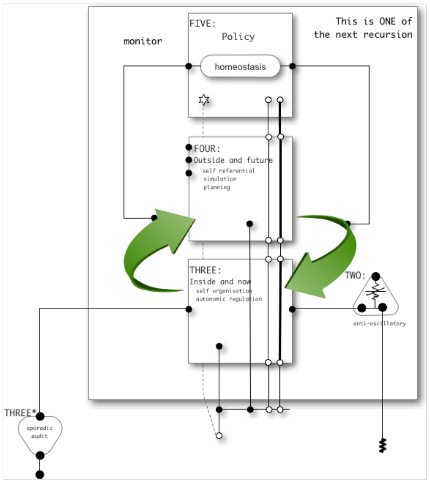


Figure 59: The "Capital Jostle" - Conflict Resolution between S3 & S4

Chapter 2.2.1.4: Conflict between S3 and S4: ATPMs and the “Capital Jostle”

It will become apparent that when the “floor managers” - S3 - meet those responsible for implementing financial guidance - S4, who’s job it is to manage the variety of states the business can achieve using a language incorporating the financial plan, there may be a conflict (figure 59) . S3 may believe that the business is potential is within boundaries but the S4 view may not see the same long-term or return horizons.

At this point the conflict could begin, or as Beer coined it – “The Capital Jostle” (the green arrows). It is also where ATPMs arise within the context of a business because, whether it is using current assets in a more regulatory/tax efficient manner or the investment in an existing or new venture, the process of discovery required to transfer the assets is the same.

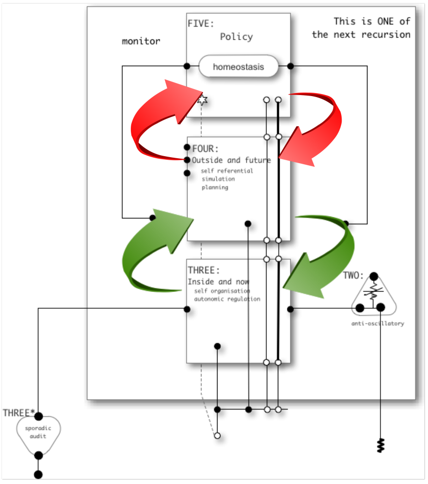


Figure 60: Conflict Resolution between S4 & S5 - Ethos of the Firm

Reflecting upon the definition of ATPMs we know there is an issuer, an agent requiring investment, and an investor, those with assets that need putting to work. Within the description of the firm using the VSM above the production roles reflect the "issuer" (they need capital to employ) and the "S4's" are the investors (the "keepers of shareholders assets"). The model to be employed in assessing the veracity of performance (and therefore expected return on assets) is the same as if the "S4's" were external investors. Functionally the language of the investor (whether external or internal S4) has wider "grammar" than that of the production team, as its objectives are subtly different. This process is replicated at each transition between recursive levels.

Chapter 2.2.1.5: Conflict between S4 & S5: A modern perspective

There is a similar process (figure 60) occurring at the S4 vs S5 level and to interpret Morlidge in another way System 5, as the stakeholder board, must stand outside the general running of the business (see red arrows). This means that the role of the head of that board, the Chairman, though non-executive from an internal governance perspective, could in fact be in conflict with the Chief Executive Officer who is the most senior member of System 4.

The Chairman maintains a language that includes ethical issues and shareholder perspectives that may be at variance to those of the management board led by the CEO.

To put this in perspective the current debate about the role of Jamie Dimon is a case that clearly articulates this issue. From a systems theory point of view (using Beer and Shannon's arguments) the issue revolves around the potential conflict between the roles of S4 & S5 in Jamie Dimon's own mind.

Conceptually each communicant in the system has a dualist problem as the observer/observed of that system and as the CEO of the company Dimon has S4 responsibilities that may require an external language to resolve a problem.

The conflict arises only when Dimon cannot *internally* sustain the separation of required languages and proves to outside participants, especially significant shareholders, that their “world-model” of separate roles of Chairman and CEO is correct.

Chapter 2.2.1.6: Beer’s Laws and Axioms

The following can be found in Appendix ONE of the Heart of the Enterprise(Beer 1979), the reference to pages are of that book, and any comments are this authors.

> *The First Regulatory Aphorism:*
>
> It is not necessary to enter the black box to understand the nature of the function it performs (page 40).
>
> *The Second Regulatory Aphorism:*
>
> It is not necessary to enter the black box to calculate the variety that it potentially may generate (Page 47).
>
> > Comment:
> >
> > In this context Beer is referring to a black box that is a complex entity that’s internal operations are not immediately visible. Variety being all the possible states of the system.
>
> *The First Principle of Organisation:*
>
> Managerial, operational and environmental varieties, diffusing through an institutional system, tend to equate; they should be **designed** to do so with minimal damage to people and to cost (page 97).
>
> *The Second Principle of Organisation:*

The four directional channels carrying information between the management unit, the operation, and the environment must each have a higher capacity to transmit a given amount of information relevant to variety selection in a given time then the only generating subsystem has to generate it in that time (page 99).

The Third Principle of Organisation:

Wherever the information carried on a channel capable of distinguishing A given writing crosses a boundary, it undergoes transduction; the variety of the transducer must be at least equal to the variety of the channel (page 101).

The Fourth Principle of Organisation:

The operation of the first three principles must be cyclically maintained through time without hiatus or lags (Page 258).

Comment:

Much of this can be found in Shannon and Weaver's original paper but Kelly augmented their propositions in a later paper. The use of the word *design* in the first principle is crucial to Beer as he makes the point about the use of computers as a filtering mechanism. The crucial line on page 97 is "*since the computerized system has to be designed in some sense, in what other sense is design absent? The answer lies in the belief of managers and their data processing staffs that the purpose of the system is to 'tell the manager what he needs to know'. Maybe he knows what the manager needs to know; since that is hidden and unnamed in the proliferating variety of the muddy box*". The second principle concerns what information theory considers the bandwidth of communication channel which must take into account not only the data that being transmitted but the possible states of the language being used. Beer is using transduction as a concept to explain how variety is exchanged between different parties, in this case human intermediaries. His concern revolves around the issue that human beings are not all made equal and that communication between sub units and its governance structure must have the same level of variety management on each side of the connection point. The fourth principle may state the obvious but variety in all its uses for Beer are states of the system and not snapshot decisions therefore we are dealing with a dynamic, conditional system and the management thereof maintained continually if the correct State is to be acted upon.

Recursive System Theorem

In a recursive organisational structure, any viable system contains, and is contained in, a viable system (page 118).

Comment:

Beer's system seems functionally hierarchical but is in fact heterarchic in nature drawing resources from many places to achieve functional closure. However a perfectly formed Viable firm seldom exists, systems collapse and boundaries between governance broken leaving the system porous within. When turning to its external relationships the economy itself is not perfectly viably formed with varying levels of commercial performance driven by differing governance regimes. This can be considered an "open/closed system" issue and presents a problem when it comes to dealing with entropy, whether informational or otherwise, as the firm is not affectively a closed system and therefore subject to the 2^{nd} Law of Thermodynamics.

The First Axiom of Management

The sum of the horizontal writing disposed by *N* operational elements ***equals*** the sum of vertical variety disposed on the six vertical components of corporate cohesion (page 217).

The Second Axiom of Management

The variety dispose by System Three resulting from the operation of the First Axiom ***equals*** the variety dispose by System Four (page 298).

The Third Axiom of Management

The variety dispose by System Five ***equals*** the residual variety generated by the operation of the Second Axiom.

Comment:

Here Beer is reinforcing the principals of variety management as stated above.

The Law of Cohesion for Multiple Recursions of the Viable System

The system one variety accessible to System Three of Recursion X ***equals*** the variety disposed by the sum of the metasystems of the Recursion Y for every recursive pair (page 355).

Comment:

Page 355 of the Heart of the Enterprise presents an important point because it introduces the notion of redundancy in communication, core to Information Theory, and to quote Beer "the right to balances that have been expressed as equalities (to make clear the notion of balance) require some extra variety, which is called redundancy, to deal with noise in the system". Beer is addressing a vital issue in that, any filtering process must decide what is data compared to noise, such that the receiving model can make sensible decisions and act appropriately. This redundancy is excess to the variety management capacity, it is effect the error checking method to make sure the data is transmitted correctly.

Chapter 2.2.2: Governance: A Performative Ontology?

"*The sheer oddity of trying to use a pond to manage a factory dramatizes the point that ontology makes a difference*"

Pickering ((Pickering 2010),p.234) is describing his opinion of Beer's approach to deriving a world-view, a model, to explain how things work or as Harnden puts it in his review of the book:

> "*the book provides wonderful insight into the creative process of such a performative ontology - how this disparate group of highly original thinkers 'ran their intuitions past reality' as it were, through the conception and construction of physical artefacts, artefacts whose behaviours*

> *embodied a radically novel insight into life and human experience of it, enabling further new realities to emerge in a range of new disciplines".*

Pickering is addressing a range of cybernetic pursuits and is not at all interested in ATPMs and yet, as we have seen above, the continual dialogue provided by Beer between different sets of "languages" in a recursive governance structure mirrors Natures approach to redundancy yet simple forms evolving complex behaviours.

This dialogue is at the heart of commercial enterprise and ATPMs: it is a meeting of minds; an art of war; a strategy of competition; and/or cooperation between multiple agents; and the *Laws of the Game* (see Eigen & Winkler (Eigen and Winkler 1983) are chance governed by Nature.

Eigen & Winkler challenge us to rethink what we understand as chance and history. From page 133 to 135 they identify the need for motivation and how ideology is perverted by specific goals (Marxist-Leninist) but curiously the core beliefs quoted run counter to the propaganda. In a way they too are discussing the use of language to govern, in their *Metamorphoses of Order*, proceeding to discuss the demons of Maxwell, Monod and Loschmidt when considering biological order, entropy and the Second Law of Thermodynamics. However in accepting the veracity of the Second Law they fall foul to a simple error that Bohm points out and will be discussed later when considering causality, time and models.

Pickering observes in the Cyberneticians (I think he would also agree with Eigen that Wolfram, Kaufmann and Laszlo be included) an ontological approach that searches out the emergence of things from activities within Nature and not the purely reductionist of Newton (though later a review of the Enlightenment/Romantics will justify their role).

Beer has proffered an epistemology in the Yo-Yo model by which Natural dynamic, conditional activities such as commercial governance can be interrogated and a model in the VSM by which recursive governance provides closure of a system and the conditions for self-renewal.

It is the emphasis on the role of governance and different levels of language use that differentiate the VSM from many other commercial governance models(Jackson 2003) and Beer used a mixture of deduction and induction to arrive at the solution.

Therefore in Eigen's penultimate chapter he challenges us in *the Art of Asking the Right Question* to look at what we know and how we ask it. As he points out that legend had it wrong, Galileo worked out the laws of gravity in 1604 and wrote them down after his incarceration in 1633. It was Riccioli and Grimaldi that confirmed the laws of free fall (page 303). Traditional epistemology seems to have been written by a biased pen, perhaps when reviewing the Enlightenment it will surface as to why?

In Self-Producing Systems(Mingers 1995) Mingers gives us a philosophical (ch.7) and comparative (ch.8) analysis of how Autopoiesis may be applied and its implications. He gives us a good grounding in the ontological and epistemological aspects of Maturana (p.90/91) comparing his approach to Husserl and Heidegger but grounded in a phenomenological approach. In chapter 8 he moves from outlining Maturana's focus on biology to social systems mentioning Beer as one "*characteristically enthusiastic*" (p.119) author that "*easily made the assumption that social systems could be seen as autopoeitic and that human Organisations either were or should be made to be*" (p.121).

Whilst he goes on to analyse Maturana and Luhmann he concludes that Morgan's assertion that Autopoiesis is a good metaphor for social organisation is preferable to Luhmann's "*highly developed autopoeitic social theory but is based on a number of questionable premises, particularly the relations between communication and actors*".

It is odd that such a good analysis does not include Beer whose work from 1957 to the late 1990's detailed how communication theory could be applied to social interaction and commerce especially with his close cooperation with Pask(Pask and Scott , Pask 1962, Pask, de Zeeuw et al. 1992) and Actor Theory, both of whom included their own ontological and epistemological approaches.

It is therefore proposed that Governance in ATPMs be Performative Ontology from the manner in which emerging social structures inform the performance of a business and that favourable commercial outcomes are predicated on its correct inclusion in ATPMS.

Chapter 2.2.2.1: Mergers & Acquisitions, ATPMs and The Viable System Model

Commercially the aggregations of production facilities do not solely occur unitarily but through the merger or acquisition of whole businesses much in the same way that Nature utilises synergistic and symbiotic processes to build larger functional entities. When the latter goes wrong or the emergent system fails to achieve its full objective the entity either collapses or possibly becomes parasitic, forever in search of the missing components or worse.

At the genesis of any commercial merger is the concept or model of its expected outcome. The veracity of the outcome is in the process of understanding the actual operations and governance of the target in such a way that they can be assimilated into a new form successfully.

It is at the genesis point that ATPMs simple premise is employed, that of validating the transfer of assets according to a specific plan and then iterating discovery of data until value is proved or not.

From a VSM perspective if any of the participating agents in the merger and the expected organisation structure is not variety managed then the expected outcome becomes decidedly unsure. Successful mergers,

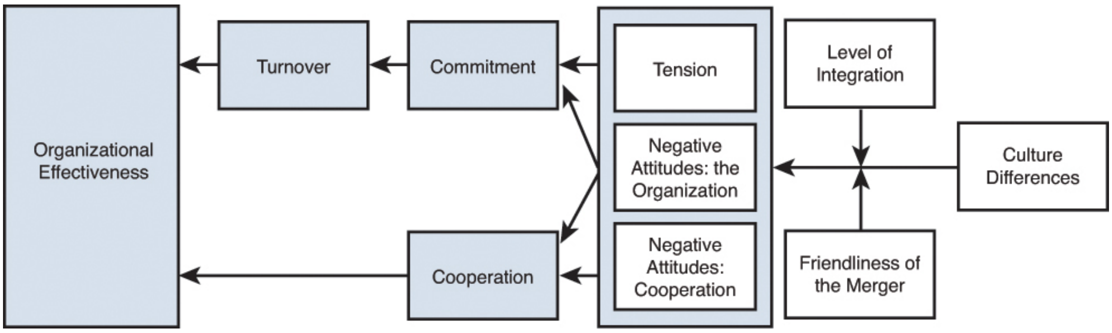


Figure 61: Source - The M&A Paradox: Factors of Success and Failure in Mergers and Acquisitions[xxxiv]

Weber ((Weber, Tarba et al. 2013),ch.1) gives us the figure 61 whilst Kummer (Kummer and Steger 2008) gives us the frequency and Life Cycle of Mergers and Acquisitions up to 2000/2005 respectfully figure 62:

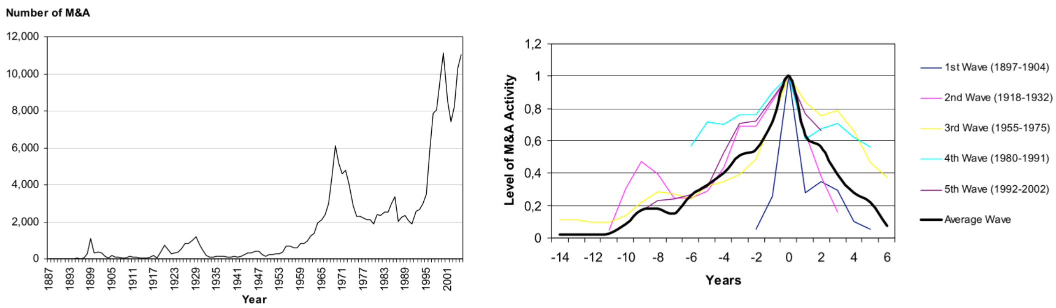


Figure 1: Merger and Acquisition Activity in the United States (1887-2005)[5]

Fig. 2: The Life Cycle of Merger and Acquisition Waves[6]

Figure 62: Why Merger and Acquisition (M&A) Waves Reoccur - The Vicious Circle from Pressure to Failure, Steger & Kummer

Weber's objective is to inform and maintain whilst Steger/Kummer are critical of he process but whilst both mention organisational form as a failure neither observe that by creating a variety managed and functionally-based structure many of the problems of failure would be overcome.

This is not the place to discuss why Mergers & Acquisitions took a dramatic leap from the post Second World War or why the Life Cycles follows a certain trend although an assumption for the former may be the sudden leap in technological change and the consequent effects on commerce as Tapscott and Weinberger (Tapscott 1996, Weinberger 2007, Tapscott 2009) point out. Rather it is the focus of the conceptual assumption that functional order and variety management play a bigger role in ATPMs as they are formed at the genesis of the strategy (see Dixit (Avinash K. Dixit 2008)).

If an approach had been to incorporate a VSM style review and compare the cost of implementation to the extra value derived then one major risk aspect would have been the timeframes required. The results may not be clearly determinative but at least the temporal frameworks of implementation versus financing structure would be included in the probability of value creation.

Conceptually therefore ATPMs would benefit from the inclusion of a VSM integration review in their risk assessment.

It is interesting to note that in a market sense M&A activity is a variety reduction process but one led by the managers of enterprises and not a governing influence at a higher level or recursion.

Chapter 2.2.2.2: Can Recursive Governance destroy Variety?

If we take Beer's discussion on Chile and proposals on extending his recursive structure to a global governance process are we not in danger of destroying the variety we seek to manage?

Experience in 1972 Chile would seem to challenge Beer's claims however, as the we shall propose later, this was a mixture of naivety on his part at the time and unseen conditions prevailing, not the result of a fault in his model. In effect it is suggested here that there were faulty parts and not the design.

If the global governance structure was correctly established in accordance with Beer's approach to matching governing appropriate languages and building variety management plus redundancy to each level of recursion the system theoretically it should work as the states would be dynamically managed within the boundaries set. However as Beer points out himself, someone has to set the boundaries and what is expected. What happens if they are wrong, or worse, they do not exist at all?

Following the 2008 Credit Crisis various researchers reviewed its cause two of which were Caccioli(Caccioli, Marsili et al. 2009, Caccioli and Marsili 2010) and Haldane (Haldane 2012), the latter as leader of the Bank of England's Financial Stability Board produced works with Sir Robert May that analysed the governance structures of the financial marketplace and its behaviour.

In this particular instance from Nature Magazine Caccioli is reviewing the proliferation of financial instruments by contrasting the Arbitrage Pricing Theory (APT) against a dynamic interacting market and Haldane is addressing dynamic, conditional markets comparing non-linear dynamics, fat tails and normality.

Caccioli's work, like Arthur's, Squazzioni, Durlauf, Vidgen and Kaufmann (Vidgen and Padget , Arthur 1995, W. Brian Arthur 1997, Arthur 2005, Squazzoni 2010), resolved:

1. "We presented here a very stylized description of an arbitrage free market, showing that also within the ideal context of APT the uncontrolled proliferation of financial instruments can lead to large fluctuations and instability in the market. Interestingly, within our simplified model, the proliferation of financial instruments drives the market through a transition to a state where volumes of trading rapidly expand and saturate investors' demand";
2. "The focus of the present paper is on theoretical concepts. Their relevance for real markets requires quantitative estimates of the parameters. Given the abstract nature of the model, this appears to be a non-trivial task which is an interesting avenue of future research";
3. "It has been recently suggested that market stability appears to have the properties of a public good [22]. A public good is a good (i) whose consumption by one individual does not reduce its availability for consumption by others (non-rivalry) and (ii) such that no one can be effectively excluded from using the good (non-excludability). At the level of the present stylized description, the expansion in the repertoire of traded assets introduces an externality which drives the market to unstable states. This suggests that systemic instability may be prevented by the introduction of a tax on derivative markets, such as that advocated long ago for foreign exchange markets by Tobin [23]";
4. In summary, this paper suggests that the ideal view of the markets on which financial engineering is based is not compatible with market stability. The proliferation of financial instruments makes the market look more and more similar to an ideal arbitrage-free, efficient and complete market. But this occurs at the expense of market stability. This is reminiscent of the instability discussed long ago by Sir Robert May [20] that develops in ecosystems upon increasing bio-diversity[13]. For ecologies this result is only apparently paradoxical. Indeed the species, which populate an ecosystem, can hardly be thought of as being drawn at random, but are rather subject to natural selection. Indeed, on evolutionary time scales stability can be reconciled with bio-diversity, as shown e.g. in reference [21]. The diversity in the ecosystem of financial instruments has, by contrast, been increasing at a rate much faster than that at which selective forces likely operate"; and

5. “In contrast with the axiomatic equilibrium picture of APT, on which financial engineering is based, the model discussed here provides a coherent, though stylized, picture of a financial market as a system with interacting units. In this picture, concepts such as no-arbitrage, perfect competition, market efficiency or completeness arise as emergent properties of the aggregate behavior, rather than being postulated from the outset. We believe that such an approach can potentially shed light on the causes of and conditions under which liquidity crises, arbitrages and market crashes occur”(Caccioli, Marsili et al. 2009) p.9/10.

Caccioli is building a conceptual framework where agent behavior create emergent structures that promote the proliferation of financial instruments and, without proper regulation, new conditions are emergent that bring instability to the general market: Effectively a multi-state Mandeville “”Private Vices, Public Virtues”/”Private Virtues, Public Vice”” depending upon the emergent phenomena relating to financial product proliferation.

Caccioli’s solution is a commercial tax (Tobin (Tobin and Brainard 1977, Tobin 2001)) but this is a non-starter because Tobin himself did not believe it was interpreted in the right way and both Seely (House of Commons)(Seely 2013) and Weaver(Weaver, Dodd et al. 2003) see this as an unworkable proposition.

If Beer’s application of variety management within functional systems is implemented properly and works then are there conditions where recursive structures become toxic to the system? The biological proposal was an absence or failure in component adaption resulting in a parasitic system: Could this be conceivable in commerce?

If we reconsider Caccioli again but instead of requiring the enforcement of a tax we identify the collective functional effect of the instruments we could propose a situation where a financial instrument, say a credit default swap structure, could strangle the underlying economy. The operation might appear like this:

1. Individual transactions proceed and proliferate across the economy creating a high value at risk compared to the liquid economy in terms of possible states of the system.
2. A probable cause of loss might be:
    a. A change in the underlying economy that would start a cascade of calls; or

b. A secondary contract type creates conditions that amplify the possible values at risk for a normal range of economic states.

In each of these possibilities the variety in one part of the economy is not being managed by a variety in another: to use Beer's terms, variety of possible system states is not being *rectified* by an anti-oscillatory System 2.

Of course this situation can be reversed in functional process with a similar net effect but the possible variety needed to be *amplified* in order to protect the overall strategic state of the economy. Is this a possible scenario and if so what contributory conditions may prevail to bring it about?

Let us propose two events as likely candidates using simplistic criteria:

- **The 1988 Reinsurance Spiral at Lloyd's of London(Stanard and Wacek 1991, Bain 1998, Kay 2007, Schwartzman 2008, Stewart and Sigalow 2010, Fackler 2013)**
  In the late 1970's to early 1980's the global insurance market had expanded by the removal of inter-country capital investment barriers and the design of new types of insurance product especially reinsurance. Regulatory structures were weak and untimely based upon rules stipulating caps on premium relating to capital. Competition increased and to replenish lost premium to meet rising claims values inter-company reinsurance programs within a single market were created to pass risk from year to year with the aim of "smoothing the total effect"; and
- The 1998/2007 Credit Crises(Jarrow and Turnbull 1995, Benninga and Czaczkes 2000, Daníelsson and London School of Economics and Political Science. Financial Markets Group. 2000, Lowenstein 2000, Cuthbertson and Nitzsche 2001, Parlour and Plantin 2005, Bookstaber 2007, Greenspan 2007, Kay 2007, Taleb 2007, Taleb 2007, Kashyap, Rajan et al. 2008, Schwarcz 2008, Turnbull, Crouhy et al. 2008, Geanakoplos 2009, Huertas 2009, Michalopoulos, Laeven et al. 2009, Sorkin 2009, McLean and Nocera 2010, Patterson 2010, Prechter 2010, Geanakoplos 2011, Huertas 2011, Skeel 2011, Aigbe, Jeff et al. 2012, Haldane 2012, IMF 2012)
  In the late 1990's to mid-2000's the global credit market had expanded by the growth capital investment and the design of new types of credit products based upon an underlying theory of efficient global markets and arbitrage. Regulatory structures were weak, had untimely reporting that were based upon rules stipulating few or little disclosure and even those that did act as a break on leverage removed. Economic competition increased and to replenish lost returns to meet rising claims values inter-market credit portfolios were created to pass risk from year to year with the aim of "smoothing the total effect".

These examples are necessarily simplistic but a cursory review of the articles cited, especially John Kay's "Same of folly, new spiral of risk", will reveal a similar story and using Beer's terminology in both cases:

- System 2 variety managers were either inadequate or removed;
- System 3 audit requirements used the wrong metrics;
- There was no external language between any of the System 3/System 4 recursive levels to regulate the states of the systems; and
- There was no System 5 ethical or market regulatory system at all.

From Short (Short and Ketchen 2007) we take two observations as to the correct approach to performance:

1. "Our third insight is that the results support past calls for managers to move beyond financial measures alone when evaluating their firm's performance (e.g., Kaplan and Norton, 1996). Reliance simply on return on assets would suggest that firm attributes explain about two-thirds of the variance in performance. For the long-term measures, however, firm effects exceed 90 percent. The implication is that a focus on financial measures will understate the importance of strategic execution for achieving sustained competitive advantage"; and
2. "We found that, when examined together, the firm, strategic group, and industry levels each contribute significantly to accounting for performance. This implies that if a study includes only one or two of the levels, the resulting portrayal of the interwoven systems that collectively shape firm outcomes is incomplete. For managers, our findings suggest that achieving superior performance is tied primarily to firm characteristics, but it also depends on appropriate positioning within a strategic group and the industry".

From Gungoraydinoglu (Gungoraydinoglu and Öztekin 2011), who also analysed corporate structures, the conclusion is:

> "[This paper] examines the firm-level, industry-level, macroeconomic, and country-level determinants of capital structure across 37 countries during the 1991–2006 period. We conjecture that the effectiveness of a country's legal, financial, and political institutions is systematically related to cross-country differences in firms' choices of capital structure through the influence of bank- ruptcy costs, agency costs, and information asymmetry costs imposed on firms. Our intuition is that the capital structure determination of a firm is not only the outcome of its own characteristics but also the result of its environment and traditions in which it operates. We first examine which factors, at the firm and country level, are reliably important for predicting the variation in leverage. We find that institutional arrangements matter for capital structure decisions; however, the firm-level covariates drive two-thirds of the variation in capital structure across countries, while the country-level covariates explain the remaining

> one-third. In general, the institutional factors affecting bankruptcy costs and taxes drive most of the country heterogeneity in capital structure, followed by the agency costs and information asymmetry costs.

Taking these two simplistic examples and research findings together we could postulate that there is indeed a set of conditions where a recursive structure of nested, coupled "economic engines" exists where no regulatory function persists and that it is only a matter of time before a tipping point occurs and cyclical instability develops (Beinhocker 2006, Sterman, Henderson et al. 2006, Farmer and Geanakoplos 2009, Huertas 2011, Haldane 2012) with visions of Henon's "Attractor".

Chapter 2.2.2.3: What happens if it isn't Viable?

Conceptually we are dealing with a matter of unknowns and system closure that pose several questions:

1. Over what timeframes are we to determine whether a system, using Beer's criteria, is "viable"?
2. Over what timeframes are we measuring comparative performance?
3. Are we determining open or closed system parameters?
4. Does Time exist?
5. What criteria are we setting as the boundaries for the system?
6. Is there such a thing as Causality?
7. What are we measuring? and
8. Can we measure anything?

The first three are practical issues but the last five deeply profound concerns arising from fundamental philosophical issues that pose another question: should we worry about them?

Asset Transfer Pricing Models exist within a milieu governed by a human social network that has emerged and evolved over a very short part of a geological timeframe. Conceptually therefore time is a relative issue for assessing whether ATPMs and the system context are comparable. Indeed it presents a problem of whether we can essentially measure what is "viable" for the context.

To address these issues an assumption will be made and then a general review of the issues given in order to establish a context. This is will be particularly relevant to the conceptual background of why the Enlightenment and Romantic periods have affected the approach taken.

For all intents and purposes because the relative timespan between geological and ATPMs is so vast, and because no discernable empirical proof can be made that the Planet has a viable system but that it is currently hospitable to Life it will be assumed that it is an open-system but with fluctuating boundaries. The reason is to make a distinction between immediate ATPMs commercial temporal frames and the limit the effect of entropy such that it is possible to entertain negative-entropy or negentropy, as Beer puts it (Beer 1959, Beer 1972).

This assumption will also allows us to entertain “viable” recursive heterarchical systems that can co-exist with other less-“viable” but temporarily stable systems from which components, at whatever level, may be used as a resource in a continuous “re-imagining” of a commercial landscape for the purposes of monitoring agent-based behaviour and the coupling strengths within networks.

The former will become important as “free” agents will determine temporal changes in commercial landscapes and the latter the permanence of current business structures and the communication channels they require over time.

Chapter 2.2.3: Contributory concepts: Causality, Time, Models and Measurement

It was proposed that ATPMs deal with a tightly focused part of the world’s commercial activities, the exchange of assets prior to, or the maintenance of, business processes. Within this business process we say that “a begets b”, “the reason why we do this is because” or “the proximate cause of this loss is the burst pipe”. However what do we mean by “cause” or “reason” in this context?

Broadie(Beebee, Hitchcock et al. 2009) gives us an insight from the Greek “aita” that traditionally is translated but also means “reason” or “explanation” words originally attributed to ascribing fault or credit. A Platonic notion regularly revisited as Aristotle observed “all these things are for the sake of an end, though they differ from one another in that some are activities and other instruments” (The Purposive-Agency

Model) part of his four-fold causal scheme that he applied to organic systems as well where:

> "each individual is a vitalistic principle ("*phusis*-nature", "*phuche*-soul(?)") expressing itself in and through the material body whose shape and organisation, as well as its growth and maintenance, are effected by that principle itself, which operates as an inbuilt non-mental skill for realizing just that organism and its lifestyle, including its propagation".

Aristotle had a major impact on the philosophers of the Enlightenment/Romantics, especially the founders of the US Constitution(Chan 2006), but within this description lies something more profound for Beer and Maturana/Varela: paraphrasing Brodie:

> "Thus a full causal explanation of an organ, or of a process….., or of ….an arrangement, will account for its ordering and its properties, material and structural, by showing in detail what ….. good the item contributes. The good in question is that very same individual whose …………. Is being considered. The immediate and fundamental explanation of the presence of the items is that each contributes to well functioning of the individual to which it belongs".

Brodie observes the usefulness of this teleological approach in biology where

> "thinking about objects in terms of their possible purposes in an overall system is indispensible for generating fruitful lines of research into the material and workings".

Some text has been excluded to make it easier to now compare to Ashby's development of Haeckel's thoughts on Homeostasis, Maturana/Varela's sense of Autopoiesis, and Beer's use of the nervous system in Management Cybernetics including his acronym POSIWID (the Purpose Of a System Is What It Does) and which he developed into his – Science of Effective Organisation.

As Chan notes on page 100 (Manufacturing) "Hamilton's final and most controversial economic report was his *Report on Manufacturing* (1791). Frequently overlooked was the report's main purpose, which was to seek the means 'to render the United States independent [of] foreign nations for military and other essential supplies'". Taking this in terms of Aristotelian Causation and an Autopoeitic approach Hamilton is creating *biological* closure and purpose for the United States as a system – he is allowing, with the aid of the Constitutional structure, the Nation to defend and renew itself from within.

Brodie also brings us to Hume(Hume 1751), another influential Enlightenment philosopher for the US founders, in the concepts of "Agency", "Efficacy", "Bringing about" and "Production" whereby [Hume's] "*empiricist deconstruction, whereby the 'supposed idea' represents only the impression of mental transition that occurs when an experiencing mind fits in expectation from some presented item to the lively idea of its concomitant*" and by contrast that Aristotle assumes that 'efficacy' (out-there) is real. This is a subject to continue when considering models and their use.

Brodie then takes us to the core of causation in the four-fold model, and where out of necessity this review must move on, to discuss 'first-cause' and 'last-cause' whereby in any system that is necessarily interconnected the agent, or efficient cause, that is attributed blame or credit can be considered under Hume's "regularity theory" both an independent agent yet necessarily connected through a chain of causation to a "first cause" [elliptically meaning God]. The lack of conflict here suits this conceptual framework well as it not only removes unnecessary complication but also resonates with the concept of an open-system at a Universal level but functional competing sub-components that can seem independently motivated.

Chapter 2.2.3.1: Causality: Project Finance, Accounting and Contract Law

A great deal off ATPMs concerns the issue of a causal inference between two or more variables and how the participants perceive it. From Erik Weber, and Daniel Steel, we take the following:

- *A central problem confronting social research is that an association between two variables can often be explained by the hypothesis that one is a cause of the other or that both are effects of a common cause(Steel 2004)p55;*
- *Social mechanisms, in particular, are usually thought of as complexes of inter- actions among individuals that underlie and account for aggregate social regularities. . . . But there is more to social mechanisms than just individual interactions: typically, the individuals are categorized into relevantly similar groups defined by a salient position their members occupy vis-à-vis other members of the society* (Steel 2004)p57-58; and
- *I have shown ……….. that there is a difference between reliable causal inference and showing that a causal claim has policy relevance, and that*

> *we need social mechanisms to establish the policy relevance of causal claims. In section 4 I have shown that, although (M*) is false, in most research contexts social scientists will conclude they do need mechanisms to make reliable causal(Weber 2007)p359*

Though Weber and Steel were addressing the causal structures in societies they do highlight some of the issues arising from complex commercial networks as identified by Arthur(Arthur 2000), Durlauf(Arthur, Durlauf et al. 1997, Durlauf 1998, Brock and Durlauf 2003), Fullbrook(Fullbrook 2012) and Meagher(Meagher and Wilson 2002). Meagher criticises Stehr and Grundmann's thesis that economics and sociology are relatively successful policy sciences from the use of models, especially Keynes(Keynes 1937) and citing Blaug(Blaug 1980, Blaug 1990, Blaug 1992), but they do not observe that Keynes used no empirical proof for the General Theory and subsequent "Classical Economists" likewise followed suit (see Keen(Keen 2011)) as Blaug(Blaug 1997) equally shows.

Arthur and Durlauf identify the level of complexity within economic systems and question the causal links and policy decisions derived therefrom. Whereas Fullbrook quotes Einstein:

> *"Whether you can observe a thing or not depends on the theory which you use. It is theory which decides what can be observed".*
>
> [Said to Werner Heisenberg during his 1926 Berlin lecture, quoted in Salam, 1990]

Fulbrook's quote above can be extended to apply to a Cybernetic principle – "*you get what you measure*" – where Bohm(Bohm 1976, Bohm 1981, Bohm 1984) and Foerster(Foerster 1972, Foerster 1979, 1995, Von Foerster 2003, Von Foerster, Müller et al. 2014) took Einstein further, in quantum physics and second-order cybernetics respectively, both saying that the observer is part of the whole system and therefore cannot merely be abstracted from measurement of the target.

Bohm(Bohm 1984) was equally critical of using any theory that did not transparently state the limitations used to make the outcomes computationally tractable. In financial terms this could be argued to be the Normal Curve's ubiquitous application in credit default derivatives (and other instruments) where activity is assumed normally distributed but in fact is far from it (see also Scientific method: Statistical errors, Nature (Nuzzo 2014)).

So if observation and measurement are determined by theory what theory should we apply? Surely in ATPMs it is quite clear when an event occurs and what we observe? Equally if we are to believe Hume and regulatory theory, which influenced the US founding fathers, with its reductionist logic of causation and singularist, non-singularist divide we would be content with non-causal properties of (with or without the relationships between) particulars being the sole explanation of events. However Natural Law seems to depend upon regular correlated instances and in a probabilistic universe a Law may exist if two independent particles interact but have not done so to-date.

It is easy to see why the paradigm of these well-argued conceptual frameworks came together and, with the Humean insistence that such Laws and Axioms determine Natural Law, persisted so long (Tooley (Beebee, Hitchcock et al. 2009)). This is not to say the were wholly wrong, or that in being so they created a framework where scientific discovery opened material changes in society, but that along with the reductionist causal approach came the asymmetry of Time in Hume's "Treatise" definition of CAUSE as "*precedent to and contiguous of*" events. Taken together with the perception of a "closed-system" and the attendant theories of thermodynamics/entropy the subjectivity of this approach was to affect Law of Contract and how we account for value in a business, as we shall discuss in the following extend the conceptual structure for this thesis:

Project finance

In this instance we will define "Project" as any venture where an investment is required – therefore we could generalize that ATPMs deal Project where the potential transfer of assets arises. The reason to apply this is to enable a further generalization as to the distinctions made by Coase(Coase 1937, Coase 1990), Knight(Knight 1921) and Simon(Simon 1982) as to what constitutes a firm and its measurement of profit and risk.

Abstraction is a good device to start modelling ATPM outcomes if all the components are included and defined such the functional whole is achieved. Excluding any component, or possible boundary condition, therefore limits the benefit of such abstractions that would then become “models” of the target system.

By using limitations on probability and/or inappropriate underlying data financial models may indeed be defined to create Humean Laws and Axioms but subsequently applied to different data the “generalities” produce different outcomes: expectation is not satisfied and loss can occur.

In this thesis the concept of “Project” will define all of the functional components and temporal scales within them *plus* a statement as to the limitations that make them computationally tractable.

A definition of a causal framework is given here as:

“*The actions, or absence of, exogenous or endogenous agents that individually or collectively, directly or indirectly, cause an event or series of events that materially and adversely affect the performance of a persistent topographical structure. The agents may be connected or not within or without the topographical structure but it must be revealed that the interaction with the structure was necessary to alter the performance or outcomes. Performance refers to such temporally related expected outcomes that materially and adversely alter the potential viability of the topographical structure. The topographical structure shall mean an element, group of elements, and/or agent(s) made thereof that individually or collectively act in a cohesive and synergistic manner to maintain the functional existence of the whole* ”

The objective here is not to determine a fixed framework but to define the relative operational boundaries both physically and temporally.

Chapter 2.2.4: Accounting

Lukka (Lukka 1990, Lukka 2010) (Ontology and Paradigms), Mattessich(Mattessich 2008) (History of Accounting Research), Axtell(Axtell and McRae 2008)(Mathematical Representation of Behaviourial/Aggregate Discounting) and Alexander(Alexander 2002) (History of Accounting) may seem an odd mix to analyse accounting as it relates to causality and value because we would assume that Pacioli's double entry booking is standard? However as the Credit Crisis has proven, defining the nature, value and temporal status of assets and liabilities is far more complex that usually thought. Here is Lukka on the "Ontology of Accounting":

> *"In general, any discussion of accounting tends to deal with concepts like revenue, cost, depreciation and profit. Despite many significant developments in accounting thinking during the last few decades, some of the most important problems relating to accounting concepts do not appear to have been solved. It may be argued that certain misconceptions impede all the three dimensions of accounting that is practice, teaching and research, as far as the basic nature of accounting concepts is concerned. These problems often arise from the fact that accounting concepts, or actually the phenomena they refer to, are interpreted too objectively and mechanistically. Accounting concepts are usually interpreted as reflecting the reality existing somewhere "out there;" accounting is thus rather closely linked with realistic ontology. This view has many dysfunctional consequences with regard to the different dimensions of accounting, including the following:*
>
> > *(1) The value of the measures and theories based on accounting concepts is usually judged on the scale true--untrue, though judgements openly based on the usefulness dimension would perhaps be more fruitful.*
> >
> > *(2) The roles of accounting in organizations and society are often under- stood too objectively, as if accounting would give us an impartial and unbiased picture of the functioning, resources and results of firms and other organizations.*
> >
> > *(3) The mechanistic and objective ontology has not been apt to promote the adoption of a wider, i.e. behaviourally, organizationally and socially more sensitive, perspective of the roles of accounting. For example, it has led to the fact that the links between accounting and the power and interest structures in organizations and society have not been recognized in accounting research until quite recently."(Lukka 1990).*

We have equally become used to expecting annual, semi/quarterly accounts because they "represent" the current state of this "Pacioli" system of net value. However when combined with the strategies employed to derive the data and employed in achieving the commercial outcomes we see from Morlidge (Morlidge and Player 2010, Morlidge

2012) that the “snapshot” is not representative of the possible outcomes nor is it temporally accurate.

Lukka discusses the normative allocation of AAA as a metric of the business and the ontological relevance. What is not discussed in detail is the underlying accuracy of such a normative “rating” when the data contributing to it shifts regularly and the assumptions in the agency’s model also vary.

Beer takes the whole thing a lot further and interprets the business as the dynamics of the system and its states. States in this case can be values but also the nature of communication of data that modifies these values. Taken with Morlidge the Pacioli accounts become dynamic and conditional, with Eigen-states and Eigen-vectors predicting possible outcomes.

ATPMs have two elements of value calculation that, when combined, are traditionally deemed to represent the possible outcome: the history perspective and the future assumptions. These can be derived from a quantitative/qualitative models or normative assumptions but in essence resolve to “the future is a reflection of the past”. Having shown that causally and temporally a heterarchical system may not exhibit any form of regular structure, that expectations can depend upon topographic structure (Soren and Anders 2011) and that recognition and measurement is an ongoing (subject as IASB 39(Iasb 1998) indicates) building an ATPM is not a trivial matter.

Chapter 2.2.5: Contract Law

Coase Theorem(Coase 1960) deals with the symmetry of cause an effect under “terms of fairness” and the counter argument by McGaughey(McGaughey 2013) is that behaviourally, although we all have a “fairness” and “profit” motive, there is an asymmetry in favour of those that tend to be more productive. This social bias is compounded when considering that any argument is bi-directional when considering proximate cause and temporal issues: what prompted the event and when.

Stapleton (Beebee, Hitchcock et al. 2009) "Causality in Law, reviews the circularity employed in definitions upon which judgments are made according to laws as "rules" rather than as "principles". The fatal impact of such circularity is actually evidences in Goodhart's Law where laws determining the constraints of activity in one language in fact hold intrinsic failure because they cannot contain all of the conditionality required and hence why the U.K. moved to a principles-based form of financial regulation post the Credit Crisis. It is also present in the interpretation of language and the internal ontological models the "law-setters" and "practitioners" retain.

This circularity also effects how laws are made with relation to the temporal changes in social structure. Evidence-based laws may be proven wrong if subsequent data proves the result in error. At work here is the very methodology under which outcomes are being derived.

The concept of "procyclicality" brings with it a sense of "feed-forward" structure found in biological systems Okasha (Beebee, Hitchcock et al. 2009) and Nobel (Noble 2008, Noble 2012) review and discussed in both physical(Bohm 1984, Corominas-Murtra 2010, Pawlowski, Paterek et al. 2010, Sugihara, May et al. 2012) and information-based systems(Simon 1955, Goldman 1967, Ay and Polani 2008). As such temporal(Earman 1972, Corominas-Murtra 2010, Crutchfield and Ellison 2010, McGaughey 2013) considerations are necessary in both the collective consequence as well as the singular and sometimes both at the same time because the determination of the legal status of contract may have different interpretations in each case: back to Mandeville.

Chapter 2.2.4.1: Summary

Bohm and Foerster's similar conceptions of the interaction of the observer on a system resonates with much of the difficulties that philosophers argue about in their own ontological view of the universe and how we learn or interrogate it to prove our theories – epistemology.

We see from above that, within a system, it is possible to have a heterarchical structure in an "open-system" where linear "cause-effect" does not operate because we have, either, and, or, defined the wrong Laws and Axioms, cannot see multiple effects from singular events in different time periods or the interaction hasn't occurred yet but was predicate on a completely different set of circumstances that do not exist in the current time-frame.

ATPMs may at first sight seem to have a limited and relative role in socio-economics however if we consider a heterarchical open universe not only should they compensate for a different temporal framework in estimating their future values but also the strategic impact of recursive functional systems in Contract Law.

However we can see in the US Constitution the compensating structure that Beer illustrates in a governor of his steam engine and that, even given the "rule-based" approach, the whole system has persisted in its functional direction: to remain so its components and structure must remain in tact.

Chapter 2.2.6: Time: Does it exist?

Although it may be outside the specific remit of this thesis a superficial overview of research materials on Time may be useful, especially in respect to the references to physics, economics and stochastic measurement methodologies.

To show some of the different approaches we can review:

- Vannini(Vannini 2006), Time as a Variable, gives a good account of Time's perception and history from Aristotelian, Galileo, Einstein and Lorentz but persists in the causal framework of Hume;
- Poli(Poli 2002), The Present and its Surprises, brings into consideration Biological, Social, Psychological and Contemporaneity asking also whether there are Laws and Duration aspects for each: Curiously absent is any consideration of communication or heterarchical considerations but at least is thinking in terms of reference frames and units of seconds;
- Sharpere & Wilczek(Shapere and Wilczek 2012), Constraints on Chronologies, who take a strictly physics approach "*show how the metric of a Lorentz invariant spacetime can be partially reconstructed from a knowledge of the chronologies it supports. Finally, we propose a different but related criterion for allowed chronologies in curved spacetimes*" and "*For our purposes, we can take as the defining property of a strongly causal spacetime a condition that is usually derived from (and proved equivalent to) other, more abstract conditions, to wit: One can define on the spacetime a function τ whose level surfaces are spacelike*" which also brings us to;

- Cherkashin's "*Reality Game*"(Cherkashin, Farmer et al. 2009) a self-reinforcing game that has all the attributes of a real financial games but needs a topology on which to act out;
- Judd(Judd 2012), The irreversibility of time, or why you should not listen to Financial Economists, introduces an interesting aspect for a consulting actuarial practise reinforcing Ole Peters(Peters 2011, Peters 2011) approach to "*attempt to explain the difference between an 'ensemble average' and a 'time average'*" a gambling proposition and an eloquent rendition with mathematical appendix that, without the formulae's, is as follows:
    - ***Ensemble average*** *– E(r) – is an answer to the question "what is the rate of change on the investment, computed from an average over all possible outcomes (universes)?";*
    - ***Time average*** *– T(r) – is an answer to the question "what is the rate of return on this investment averaged over time"; and*
    - *For the technically minded who prefer to think of investment in continuous time, the stock price in standard finance literature normally follows a geometric Brownian motion (GBM). In other words the price is log-normally distributed with a constant percentage rate of change (μ) and constant percentage volatility (σ)*

  Out of necessity, skipping the detailed reasoning about why GBM, we see from Hale and Nobel(Halé 1995, Noble 2012) process is an important dimension for Time and Davies & Gregersen (Davies and Gregersen 2010) p161 show us that entropy comes in different "types". So a dependence on Weiner processes that do not take into account the topology of the operations is a limiting case study as is the reliance on "average" see Savage "*The Flaw of Averages*"(Savage 2009); and

- Shubik(Shubik and Smith 2004), The Physics of Time and Dimension in the Economics of Financial Control, actually asks the basic questions:
    - "At a more basic level a reasonable question to ask not only of physics, but of economics as well, is do we expect the basic properties of behaviour of the system to be dependent on the timescale selected?"; and
    - "In much microeconomic theory involving the considerations of more than one period, few papers discuss just what time period is being contemplated. Is it the hour, day, year lifetime, century or longer. What percent of the economy operates under these different time spans? Do the laws of economics vary with size and scope?"
- Crutchfield et al(Crutchfield, Ellison et al. 2009), "Time's Barbed Arrow: Irreversibility, Crypticity, and Stored Information", add to Shubik issues:
    - "*We show why the amount of information communicated between the past and future—the excess entropy—is not in general the amount of information stored in the present—the statistical complexity. This is a puzzle, and a long-standing one, since the latter is what is required for optimal prediction, but the former describes observed behavior."*

- Gillemot et al offer a different and far more prosaic view when dealing with timescales in:
    - "There's more to volatility than volume"(Gillemot, Farmer et al. 2006) where they are looking at the effect timescales have on the underpinnings of the models used: "*A stochastic time clock τ(t) can speed up or slow down a random process and thereby alter the distribution or autocorrelations of its discrete increments. When the increments of a stochastic time clock are IID it is called a subordinator, and the process Y (t) = X(τ(t)) is called a subordinated random process. The use of stochastic time clocks in economics originated in the business literature (Burns and Mitchell 1946), and was suggested in finance by Mandelbrot and Taylor (1967) and developed by Clark (1973)*"

Together Shubik, Crutchfield and Gillemot highlight some basic problems that exist involving the role economic topographies play in the transmission of data and the timeframes that are involved. Simply assuming a standard reference frame for all projects without accommodating some form of relative performance adjustment invites the type of error Savage (Savage 2009) levels at financial practitioners in the use of average, to which we can add Poisson Counting over indiscrete time periods.

For all practical purposes the conceptual framework assumed herein is that, in a dynamic and conditional universe, recursive socio-economic structures have a process dependent temporal scale at each level of the structure. Efficient processes are deemed to be those where optimal transcription and transduction occur across and within viable functional systems. Whether these timeframes are allometric remains to be decided as little data is available in the form required, i.e. state-space and real-time transactional. This does not impede the consideration of such data and the creation of any thought experiment including them.

Chapter 2.2.7: Models: Does Structure Matter?

If process matters then surely does not topological/topographical structure matter? We have seen from Noble, Wolfram(Wolfram 1986, Wolfram 1994, Wolfram 2002, Tang, Elsner et al. 2012), Fernandez(Fernández and Solé) and Vasquez(Vázquez, Oliveira et al. 2005, Vazquez, Rácz et al. 2007) that biologically, rule-based, network and sub-graph structure respectively define the properties of a system. In particular Fernandez work reflects on the evolving structure as to "feed-forward networks and Autopoiesis" which, given their importance in systems structure, is worthy reading.

If we look at Fuller(Fuller and Applewhite 1975) and Loeb(Loeb 1971, Loeb 1976), from whom Beer directly and indirectly respectively drew a great deal in creating the VSM, we find that physical structures and their geometrical/topological structure greatly influence the properties systems exhibit. Braess(Braess 1968) and Atkin(Atkin 1972, Atkin 1974) are a good start on how network structure determine functionality from which we can develop through Kaufmann(Kauffman 1993, Kauffman 1995), Granovetter(Granovetter 1978, Granovetter 2002), Laszlo/Barabasi and their students (Laszlo and Krippner 1998, Laszlo 2001, Yook, Jeong et al. 2001, Oltvai and Barabási 2002, Barabási 2003, Altman 2007, David 2007, Hidalgo, Klinger et al. 2007, Hidalgo R. 2008, Diehl 2009, Corominas-Murtra and Goni 2010, Séverin 2010, Borgatti and Halgin 2011, Marvel, Kleinberg et al. 2011, Toole and Page 2011, Thurner 2012, Galbiati, Delpini et al. 2013) to Vitali/Easley and White (White 2002, Vitali, Glattfelder et al. 2011, Vitali and Glattfelder 2011, Easley and Kleinberg 2012) to see how economic structure evolves from individuals, markets and global structures.

We have seen that traditionally models can easily become believed as more than just a proxy for the territories they are designed to represent, see Lowenstein(Lowenstein 2000), Sorkin(Sorkin 2009) and Bookstaber(Bookstaber 2007) on the Credit industry. Here we have a clear contrast to Korzybski's "the Map is not the Territory"(Korzybski 1941) and the antithesis to the emerging discoveries above where not only do properties relate to structure but also stability can be created from the network structure of processes.

Finally Thurner(Thurner, Hanel et al. 2003) gives us this as a paper on the effects topology on regulation:

> "*In the context of understanding the nature of the risk transformation process of the financial system we propose an iterative risk-trading game between several agents who build their trading strategies based on a general utility setting. The game is studied numerically for different network topologies. Consequences of topology are shown for the wealth time-series of agents, for the safety and efficiency of various types of networks. The proposed setup allows an analysis of the effects of different approaches to banking regulation as currently suggested by the Basle Committee of Banking Supervision. We find a phase transition-like phenomenon, where the Basle parameter plays the role of temperature and system safety serves as the order*

> *parameter. This result suggests the existence of an optimal regulation parameter. As a consequence a tightening of the current regulatory framework does not necessarily lead to an improvement of the safety of the banking system. Moreover, we show that banking systems with local risk-sharing cooperation have higher global default rates than systems with low cyclicality*".

Conceptually all this reinforces the belief herein that ATPMs, as dependent models within a socio-economic eco-system, are themselves dependent upon the topography and temporal(Gillemot, Farmer et al. 2006) nature of their environment. The problem comes when assuming that networks are static and agents free to roam without ties to each other when pragmatically any market is a mixture of agents, networks and processes.

Chapter 2.2.8: Measurement: Can we measure everything?

Hubbard(Hubbard 2010) addresses the commercial question directly, Yes, but look carefully at what parameters you require to measure. Beer(Beer and Casti 1975), in Investment Against Disaster in Large Organisations, clearly points out that measuring performance is not solely a matter of business performance but how dynamic changes in markets effect the strategies in place to achieve the desired corporate results. Here he points out the impact of communication delays on the ability to respond.

Morlidge(Morlidge 2010, Morlidge and Player 2010) likewise challenges the performance model upon which a business should be measured contrasting the existing historic accounting reports with a dynamic budgetary process.

In Beer's United Steel report the opening paragraph may have an oblique reference to Abbott Abbott's "Flatland"(Abbott 1885), that Stewart(Stewart 2001, Stewart 2008) later developed into many dimensions, wherein the interaction of a sphere and a two-dimensional plane brought about the awareness of other dimensions from one point of view (2-D). This proposes a problem of measurement and from measurement predictability.

If we are indeed able to measure anything how do we go about measuring emergent properties that we may not be able to appreciate from our current point of view?

Equally what models and measurement techniques should be used if we are only analysing one part of the operational functionality of a business?

Whilst Beer et al have potentially offered a solution to benchmarking recursive organisational models and their performance (Cyber-Filter (Casti 1975, Beer 1979, Beer 1985)) Jackson offers a more comprehensive analysis of the different system models that have emerged over the last 70-years.

Jackson, (Jackson 2003) System Thinking: Creative Holism for Managers, not only compares and contrasts the different types of approaches Deming, Checkland, Forrester, Beer, Ackoff and von Foerster but supplies a critique of their application including the different philosophies employed. The following table outlines the structure of the book:

Introduction			
Part I Holism and System 1Practice			Chapter 1 The Systems Language
			Chapter 2 Applied Systems Thinking
			Chapter 3 Creativity and Systems
Part II Systems Approaches	*Type A*	*Improving Goal seeking and viability*	Chapter 4 HardSystemsThinking
			Chapter 5 System Dynamics: The Fifth Discipline
			Chapter 6 Organizational Cybernetics
			Chapter 7 Complexity Theory
	Type B	*Exploring Purposes*	Chapter 8 Strategic Assumption Surfacing and Testing
			Chapter 9 Interactive Planning
			Chapter 10 Soft Systems Methodology
	Type C	*Ensuring Fairness*	Chapter 11 Critical Systems Heuristics
			Chapter 12 Team Syntegrity
	Type D	*Promoting Diversity*	Chapter 13 Postmodem Systems Thinking
Part m Creative Holism			Chapter 14 Total Systems Intervention
			Chapter 15 Critical Systems Practice
Conclusion			

Figure 63: Jackson's System Thinking: Structure of Book

The only criticism of Jackson is that, printed in 2003, it is already become eclipsed by new Network Theory that touches on the fundamentals he holds core: See Fernandez above.

In contrast, but also complementary to, Jackson is Scott Foreman-Roe and Gene Bellinger's "Beyond Connecting the Dots - BCTD" (Foreman-Roe and G 2013) that mixes self-development of systems dynamics and agent-based models with a clearly articulated chapters on models, modeling, the Mathematics of Modeling and Complexity. What is does not include is the networking structures Fernandez includes but blending both Jackson and BCTD will achieve the sort of conceptual framework of this thesis the most important aspect of which is the *free* ability to model emergent agent behaviour along with rule-based Systems Dynamics and partial graph behaviour that can only be seen in Anylogic 7[xxxv] a commercial application that does include Network Theory.

The importance of including all three aspects of System Theory: Agents-based models; Network Theory; and General Systems Theory ("GST"), is the need to capture the recursive processes that GST offers along with the freedom to discover emergent behaviour/parameters that agents deliver and the constraints networks imply on business development. That is not to mean that GST and Network/Graph Theory are conflicted as on many occasions it is only the language that differs and modeling in one can assist the other: they can provide the topography upon which agents (those that are or become free) can operate.

Chapter 2.2.9: Why are the Enlightenment and Romantic's Periods Important?

The objective of reviewing the advances and sudden changes arising from the events precipitated by the Credit Crisis was to contrast the ontological frameworks that are now evolving with those of the Enlightenment and Romantics that preceded them.

The criticism of the latter is not that they were wrong, because in fact they built the foundations of a work that allowed it limitations to become evident, but because in encouraging the reductionist approach and technology that emerged from the intellectual rigour it created its educational stance promoted an inertia in paradigms that did not allow material facts to over throw redundant models.

As Rienhart and Rogoff (Reinhart and Rogoff 2009) illustrate the volatility in the commercial and financial economies has been persistent for over 800-years but the models required to anticipate, measure and manage them within boundaries socially acceptable has only recently become available, and only then because of the accelerated technological developments of the 21st Century – all founded upon the mathematical, philosophical and biological foundations the Enlightenment/Romantic Period provided.

In direct contrast therefore Laszlo, Kaufmann, Watts and Beer offer philosophical views that ATPMs may use to develop management processes that society must first articulate both boundaries and structure.

Chapter 2.2.10: Unintended Consequences

Collating all of the above there remains one important concept that addressing:

> "If properties emerge from the actions of agents then how can they be predicate and any governance regime applied?"

Central to the concepts of Emergence, Cellular Automata, and Agent-Based Models is the concept that evolving structures including recursive ones develop properties that define them: Recursive autopoietic structures therefore sustain this process but can be susceptible to endogenous and exogenous change.

Cherkashin's Reality Game begins to address this issue(Cherkashin, Farmer et al. 2009) but it needs the prediction abilities of recursive structures and an awareness of current market constraints to be included. Applying ill-formed models in a commercial ATPM context is fraught with adverse outcomes and when the parameters change along with the topology of the market prediction and management become improbable. We are in the Rumsfeld Unknown, Unknowns.

Chapter 2.2.11: The Topography of the Eco-systems and Commercial Development

Topographically an ATPM is embedded within society and the dynamics are subject to the individual and collective actions of this society. As data is communicated, interpreted and governed by the acquired internal models of each agent or enterprise a dynamic system the interaction of agents and enterprises constantly manages changing resources to deliver the outcomes required.

Constraints come in many forms and at different levels of the recursive activity. For instance mature markets are governed by customer retention rates by product type, or in financial arenas regulators set out conventions of accounting or capital risk limits. These can be identified by experience and research methods. This process occurs at each level of recursion, for each product, but at varying rates referenced only by the collective availability of data.

Commercially the flow of liquidity and the value of capital become constrained if the dynamics of this system are catastrophically interrupted.

The process of commercial innovation, development and decay occurs at differing rates per product. They compete for a central liquidity and capital pool and can act like coupled oscillators the emergent behaviour of which then determines the availability of this liquidity. Periods of illiquidity can occur, as do surpluses, and the aggregation per sector becomes proportional to the type of interconnections with respect to the whole. This process reflects a wave-like aspect of a duality because the social properties of agents; being the principle creators, communicators and interpreters of strategy can develop dominant behavioural characteristics unless compensating governance structures are put in place. Shannon and Beer recognised this as amplification and rectification within oscillatory circuits.

As organisations become stable through collective agreement new recursion levels are created. To govern these other supra-enterprise agencies are created sitting alongside the governance framework of society to maintain the boundaries of acceptable behaviour; these are the compensating structures required to moderate collective social behaviour of agents.

As described above the physical environment, individual agents, enterprises, social-governments and supra-enterprise agencies form an influence network with a nested recursive structure and continually reforming boundaries. At each level the emerging aggregate behaviour thereon informs all neighbouring and orthogonal strategies as to potential change to meet their stated objectives. These activities precipitate both constraints and opportunities that the ATPM is asked to address, the former identified by Network Rules/Structure and the latter by Agent behaviour.

Making products and providing services for this society involves the development of processes. Processes developing within a dynamic environment infer doubts that in turn present us with a range of probable outcomes. Value in this context acquires uncertainty which we call Risk (Knight 1921). Defining the current and future value of an asset under these conditions resolves itself to the types of models used. Following our new convention value is therefore defined by Risk and Uncertainty and the objective of the *m*-ATPM is to supply a template to assess the component risks and functional operation of the targeted investment opportunity.

In order to manage discrete and aggregate Uncertainties/Risk an ATPM looks for the embedded compensating structures that can disperse certain effects: e.g. in our example a range of coupled oscillators can begin to resonate with consequent disastrous results to the whole without proper rectification. As a recursive structure with different emerging properties at each level the compensating properties may need to change but the functional structure remains similar and can be identified at each level or recursion.

To achieve effective feedback processing times need to be scaled to harmonise with the whole recursive structure. This is something modern manufacturing has become aware of but it is not limited to that operational space. In network terms it relates to the boundaries the network sets within sub-nodes of any type and the length of communication line: the structure of feed-forward parameters determine any compensation ability of any local agent and overall.

It must be noted that “rectification” is not the only requirement in governance structures or the communication of data. As with any strategy it is data that becomes core to execution and sometimes data needs “amplification” if its importance is to become useful or transmitted across the network. In both instances the effectiveness of execution of the connecting parts is important.

Chapter 2.2.11.1: Hierarchy, Heterarchy and Strategy

It is worth stressing the importance of how a discourse of agents and enterprises needs to be free to create strategies that can embed any type of enterprise or agent within the panoply of recursive structures in much the same way biological agents and chemicals form complex organisms.

As described above commerce is a network of varying levels of influences that dynamically change ex-ante strategies with their own boundary conditions. It was equally described that the collective behaviour at each successive level derived different strategies with different boundary conditions and governance languages whose implementation may vary the temporal scales within and orthogonal to each level. If the changes in governance languages at any level are sub-optimal (e.g. is rules-based with unintended outcomes) then the impact will affect the network differentially depending upon whether its recursive structure is hierarchical, heterarchical or a mixture of both: Hierarchical because of its homomorphic effect and heterarchical because of its isomorphic effect on orthogonal structures. Good examples are the effect of LIBOR interest rates or the Basle I regulatory capital for banks. In the former the outcomes of ATPMs would have been universally reset but in the latter different banks structure meant that its fixed language for capital rules did not encompasses re-hypothecated or insured risks.

However heterarchical can embed hierarchical structures and this increases the endogenous level of Uncertainty especially if local processing times are differentially longer for others. E.g. Pension funds embed strategic changes in asset/liability models to adjust to interest rates but further strategic rate changes crystallise an illiquid market for asset/liability management.

Value, Uncertainty and Risk therefore manifest themselves at all levels of the Commercial Eco-System. From the individual agent’s future actions through to the structure of the organisation’s ability to perform tasks. Interaction between agents, enterprises and recursive levels of governance create a heterarchical causal framework that inherits the properties of local and global systems embedded within it with “local” given priority. Included within must be a relational temporal scaling factor related to the efficiency of the whole system.

Chapter 2.2.11.2: Properties of ATPMs

The similarities between economics and physics have been commented upon frequently (Mantegna and Stanley 2000, Wille 2004, Schinckus 2010) and if we consider ATPMs objective as the assessment of initial and future values within a dynamic commercial economy then ATPMs approach may seem to follow similar lines of enquiry. Much in the same way differing molecular networks of the same components lead to different structural properties and as an agent it dynamic behaviour can show wave-like characteristics the issue it is an ATPM's assumptions and structure that define its behaviour in commercial activities: Incomplete internal structure and/or erroneous market assumptions can lead to mis-pricing.

In a dynamic state-space the focus is on the process by which value is created and destruction of commercial value the following begin to describe what needs to be observed in determining how that value is created: What can we say about:

- The motivation of the principals to establish the connection;
- The characteristics does "value" have; and
- How can we begin to describe the ATPM risk assessment process?

For instance:

1. Does "value" have an expiry date;
2. Is this a bounded or unbounded risk system (it affects entropy);
3. How do enterprises create recursive structures;
4. What forces act upon the targeted enterprise and investors;
5. How do the activities in the surrounding eco-system effect the perceptions embedded in the internal models of both the issuer and investor;
6. Are the boundaries between components of the eco-system permanent, permeable or semi-permeable;
7. What methods and data are available to observe the performance of the enterprise;
8. What functional forms and boundaries determine the outputs of the enterprise;
9. As a network, what are the boundaries and when do they impart constraints on performance;
10. As a relative performance framework is the absence of a qualifying temporal framework vector an issue;
11. How can you observe emergent behaviour;

12. If emergent behaviour determines properties and the environment is dynamic this is a probabilistic Universe how then can “value” be measured;
13. What compensating structures need to be in place to ensure recursive viability; and
14. What causal framework exists between and orthogonal too each agent, enterprise and component-node within the network?

This iterative approach of analysing a commercial recursive structure is a “parsing process” that also presents the following considerations:

- In managing diversity of investments within a recursively structured portfolio to achieve sustained value: Is the objective to optimise or maximise value;
- How does the cross pollination between parameter characteristics of a network and that of “wave-like flow” of agents affect the predictions;
- How can we assess the asymmetrical nature of elapsed time and data-flow within a network as variety decreases and response-time increases; and
- Can we use the structure as a determinant of fragility?

These conditions are created by the nature of all commercial transactions being a contractual agreement under some form of legal jurisdiction and accounting conventions. All contracts have a common basic structure in that:

- They must identify the parties;
- Objective(s);
- Time frame;
- Obligations; and
- Any attendant conditionality.

The objective must clearly identify the outcome and processes to achieve it whilst the conditions set process boundaries to ensure focus on the outcome is maintained.

Chapter 2.2.12: Developing a Taxonomy of ATPMs

One could say ATPM’s are concerned with the price at which assets are transferred to third parties in exchange for other assets that more ably meet the investor’s strategic objectives. The process establishes:

- The legal framework under which the arrangement is to be executed;
- At least two values, a start and exit value;
- A level of Uncertainty and by association a degree of Risk; and
- A strategy by which the process will be attained.

These are usually enshrined in a brief initial document, the term sheet, and then a full legal contract setting out the full conditions and expectations of the parties. ATPMs are essentially models that establish the initial terms of the former and precede the signing of the latter to judge whether the values are acceptable by the parties.

Value, in a dynamic Universe, is therefore a relative and ephemeral metric dependent upon the perspective from disinterested that the assets are assessed: The current owner, the purchaser or third party. Value therefore has characteristics of (nominal amount, perspective, attributes) where attributes qualify perspective that in turn qualifies the nominal amount.

It is commonly thought that investment procedures involve the exchange of cash to produce a return, however this is only part of ATPMs role as the process of investment could be the exchange of the same assets but under differing regulatory regimes to maximise profit from the lack of constraints one regime may have over the other. To achieve m-ATPM we must abstract the common processes to form a general pattern.

For instance:

- If the asset(s) are similar and generally available, the nominal amount can be obtained by comparative means and those in the possession of the investor being qualified as to their relative condition in such a process; and
- In the event that the assets are rare, and there are therefore few or no generally available comparisons, then the qualifying condition is a matter of relative subjective opinion.

We can start to apply these conditions to our Value characteristics above as follows:

((nominal amount, condition, availability), perspective, attributes).

Perspective between investor and issuer can change considerably if the exchange does not involve comparable items. It is here that process and structure play important roles as to the probable successful outcome: Process because it is the accumulation of probable failure in the concatenation of discrete elements and structure in view of the resilience of management to ensure the processes are complete to specification. We could say:

Perspective has (process, structural) characteristics.

If we were concerned with only internal aspects of the transaction then we would continue to analyse just that but both “process” and “structure” are influenced by exogenous events. This infers that boundary conditions are also a characteristic of perspective in as much that exogenous and endogenous activity must be transacted at a boundary being the point(s) where the enterprise meets its environment.

We should go further and say in a dynamic system both “processes” and “boundary conditions” operate within a Timeframe. This Timeframe cannot simply be the convention we accept as Time because each are influenced by the rate at which transactions occur. In addition exogenous and endogenous activity may occur in different reference frames and relative to each other. Temporal characteristics begin to look like a vector:

Temporal scales have (direction, velocity) characteristics.

Expanding “Perspective” to include the above:

(process, structural, boundary condition, temporal(direction, velocity)).

We now turn to an aspect of “boundary conditions” and a characteristic of Perspective being the “*type*” of asset being considered. In general there are two “*types*” of transfer with corresponding risk attributes:

Principal Forgiveness[xxxvi]: A transaction within the initial principal at issue is forgiven and not repaid subject to certain conditional events e.g. equity, insurance, financial derivatives; and

Debt[xxxvii]: An amount of money borrowed by one party from another e.g. bonds; loans and commercial paper are all examples of debt.

Commercial transactions can include elements of both of these "*types*" which of necessity, because each have different legal, regulatory and Risk conditions, would affect the Value considered.

We can further define "Perspective" and leave it to review elements of "boundary and Temporal conditions" that affect "Value" characteristics as well as help define characteristics of the next level of recursion:

Perspective (asset-type, process, structural, boundary conditions, temporal (direction, velocity))

Bring it all together we now have:

(nominal amounts;
perspective (asset-type, process, structural, boundary conditions, temporal (direction, velocity));
attributes).

Having described "perspective" in outline we can now approach "attributes" which we will split into three:

Attributes (business, governance, regulatory).

Business relates to the peculiar attributes of the business at hand and common elements of all businesses would be:

Table 6: Common Attributes of a Firm

Element	Type	Character	Conditions
Production	Existing New	Current production Possible production	Material & manufacturing costs
Revenue	Current market share Possible market share	Competitors Demand	Cash or Credit exposures
Capital Base	Equity Debt Liquidity Insurance	Current asset values Leverage conditions Liquidity supply in the marketplace	
Topography	Geographic location Social Behaviour Transactional system	Physical attributes Workforce/Society Payment systems	Natural catastrophes Political structure Credit structure

Governance relates not only to the management within and without the business but also to the functional structure, communication metrics and the experience of the managers and workforce. We should include the connection between outside and internal operations and format this:

Governance (Exogenous-Endogenous boundary (Communication metrics);
Exogenous (Functional structure, Communication metrics, Workforce experience); and
Endogenous (Functional structure, Communication metrics, Workforce experience)).

Regulatory issues are related to governance, but at a recursive level above the firm in focus, and consist of a different language relating to:

Regulatory (accounting, types of product, industrial relationships, employment, taxation, contract law, governance (global/state/local).

Combining them all together we would now have:

(nominal amounts,
perspective (asset-type, process, structural, boundary conditions, temporal (direction, velocity)),
attributes (business (product, revenue, capital, topography),
governance (Exogenous-Endogenous boundary
(Communication metrics)
Exogenous (Functional structure, Communication metrics, Workforce experience),
Endogenous (Functional structure, Communication metrics, Workforce experience))
Regulatory (accounting, types of product, industrial relationships, employment, taxation, contract law, governance (global/state/local)
).

The colour coding is to differentiate the elements but also to highlight that governance comes in recursive forms; firm related and recursive levels higher.

Having identified common elements that should be required of all ATPMs it does not mean they are material in every ATPM. Many will become immaterial if for instance the model concerns short term trading of credit within an exchange but if the parameters change the so will the dynamics of the trade.

The next stage is to identify structure and constraints that are common to the m-ATPM in the agents, firms and commercial state-space in which they operate for our TE.

Chapter 2.2.13: Freedom, Constraints, Agent Behaviour and a Recursive State-Space

Agents and enterprises exist in a dynamic, competitive environment with varying degrees of competency. Therefore though the approach and planned payoff profiles may be similar within strategy type execution will define actual outcomes. There are two particular characteristics that can influence outcomes and they are “behaviour” and “transaction constraints”. The former is a feedback loop from collective market activity to internal model strategy parameters and the latter the contractual restraints imposed in creating the network that is the enterprise. Importantly the internal models mentioned are not only the strategic models established within the enterprise but also each agent's internal "world-view".

It was noted that agents and enterprises are free to form new levels of recursion from a collection of any other level below them and that these are heterarchical structures that embed a variety of experience and hence the internal models above will need to share common parameters and a collective focus. To be resilient the governance structures will need to adapt internal variety of experience to potential external forces. The internal models therefore need to recognise that pay-off profiles are dependent upon these governance structures as well as strategic processes.

Monitoring collective behaviour and formally modelling outcomes is therefore part of the anticipatory processes that counteract Uncertainty within individual processes, the enterprise as a whole and such exogenous pressures that are present in the marketplace. The size of the individual and aggregate "Values" involved, and the velocity that the feedback and feed-forward processes must cope, will define the Risks needing to be managed.

The networks of customers (old and new) cause constraints that start to define boundaries and identify the enterprise to other agents (and enterprises) whose own strategies want to go beyond their own constraints (e.g. get market share). They may see complementary opportunities in creating a new combined entity. If the properties of the components are stable enough over relative time frames this strategy may enhance existing operations but this new sense of viability must also exhibit the same basic variety governing capabilities mentioned above. Therefore "behaviour" and "network structure" inform "boundary conditions" that set attributes for strategies and become "properties" for the next recursion level.

In the ideal ATPM model the state-space should be constructed to account for all the probable states (total variety); the sum of the variety on each of the orthogonal axes of recursion should be equal; and the network structured such that forces are distributed throughout without major disturbance to the whole.

Equally if this were a highly connected and fully recursive economy as it reaches the top-level of recursion the governance language must change drastically from managing variety (external variety diminishes) and Uncertainty in the network starts to impute a Lotka-Volterra(Lotka 1925) predator/prey characteristic(Kauffman 1993).

Imperfections in execution at all levels will be amplified by flawed competitive strategies that in turn will increase variety as failure ensues. The duty of the ATPM manager is therefore to identify the imperfections and compensate accordingly. The imperfections that increase Uncertainty and Risk appear in the different elements of “perspective” and “attributes” of our draft taxonomy.

Schumpeter(Schumpeter 1939), and many modern economists, attribute economic evolution to technology change and seldom taken into account in ATPMs temporal scale. However “physical technology” need not be the sole evolutionary force. Responses to regulatory change in the form of new financial products have significantly altered how commerce is financed and in turn the temporal scales involved. Like any tool they also had abusers of the system and unintended consequences raised later.

Nor are these issues unique to this current milieu as most of its groundwork was founded in the Middle Ages with the Knight Templar’s money broking and the Medici Banks. The following outlines some of the more complex products:

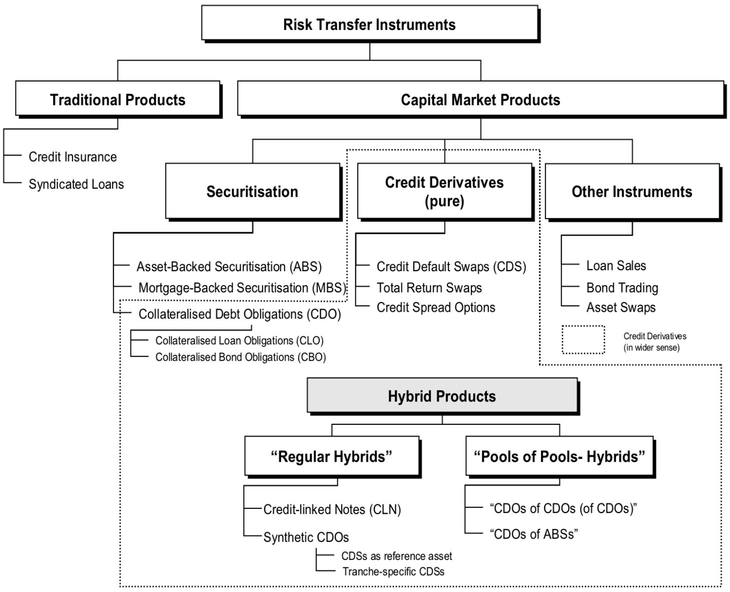


Figure 64: Types of Financial Instruments and Risk Transfer in commercial use (Jobst/Effenberger)

However evolution does keep in step with existing structures but leaps leaving some industries forlorn. Regulatory, Accounting and Financial practice matures in complexity but underlying it all there is a simple framework started above and repeated here. In general they are the two "*types*" of risk transfer above but although equity is a form of Principal Forgiveness it does have elements of "payback" and therefore a third distinction is made "insurance":

> Principal Forgiveness[xxxviii]: A transaction within the initial principal at issue is forgiven and not repaid subject to certain conditional events e.g.:
>
> - Equity: When the business has stopped being a "going-concern"; and Insurance & financial derivatives;
> - Debt[xxxix]: An amount of money borrowed by one party from another e.g. bonds; loans and commercial paper are all examples of debt.

Commercial transactions can include elements of all three of these "*types*" which of necessity, because each have different legal, regulatory and Risk conditions, would affect the Value considered. We can braid these three "*types*" and add regulator structures by mapping them to a tetrahedron figure 65:

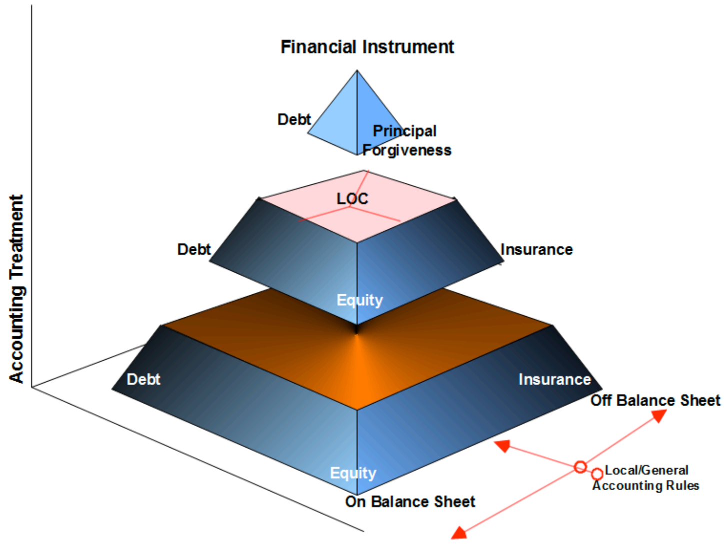


Figure 65 : Author's Presentation on Contingent Capital Products to Merrill Lynch 1995

An ATPM therefore deals with a financial instrument that can be broken down into a combination of the three components mentioned above. Depending upon the local/global accounting or regulatory regimes a balance sheet is created and the instrument placed accordingly.

The graphic above is a device by which combinations and permutations of the three elements can be made to construct the type of instrument required by the ATPM to match the expectation of the parties. Along the right-hand side the red arrow stipulates how that instrument might be treated according to the local and global rules.

In the perfect Universe commercial evolution would reach a steady state across the globe and complex instruments would disappear leaving simple products whose pricing is derived by broadly free performance metrics. In reality the situation is the same as above, competition, poor execution, non-standard internal models and fractured structures will impart fragility and chaotic dynamics ensue.

Chapter 2.2.13.1: The Cellular Potts Model and its Hamiltonian

We saw from Cipra (Cipra 1987), Beaudin (Beaudin 2007) and Scianna (Scianna and Preziosi 2013) that the CPM Hamiltonian is a useful framework that ATPMs may amend to enact strategies the agents of a target investment and the networks they create. It will be discussed in Chapter 3.2 that the need to move away from deterministic pricing models is important, as they do not readily capture the recursive structure of the environment and the properties agents/networks possess. This will be discussed in conjunction with Beer and Casti's paper on "Investment against Disaster in Large Corporations" wherein strategies are shown to materially changed by structural and organisational parameters not usually accounted for in corporate finance: hence the ontological imperative with a proposed artefact to include such a framework as a multi-dimensional recursive Hamiltonian for ATPMs.

Chapter 2.2.13.2: Summary

The concept of "bounded rationality" recurs throughout economics and economic philosophy especially when describing the components of socio-economic systems – the firm (see Coase(Coase 1937)) and what constitutes the interactions between individuals in cities (see Simmel on dialectic tension, dyad, triad and parameter differentiation per scale, and Popper (Popper, Ryan et al. 2013)).

Coase may have not applied it the same way but a layer of recursion within systems consist of a dynamic relationship between one or more agents, that may themselves be economic ecosystems, will have constraints that will impute temporal and other contextual conditions.

For instance a 'widget' manufacturer may achieve independence locally, nationally then become transnational only to find it loses one of its local markets to a local competitor without losing its higher viability and visa versa. Equally either a local or transnational 'sector/agent' can be critically constrained if another attracts capital resources at higher rate. The ability to predict activity breaks down at a certain time horizon for each system (Vester 2007) and is further complicated if systemic formation is unclear or is emergent (Vester 2007).

The researcher's experience, and therefore view, conditions the approach herein and follows Weick (Weick 1995, Weick 2001, Stokes 2009) in many respects: 'little *islands* of *relative* stability and *relative* certainty in a complex and uncertain environment' and that this environment is in 'constant flux' where the islands are businesses grown from concept to manufacture through an organising principle (Weick 1995, Morgan 2006, Stokes 2009) into different structures (Beer 1972, Beer 1985, Morgan 2006, Ostrom 2009) that can be cooperative or competitive but all of whom are dynamic and must be measured in some form (Fukuyama 1995, Ormerod 1999, Jackson 2003, Gharajedaghi 2006, Bookstaber 2007, Greene 2008).

Daniel Trietsch (Trietsch 2009) reviewed the prevalent business models such as TQM, SSM, except Six-Sigma (Keller 2005), and compared them against my preferred 'the Viable System Model (Beer 1972)' identifying their strengths and weaknesses; See Appendices. It is the VSM's holistic approach of multi-layered systems that fits well with an economic ecosystem perspective because its identification of function over form that then allows simple algorithmic structures to be created.

We have seen above that connecting Network/Graph Theory for constraints, Agent-Based Models for emergent behaviour, within the CPM/Hamiltonian framework that is recursive may offer additions to current ATPMs that overcome their failures, however the universe in which they inhabit must be probabilistic and heterarchical if the resultant model is to correctly construct a commercial recursive network.

Chapter 2.3: Risk Acceleration & Process Related Time

A preference for potential investors in an asset is that likely outcomes have a high confidence of being achieved in the allotted timeframe. If the due-diligence conversation is carried out well either the sense of or an actual probability range will be present changes to which will be deemed due to random events.

According to Dunning of Business Insurance (Dunning 2014) :

> *"The emerging concept of "risk velocity" is likely to be unfamiliar to most risk managers, but experts say its underlying principle — measuring how fast a risk may affect an organization — may be more pervasive in companies' risk management strategies".*

Yet the basic construction of risk measurement requires the frequency by which a risk impacts cash flow and possibly the balance sheet? Using the word "velocity" - *The speed of something in a given direction (OED)* – implies a constant rate and direction that we note in Ruin Theory (Beard, Pentikäinen et al. 1969, Beard, Pentikäinen et al. 1977, Dickson 2005) and is taken into account when reserving for known fluctuations of performance. Surely it is the sudden change in this "vector" – acceleration - *The rate of change of velocity per unit of time (OED)* - that should alarm management i.e. the extreme negative of which causes catastrophic losses to performance?

In both calculations, of velocity and acceleration, time is a divisor and assumed constant whilst events are assumed to occur randomly. However there are other influential factors one of which is the processes under which the business's functional objective is carried out changes to which fundamentally alter the assumptions embedded with risk assessment above. These changes could be as fundamental as technology change or more prosaically constant management change resulting in governance errors. Accelerating risk could therefore be due to: unmeasured process change; genuine exogenous and random events; and/or both.

It was noted in the Conceptual Framework that deterministic asset pricing became problematical for just these types of reasons: Outcomes are therefore subject to risk "acceleration" and type of governance. The following simple example may offer an insight.

Let us assume an investor is considering an equity asset in a conglomerate business of varying types of business and that for each business:

- Traditional risk factors have been calculated using standard metrics;
- Market forces are assumed to be stable;
- A future performance graph can be derived taking into account the above; and
- Governance structures do not change.

Let us further assume that two of the business performance lines can be derived using a simple formula as follows:

$$y = a\sin(bt + c) + r$$
$$Period = \frac{2\pi}{b}$$
$$Displacement = \frac{-c}{b}$$

Where:

t = *Time;*

a = amplitude displacement;

b = adjusts frequency;

c = adjusts displacement along the x-axis along with b; and

r = adjusts the y-axis displacement.

and their respective individual and combined performance lines produced figure 66:

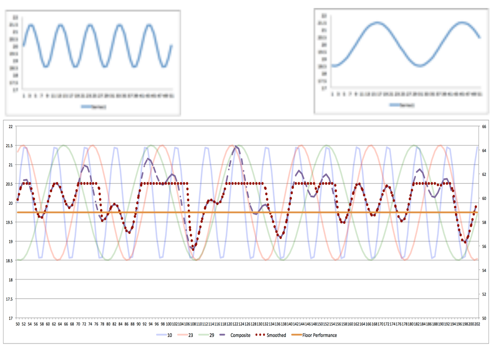


Figure 66: Two Uncouple Business Lines Consolidated

From the combined performance any change in fundamental risk factors will substantially alter long-term performance and any deterministic outcome must be accompanied with a set of caveats. Using the negative of Keynes (Keynes 1937) own caveat in section 1.ii – “*An improvement in organisation or in foresight* “ –process driven events will materialise as either additional loss event types or a change in performance frequency: timescale - core to which is proper governance.

It is therefore important for an investor to use an ATPM that includes a level of due-diligence capturing the approach offered by Knight (Knight 1921) in separating known, known-unknowns and unknown-unknowns or in loss terms known claims, stochastically tractable reserves and a buffer reserve.

Though over-simplified the case for probabilistic outcomes seems clear and more so currently (2015) as many of the risk factors normally taken for granted prior to the 2008 Credit Crisis are now more volatile or as John Kay (Kay 2015) observed:

> *“When the “off-model” event was the breakdown of parts of the wholesale money market in 2007, their surprise was just about forgivable: in the case of the Swiss revaluation, to have failed to visualize the possibility is rank incompetence”.*

The importance of governance, and its structure, was outlined in the Conceptual Framework and will be expanded in the following review of the relationship between the investor, management and their environmental forces.

Chapter 2.4: The Observer & Recursive Governance

If ATPM's have a self-similar structure across all recursive financial levels then at one point they merge with those financial aspects of economic as observed in the Concept Framework. This short section however reflects upon the observer and their interaction with the system observed. At the end there will be a summary of Chapter 2.

As that system can be defined recursively with different operational parameters and values at each level then each level could be considered a self-contained entity that acts as an observer to those levels below but not above as it would not possess sufficient understanding of those levels purpose.

Fullbrook (Fullbrook 2012) attacks the economic method quoting physicist Jean-Philippe Bouchard as follows:

> *"the crucial difference between physical sciences and economics…is.. the relative role of concepts, equations and empirical data. Classical economics [meaning today's mainstream] is built on very strong assumptions that quickly become axioms: the rationality of economic agents, the invisible hand and market efficiency, etc. An economist once told me, to my bewilderment: ""These concepts are so strong that they supersede any empirical observation""*

Although the attack is somewhat measured the goal is the same, a model if it is to have a functional use must draw upon observation communicated efficiently. At each level of recursive activity therefore if the system is to be autopoeitic then it must become aware of the differences between its own and any sub-systems operational parameters. As we will discuss later in Probabilistic vs Deterministic Asset Pricing this requirement becomes essential as each observation must be clear about the effects of strategy change and not try to impose "global rigidity upon local looseness" thereby collapsing the whole.

The observer must therefore retain a sense of perspective holding its own relative position in one hand and perceiving the operations of that below it in another. It must be recognised that this approach has severe drawbacks as Capra (Capra and Luisi 2014) shows when discussing Human observation, Bohm (Bohm 1957) on measuring a system, and especially in economic ATPMs (Fullbrook 2012): The system may affect the observer but the observer is part of that system and therefore influences the system itself.

Chapter 2.4.1: Summary

The literature of the Complexity Sciences is vast and yet falls into three main sections: GST, ABMs and NT that have been lightly touched upon herein by comparison. However the growing insights from work being done by the Bank of England, Santa Fe and other universities is beginning to illustrate that by observing the construction of the networks financial agents create and monitoring their activity within and without them similar emerging behaviours are found if only for a short time span.

Though Jackson critiques most of the GST elements the advancement in ABMs and NT is very recent however it is considered herein that the VSM, and Beer's prior works, are pre-eminent in the field of GST as the only integrated Organisational Cybernetics framework based upon its empirical upbringing and foundation in recursive governance structures and probabilistic strategic outcomes. However a close adherent to these principals by Weick (Weick 1995, Weick 2001) has had some commercial success.

The concept that ATPMs are principally conversations resulting in a decision to either accept or reject a proposal belies the depth of due-diligence that conversation undertakes that is itself complex. Equally considering it a deterministic process would lay bare the issues found in the 2008 Credit Crisis where iterative governance miss management and the failure to apply empirical results to "top-down" economic policies failed to observe the role corporate structure and governance regimes played in the timely execution of processes. This emphasis on "time" was observed in "risk acceleration" that meant technology, bad governance and changes in financial regulation could overtake the assumptions that grounded an initial investment idea. Had the investor used a probabilistic vector outcome based upon various scenarios including a recursive marketplace and governance regime then as Morlidge and Beer points out investment outcomes would have been revised on a timelier basis.

Special emphasis herein was given to the role of all the observers in an ATPM conversation especially those within the target investment. As Beer points out the ability to manage variety, per Ashby, is paramount in controlling the strategic direction of complex interlocking processes and as (Schwaninger 2006, Schwaninger 2006, Schwaninger 2009) notes. The observer within a closed system, it was shown that the Universe is such though an imperfect model exists, cannot fail to interacts with that being observed (See Bohm) this was especially poignant when considering the market practise of leverage and its application to mortgages, considered by most the start of the 2008 Credit Crisis but not its reason that accolade being left for investor lack of confidence in the models being used resulting in panic selling and a loss of sustained liquidity in the market place: something that persists today.

The Cellular Potts Model was considered the best means by which to introduce probabilistic agent activity and network structure into an ATPM due to its ability to handle multi-state parameters. However the exact structure of the network would need to be observed and then compared to a framework that proposed the most stability and the reason why the VSM was considered.

The VSM is not the end of the modelling conversation because different organisational structures may suit different types of organisations. However by comparing the observed organisational structures within the target investment and comparing them to the VSM does allow the dependences and changes in processes parameters to be highlighted and accounted which by constructing the CPMs Hamiltonian to be shaped topographically like the VSM would allow for a recursive, multi-dimensional framework.

Finally considering the ATPMs overall environment to be that of a conversation the proposal was to include a rigorous framework along the lines of Klonowski but augmented by Duarte’s notion of managing noise within the conversation as per Information Theory: This would alleviate any misunderstanding that may occur through language or lack of appropriate knowledge. However Klonowski’s approach must be amended to include all of the above if it is to be useful.

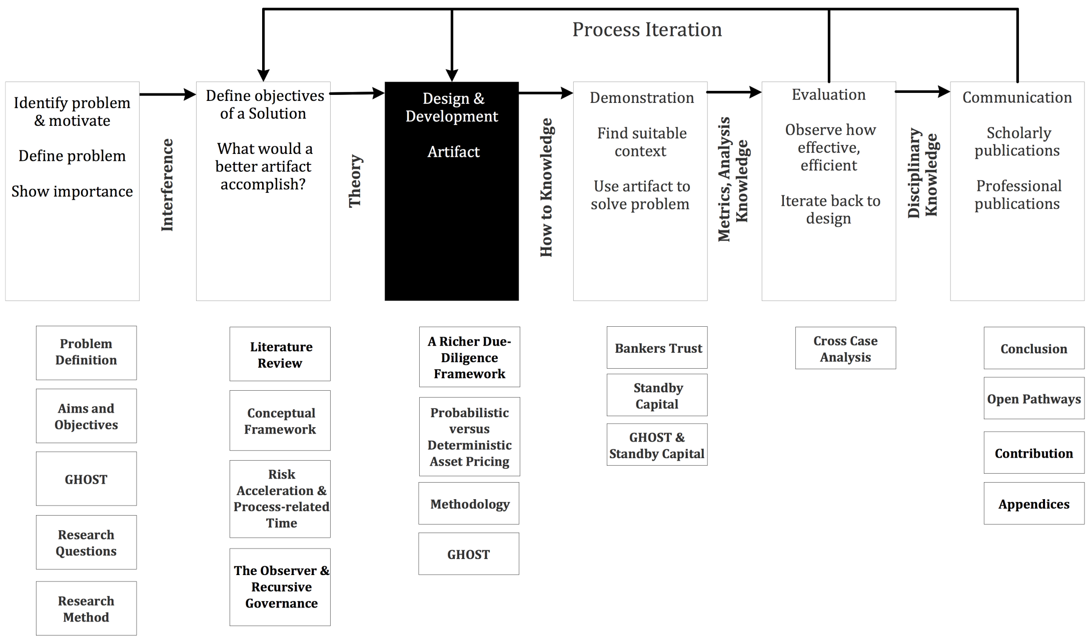


Figure 67: Chapter 3

Chapter 3 – Design & Development

Chapter 3.1: A Richer Due Diligence Framework

Chapter 3.1.1: Introduction

The objective is to design an artefact that will serve as a richer due-diligence framework feeding a set of models that will sustain an ATPMs requirement to verify a sellers proposal. The artefact has been given the acronym GHOST – General Heuristic on Structure and Time.

The artefact is at once a conversation, a set of models and a due-diligence framework. The latter therefore aims to informs the two former elements first to ensure that the data and processes required to achieve the financial outcome of the ATPM is present but also to confirm these are communicated accurately to all parties.

The following builds upon the Conceptual Framework by identifying practical issues and showing the methodology as well as a discrete breakdown of the artefact.

Chapter 3.2: Probabilistic versus Deterministic Asset Pricing

Further to the discussion in the Conceptual Framework on the above and in keeping with the objective of testing the artefact in the real world the following briefly outlines the conclusions from a paper written by Stafford Beer and John Casti (Beer and Casti 1975) titled "Investment Against Disaster in Large Corporations" ("IAD").

Although the paper was written to illustrate Zeeman's (Zeeman 1977) popularisation of Rene Thom's 1960's work the premise behind it, to assess the proper strategic investment approach when considering "off-model" or extremely large loss events, resonates with the objective of using the artefact to assess the veracity of an investment in a seller's Standby Capital product, itself aimed at providing loss-bearing liquidity when catastrophic performance events occur.

In Beer's (page 1) terms:

> *"Increasingly we are aware that the large systems we attempt to manage show signs of disastrous breakdown. For purposes of this discussion, we define 9isaslel as the passage of some important systemic variable beyond a threshold of acceptability. Thus in managing the ecosystem, we may find that pollutants have killed all the fish; in managing the city, we may find that it becomes too noisy, dirty or crime- ridden to live in; a social service, such as the postal system, may break down altogether; a firm may go bankrupt.*
>
> *Yet it is naive to imagine that one can draw up lists of possible disasters, and make investments that will avert them, although this is the standard managerial approach. Some cities, for example, have appointed officials to "do something about noise. " But noise is a product of how the city is, just as inflation is a product of how the social economy is and the naivete lies in contemplating abstractions as noise and inflation as dragons walking abroad, who can be cut down by sufficiently intrepid knights. We have to find an approach to the total system in which potential disasters are embedded."*

Beer discusses the homeostatic relationship between two entities, coral and starfish, that can be modeled system dynamically. When the homeostatic relationship breaks down the following outcome occurs:

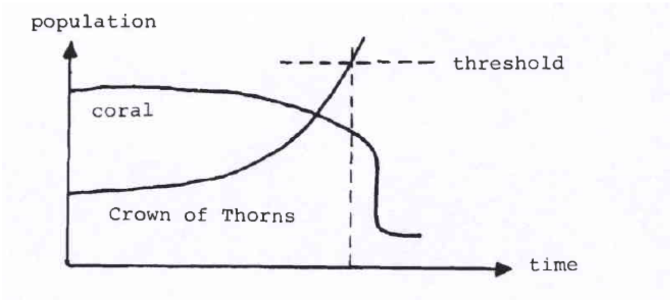


Figure 68: IAD Figure 2

In observing that large organisations that exhibit stability are the result of interlocking homeostats rather than "active management" that he defines as "*concerned with the objectives laid down upon the organization, and with meeting goals set for the organization*" he notes that the latter often "*provokes instability….rather than the reverse*".

In abstracting this example Beer postulates the following:

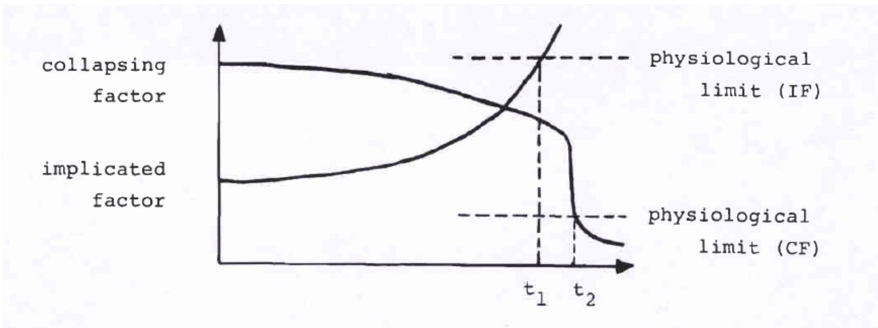


Figure 69: IAD Figure 3

Given a known set of variables this too could be modelled system dynamically but Beer equally observes that it is not the "plotting of the course" of a variable but the "aversion" of disasters that needs understanding here e.g. bankruptcy or takeover.

Religious adherence to modelling, in Beer's opinion, results in global consequences of very precise local interactions are forced upon the system, the critical feature being "*locally rigid but globally vague*" whereas when trying to model social interacts no such local precision is available usually through a "*lack of data or an inadequate* *understanding of the underlying mechanisms"* these being *"globally rigid but locally vague*".

Beer then describes a dynamical system in terms of catastrophe theory that observes the qualities of divergence, discontinuity and cusp catastrophe that he then describes. However the objective here is to discuss the "cusp catastrophe" that emerges in the 3-dimensional graph figure 70:

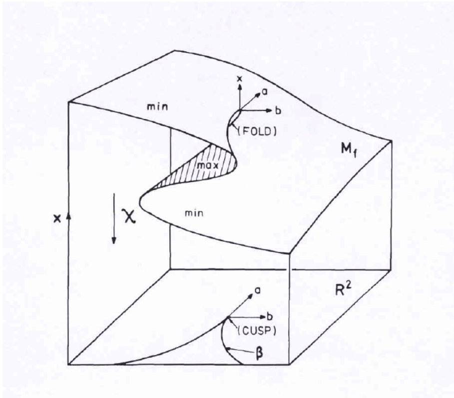


Figure 70: IAD figure 5

The forms of systems have unique qualities that simply put means linear changes can see jumps occurring in outcomes. When applying this to investment Beer (page 15) observes some fundamentals of resource allocation when faced with collapse that management may not have identified all "collapsing factors" and that "all investment impacts some organisational homeostats…. and therefore may impinge (positively or negatively) on an incipient disaster".

Beer focuses on the action of investment adding an investment variable as a 3rd dimension to the abstraction above figure 71:

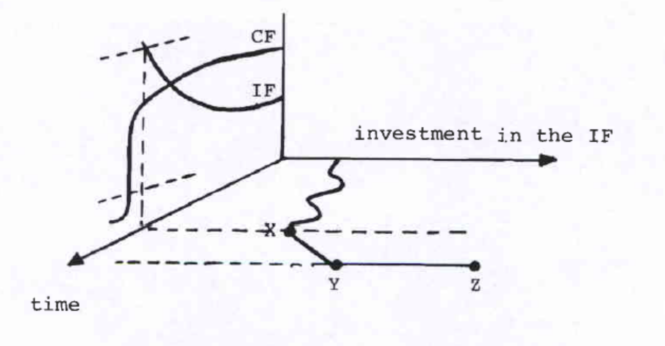


Figure 71: IAD Figure 6

It is suffice for the purposes herein to jump to a major conclusion illustrated figure 72:

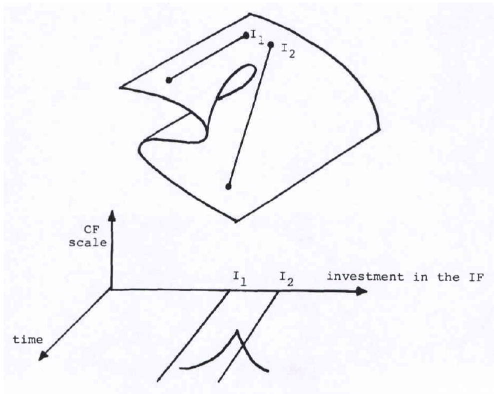


Figure 72: IAD Figure 8

It effectively observes a given level of investment may not have the same strategic effect as another. The conclusion herein is therefore that deterministic pricing models overlook the effect of dynamic systems that are probabilistic in nature and should therefore be treated as such: Such systems variable are vectors.

Chapter 3.3: Methodology

Chapter 3.3.1: Design Science Research Methodology

The philosophical position adopted by this thesis is effectively as a Critical Realist believing that, like Hill (Hill 2009), objects in the Real World have a stratified and independent existence "*whose behaviours are governed by well-understood physical laws (such as Maxwell's electromagnetic theory)*" but at the same time "*they have been explicitly designed to implement abstractions such as microprocessors, operating systems, databases, applications and work flows*". The objective is to better understand these structures, events and behaviours in order to correctly identify the financial outcomes of investment proposals given that current ATPMs have broken down.

The thesis has defined ATPMs as both a set of models and a due-diligence process the former arriving at outcome values from the processes involved and the latter a framework to discover the data informing the models. It is also considered that ATPMs can be viewed as a conversation between a set of buyer/agent/seller parties that can be defined by Information/Communication Theory (Shannon and Weaver 1949, Duarte 2010) and subject to similar noise conditions identified by Duarte. This positions ATPMs as an aspect of Information Systems and a candidate for Design Science Research Methodologies ("DSRM") (Peffers, Tuunanen et al. 2007).

Although the capital markets are regarded as a source of innovation (Soros 2003, Soros 2008) practical experience indicates that it suffers from a dearth of appropriate data to inform the models that describe its operation. This lack of data further defines ATPMs as a suitable candidate for DSRM as that methodology allows the creation new knowledge through specifically designed artefacts "*and analysis of the use and/or performance of such artifacts along with reflection and abstraction—to improve and understand the behavior of aspects of Information Systems. Such artifacts include—but certainly are not limited to—algorithms (e.g. for information retrieval), human/computer interfaces, and system design methodologies or languages*" (Vaishnavi and Kuechler 2004). Given the absence of data and reluctance of firms within the sector to allow their own to back-test any artefact created herein the thesis assumes back-testing through the lens of a Thought Experiment using the practical experience of a team of professionals and the application of the artefact to pricing Standby Capital for a range of different proposals.

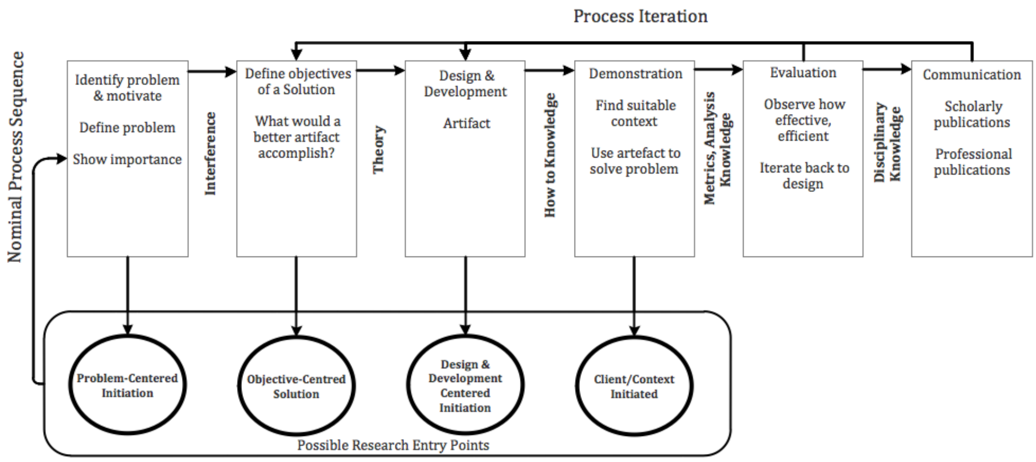
Although other methodologies were considered as follows:

Characteristics	Case study	Action Research	Design Science Research
Epistemological paradigm	Traditional sciences (natural and social)	Traditional sciences (natural and social)	Design Science
Objectives that can be achieved	Assist in the understanding of complex phenomena. Test or create theories	Solve or explain problems of a system generating knowledge for both practice and theory	Develop artifacts that allow satisfactory solutions to practical problems. Contribute to the building of theories (mid-range theories)
	Explore, Describe, Explain and Predict	Explore, Describe, Explain and Predict	Design and Prescribe
Main activities planned for a proper conduction of research	Define Conceptual Framework Plan cases Conduct Pilots Collect Data Analyze Data Generate Reports (Cauchick Miguel, 2007)	Plan Action Collect Data Analyze data and Plan actions Implement Actions Evaluate Results Monitor (Continuous) (Turrioni and Mello, 2012)	Define the Problem Suggest Develop Evaluate Conclude Communicate Manson (2006), Peffers et al. (2007), Takeda et al. (1990) and Vaishnavi and Kuechler (2009)
Research results	Constructs Hypotheses Propositions Descriptions Explanations	Constructs Hypotheses Descriptions Explanations Actions	Artifacts (Constructs, Models, Methods, Instantiations, Design Propositions)
Generated knowledge	On how things are or how they behave	On how things are or how they behave	On how things should be
Role of the researcher	Observer	Multiple, depending on the type of action research	Constructor and/or evaluator of the artifact
Collaboration between researcher-researched	Not required	Required	Not required
Empirical Basis	Required	Required	Not required
Implementation	Not applicable	Required	Not required
Evaluation of results obtained by research	Confrontation with theory	Confrontation with the theory	Applications, simulations, experiments with the artifact
Nature of data (collection/analysis)	Normally qualitative	Normally qualitative	May be qualitative and/or quantitative
Specificity of research results	Specific situation	Specific situation	Generalizable to a certain Class of Problems

Note. Adapted from "Design Science Research: A Method for Science and Technology Advancement," by A. Dresch, D. P. Lacerda and J. A. V. Antunes Jr., 2015; and "Design Science Research: A Research Method to Production Engineering," by D. P. Lacerda, A. Dresch, A. Proença and J. A. V. Antunes Jr., 2013, *Gestão & Produção, 20*(4), 741-761.

Figure 73: Table 3 from Dresch - A Distinctive Analysis of Case Study, Action Research and Design Science(Dresch, Pacheco Lacerda et al. 2015)

It was decided that Peffers provided a framework for: "*problem identification and motivation, definition of the objectives for a solution, design and development, demonstration, evaluation, and communication*" (Peffers, Tuunanen et al. 2007) :



A Design Science Research Methodology for Information Systems Research: K Peffer, T Tuunanen, M Rothenberger, S Chatterjee:
Figure 1. DSRM Process Model

Figure 74: Peffers Framework from which the chapter titles are adapted

The Method Chapter for this thesis is the establishment of a "Thought-Experiment (Gedankenexperiment)" "TE" describing a *meta*-Asset Transfer Pricing Model (*m*-ATPM) whose general functional form can be used as a benchmark in investment or risk pricing. The Chapter will describe the framework, processes and assumptions involved in using the *m*-ATPM along with comments linking it to a conceptual framework.

The TE will draw upon the following:

a. An expanded Longevity Report using a Models-Based Management paper(Wasilewski 2010) detailing the experience and development of a model-based approach to risk pricing and governance;
b. Research into current ATPMs and capital market governance in the insurance and capital markets leading up to and post the 2008 Credit Crisis; and
c. The development of:
    i. General System & Complexity Theories in Economics;
    ii. The application of Agent-based Models in market analysis;
    iii. Network Theory on structural sustainability; and
    iv. In particular the use of Stafford Beer's Viable System Model along with its associated performance metrics.

This Method was arrived at after considering the following approaches:

1. Initially it was considered sufficient to do a longevity analysis expanding a paper written for Kybernetes called “*Model-Based Management: A retrospective on the role of models in building new financial businesses*”(Wasilewski 2010) wherein experience had developed a particular methodology of assessing new business risk was based upon profiling businesses and management performance. This developed into an Asset Transfer Pricing Model specifically for the insurance and capital markets. The resultant model included analysing the performance of endogenous and exogenous networks of a business using Stafford Beer’s Viable System Model as well as various standard reductionist risk pricing models. The 2008 Credit Crisis showed that a wider range of capital market ATPMs were at fault and did not take into account market structures and therefore this approach was deemed insufficient.
2. In trying to accommodate the above a mixed methods approach was considered consisting of the Longevity Report and research into the existing ATPMs in the capital markets. This however faltered as a cursory search found no general approach to ATPMs and certainly no coherent governance regime that accounted for recursive commercial structures: The latter being evidenced by:
    a. The Bank of England’s own research department through speeches given by Andy Haldane(Haldane 2009, Haldane 2010, Haldane and Brennan,Ä¶ 2010, Haldane 2011, Haldane and May 2011, Haldane 2011, Haldane 2011, Haldane 2012) of the Financial Stability Board and books by Soros(Soros 2000, Soros 2008) and M. Huertas(Huertas 2009)/T Huertas(Huertas 2011);
    b. A lack of consistent and applicable data sources, especially the roles of the Rating Agencies and J P Morgan’s CreditMetrics™ and RiskMetrics™ in risk pricing;
    c. Apart from the development of the Viable System Model, the application of General System and Complexity Theory has either not been published or is sparsely available; Complexity Economics was itself ill-defined until 2012/13(Arthur 2013); and
    d. Proprietary trading methods were also cited as a reason for non-disclosure.
3. Taking all the above into account it was considered that a “Thought-Experiment (Gedankenexperiment)” “TE” describing a *meta*-ATPM was believed to be the best approach to resolving the original objective which was to show:
    - How existing ATPMs might be augmented by moving away from a reductionist approach to risk pricing and incorporating:
        - The Viable System Model’s recursive commercial structure;
        - Stafford Beer’s original work on performance metrics including additional material on:
            - Consideration for various temporal effects on stochastic pricing models; and
            - Agent behaviour at each recursive level to show commercial trends and market availability.
        - Research into aspects of Network Theory that could:

- Compensate for Beer's restriction on the VSM's definition of "viable" systems;
- Identify commercial market constraints for other pricing models; and
- Provide a dynamic topology for agent behaviour.

- The TE will be described as to its working hypotheses, a taxonomy and structural form.

The *m*-ATPM that arises therefrom has been given a descriptive acronym of GHOST referring to – General Heuristic On System and Time. Though generally describing the purpose of the model it is also an allusion to the emergent, and sometimes counter-intuitive, properties of commercial complex systems: indeed all recursive complex systems.

The following sections will:

- Describe the background to TE's in order to validate their application;
- A set of hypotheses supporting the *m*-ATPM along with a functional framework;
- A possible taxonomy for GHOST;
- An analysis of GHOST using Beer's Cybernetics and Management and VSM frameworks as a possible functional form;
- How aspects Agent Based Models and Network Theory could combine with Beer's Viable System Model to define a wider lens on Asset Transfer Pricing Models;
- Some considerations as to applying GHOST in the market place;
    - The core issues;
    - The use of recursive governance;
    - How existing risk model may be incorporated;
- Possible software applications that could deliver and why; and
- What framework would best describe its day-to-day application.

Chapter 3.3.2: Gedankenexperiment ("Though Experiments", "TE")

Though Experiments – TE's - have a long history in developing models of the Universe and its specific properties. In the Conceptual Framework Eigen (Eigen and Winkler 1983) and Popper "Logic of Scientific Discovery"(Popper 1959)p.465 use Galileo's disproof of Aristotle's Theory of Motion and show that his original ideas of gravity were not actually proven physically until Riccioli and Grimaldi confirmed the laws of free fall ((Eigen and Winkler 1983)p.303).

Krimsky (Krimsky 1973) gives us the thought experiment or "Gedankenexperimente" proposed by the German physicist-philosopher Ernst Mach (1876) where he explored the uses of thought experiments as highly rationalistic tools of science and Popper critically assessed the use of thought experiments as a taxonomy differentiating between: heuristic (to illustrate a theory); critical (against a theory) and apologetic (in favour of a theory) thought experiments. We see from Stanford (Brown 2011) a good explanation of the development of thought experiments and their analysis by Kuhn (1963/4)(Kuhn 1977).

Thought experiments have therefore been an essential part of ontological and epistemological development in physics, from Aristotle to Galileo and Newton to Ernst Mach. TE's have preceded development of atomists and the grounding of relativity theory. Regardless of whether one is a rationalist, positivist, a priorist etc the role that thought experiments have played in developing factual or counterfactual epistemological debate will continue.

In political economics the thought experiment has been central to developing our current worldview from Adam Smith (Smith 1991), Malthus (Malthus 1798), Ricardo (Ricardo 1817), Leon Walrus (Walras 2010), Jevons (Jevons 1888) through to Keynes (Keynes 1937) himself empirical evidence took a backseat until the early 21st-century when Goodwin (Goodwin 1951), Hayek(Hayek 1944), Schumpeter (Schumpeter 1939) and Minsky (Minsky 1986) started to develop dynamic models, that set them apart from the "General Theory" and developed into the dynamic stochastic general equilibrium model ("DSGE").

To the lay-person the famous TE's would be Einstein's "photon box", "Maxwell's Demon" and "Schrodinger's Cat"; the first two being discussed by Popper (Popper 1959), pages 464-480, Maxwell's Demon discussed at length by Moue (Moue 2008), and each stimulating research up until the current day where Maxwell's Demon is still a controversial subject(Hyötyniemi 2004, Fehige 2006, Maccone 2009, Guenneau, Amra et al. 2012).

Reiner (Reiner and Burko 2003) discusses five stages of partition Thought Experiments in Physics:

1. *"The question and general assumptions, such as the physical theory to be used;*
2. *The features of the world as imagined by the physicist, i.e., what the (relevant) system looks like. The features of the world, of course, determine – in conjunction with the assumptions – the formulation of the TE and the choice of the physical model to be used;*
3. *The carrying out of the TE itself, usually a series of formal deductions from the first two stages;*
4. *The extraction of the results; and*
5. *The drawing of the conclusions."*

Reiner concludes that the first two stages of this process are more susceptible to errors than laboratory experiments but they are a "central tool in research and in learning and conceptual refinement". We can see from Haldane & Others (Haldane 2012) that whilst Reiner's target discussion was physics it need not be so limiting.

TE's formed an essential part of the development in Second-Order Cybernetics where the role of the Observer is taken into account and discussed at length in the Conceptual Framework as to reflexive studies on what is real and how we assimilate, communicate and test our existence. As an epistemological device they offer a non-destructive tool to test our ideas.

TE's presented just such a device by which an abstraction of ATPMs could be considered – a meta-ATPM – an approach to observer/observed issue. Reiner(Reiner and Burko 2003)p.365 gave us one example and Fehige(Fehige 2006) gives a good table on the "Array of positions spawned in the debate over the cognitive efficacy of thought experiments"p4 , a working set of "Crucial Working Hypotheses"p18 along with a critical analysis on how intuition (p.22-25) is used in the process. The latter is an important aspect of this Thought Experiment as it emerges from the assumption that experience engenders a "gestalt" that can infer an ontological model; as discussed in Pickering(Pickering 2010) "Performative Ontology".

Chapter 3.3.3: A Set of Hypotheses – The General Form

Beer's "Yo-Yo" model, Reiner's list and Fehige's "hypothesis method" were used to create a taxonomy and set of processes that would be used to show how a *meta*-ATPM may compare the performances of other ATPM's functional forms, the objective being the ratification of the risks within a potential investment.

The construction of the *meta*-ATPM ("*m*-ATPM") is based upon a set of hypotheses and methods to investigate the risks involved. They will take the form of:

Hypothesis:	
Assumptions:	
Comment:	To show where existing, or possible, methods may be found such as to test its veracity, whether by factual or counter-factual approaches.

The objective being not to only prove the model but also to ensure that:

- This thesis has a practical yet rigorous philosophical background; and
- To ensure the practitioner interrogates each occasion deployment of an asset with the same rigorous approach to the risks involved.

Chapter 3.3.4: A Hypothetical Framework

Hypothesis-1:	Asset Transfer Pricing Models exist within a set of social mores that may differ according to their topography: i.e. geography, cultural or religious preferences; language - the meaning under which they are transacted; and temporal scales over which processes take place.
Assumptions:	For the purposes herein only those ATPMs relating to human commercial environments are being considered and only those with a bias to trade.
Comment:	The boundary set here provides a device to test the consequences of emergent commercial human behaviour in the use of existing financial models.

Hypothesis-2:	ATPMs are a set of formal and/or informal models in which assets may be potentially employed under a set of agreed parameters and executed in accordance with varying sets of contract law.

Assumptions:	The parties to the transaction may not necessarily share the same model; the assets may or may not belong to the parties involved; the parameters may evolve over the time but the point at which the contract is executed the parameters are set. The agreement under which the transacting principals will be bound must be a commonly shared set principles and/or rules, verbal or judicial, that may be referenced should the outcome(s) not meet one or more of the parties perceived expectations. No requirement is made that all parties understand the external set of rules/principles.
Comment:	The legality of the executed contract is not the issue here but the method by which it becomes so. For instance, a principal to the negotiation may not have the assets that are to be pledged but be acting on behalf of another without their permission; the transaction may not be "fairly priced" for the ultimate owner of the assets but the intermediary may deem it successful; and/or the perception of the external set of rules (the law under which it is bound) may not be fully appreciated by the principals.

Hypothesis-3:	ATPMs have a general functional form, taxonomy, and epistemological approach.
Assumptions:	The form is an abstraction of the processes involved such that they are not dependent upon the local context. The taxonomy is dependent upon recognising the abstractions involved and the order in which they are interrogated.
Comment:	A "Project" can be any entity from which or to which "Assets" may be a moved and "Assets" may be physical or not. The "Process" under which the transfer is conducted and the outcome achieved involves a set of initial values,

the act of transformation of the assets from one form to another that may be circular but whose relative values change: The enquiry is a process in itself.

Hypothesis-4: If ATPMs exist within a topographically sensitive social context then the processes that are involved are subject to endogenous and/or exogenous forces on the agents and process that vary over different temporal scales.

Assumptions: For the purposes herein ATPM processes can also be considered as strategies seeking to navigate a competitive commercial topographical landscape. These strategies will be embedded in a process that generates an outcome that is subject to dynamic forces to which it must compensate.

Comment: The next three Hypotheses deal with issues arising from this and are labelled accordingly.

Hypothesis-4a: Endogenous forces: Those forces acting within the agent that dynamically change dependent the internal topographical structure and ability to communicate effectively such as to materially effect the expected outcome.

Assumptions: In this sense topographical structure includes the topological structure of its functional parts and the governance regimes put in place to regulate their activities. Communicating effectively is defined as the abilities of the component functional parts and governance regimes to transcript, transduce and translate data from one place to another (See Beer,(Beer 1972) Shannon (Shannon and Weaver 1949, Beer 1959, Beer 1972)).

Comment: It is considered irrelevant as to the organisational form of management in that it may be hierarchic, flat, heterarchical, or a mixture of them all but what does matter is the presence and composition of the functional parts that all commercial enterprises must avail themselves. Transcript, transduce and translate data refer to the ability of the agent to communicate data of whatever form from one place to another and if it must cross from one sub-agent to another, that the data is passed faithfully and accepted intact for further transmission or acted upon by local internal models that determine subsequent actions.

Hypothesis-4b: Exogenous forces: Those forces external to the boundaries of the agent that impart dynamic change upon the physical topographical structure, competitive commercial landscape and the agents own ability to communicate such changes effectively within.

Assumptions: In this sense topographical structure includes the topological structure of the marketplace, physical environment and governance regimes put in place to regulate their activities. Communicating effectively is defined as the abilities of the component functional parts of the agent to assimilate and interpret the data with a high degree of accuracy.

Comment: Similar comments apply here as in hypothesis-4a to communication but in addition the structure of the topographical context will determine the constraints under which actions/processes may be transacted.

Hypothesis-4c: Temporal scales: In this context is not considered to be linear co-ordinate time corresponding to any calendar and sub-divided into months, weeks, days, minutes or seconds, as used in current financial models, but the combination of processing times relative to a common metric for the functional system as a whole.

Assumptions: In this sense Time is considered to be that relative framework within which the processes required to achieve the desired outcome can take place. Processes include the aggregate of all functional sub-processes that they have a relative timeframe to the whole.

Comment: Gillemot (Gillemot, Farmer et al. 2006) showed that temporal scales materially affects the potential outcomes of statistical models. Taking this one step further one could say that by ignoring the variances in processing time within a network materially changes the outcomes not only locally but also cumulatively across the whole.

Hypothesis-5: The competitive landscape comprises a variety of efficient and/or inefficient agents and/or governance regimes that also includes the communications systems they create.

Assumptions: In this sense efficient regimes/agents are those that execute the process sustainably over the time and may correspond to those Beer deemed “viable”, or aware of their own existence, and govern themselves accordingly. Inefficient regimes/agents are those whose probable failure is high but whose success may be equally likely. A variable may therefore be assumed that might differentiate between efficient and inefficient agents.

Comment: Beer’s Cyber-Filter(Beer 1972, Beer 1979, Beer 1985) rationalised a set of efficient performance metrics that used his Laws and Axioms to determine the state-space and therefore Eigen vectors for the “agent” being reviewed however as they only applied to “viable” agents these were not sufficient to describe the complete market. The objective of any *m*-ATPM should be to encompass all activities in the stated commercial space.

Hypothesis-6: ATPMs comprise risks and uncertainties that may avail themselves to qualitative and/or quantitative analysis but existing methods do not take into account organisational, whether recursive or not, or temporal variances.

Assumptions: Organisational variances would include recursive structures and constraints for both agents and governance regimes. Recursive structures, like agents, may be inefficient or efficient as defined above and each level dependent upon the relative strengths of the organisational structure and temporal scaling.

Comment: In common with hypotheses 4a-c recursive organisational structures whether within a consolidated firm or as a market share the same considerations as to their properties and temporal variances as do agents. Response time within governance regimes were seen to be appalling at the outset of 2008 post events in August 2007 that subsequently emerged as the Credit Crisis, UK Gilts were effectively frozen for months and borrowing ceased at a national level.

Hypothesis-7: The definition of Risk and Uncertainty will be taken from Knight(Knight 1921) being, Risk has an element that allows it to be quantified, whereas Uncertainty has no such thing but may have qualitative considerations.

Assumptions: All factors that may be open to quantitative risk assessment must be fitted into the whole and not as a reductionist island. The whole must include its context and temporal scaling factors.

Comment: It may be possible that implications of multi-modal risk analysis that has exercised actuaries over recent years may be that these datasets do not reflect the influence of recursive multi-level heterarchical systems.

Hypothesis-8: The past is not a good reflection of the future.

Assumptions: In a dynamic, conditional, recursive system changes to the context influences the outcomes of strategies and processes in counter-intuitive ways.

Comment: Models that impute conditionality of future actions from past events do so for computational tractability and at the sacrifice of the contextual dynamics(Gillemot, Farmer et al. 2006, Haldane and May 2011, Peters 2011). Changes in historic structure and future influences will necessarily change the outcomes.

Hypothesis-9: The Viable System Model can be used as a benchmark to test for critical dysfunctional performance structures.

Assumptions: The VSM provides a recursive governance language that would highlight any absent or critically malfunctioning structures impeding optimal performance. It is not THE model but part of a bigger model.

Comment: The VSM has known faults(Schwaninger and Ríos 2008) and does not fit all requirements but when operational viability is required to meet expected outcomes its merits have been tested(Beer 1984).

Hypothesis-10: Not all ATPMs require VSM compliance.

Assumptions: By identifying outer and sub-net boundaries the dynamics of a network may be identified and its topology tested for recursive structures. They may not be as efficient/viable as

	the VSM but their probability of failure is within acceptable temporal scales.
Comment:	Certain Network structures are beginning to provide a glimpse at optimal performance in commercial structures by isolating and predicting endogenous failure as well as exogenous constraints in governance regimes. These may be acceptable if temporal parameters are not critical to performance.
Hypothesis-11:	Agent-Based Models may use the outcomes of dynamic Network structures and their constraints, as described above, to provide the topology upon which to operate. This would allow any emergent properties of free agents to feedback to the ATPM and its likely outcomes.
Assumptions:	As with hypothesis 10 certain transactions do not require a full organisational analysis but awareness of constraints on landscape may improve behaviour or even contract structure.
Comment:	Derivatives trades may not require full operational analysis but are open to recursive market and governance impedance. Outsourcing of any form imputes communication delays and transfers operational and business risks.
Hypothesis-12:	Current databases of firms' activities and economic structure are insufficient to guide market or macro-economic decisions.
Assumptions:	The current global marketplace uses the public domain and historic accounting reports to guide micro/macro-economic decisions.
Comment:	This process is dangerous as the data is out-of-date and historically inaccurate due to changes in accounting and

regulatory frameworks. At a micro level changes in credit rating uses assumptions that are not transparent from one year to another. This also applies at a national level. It does not include all the activities of the shadow-banking work and therefore any returns on capital calculations, tax returns or GDP are grossly inaccurate.

Chapter 3.3.5: A Major Constraint

The above set of hypotheses may include transactions that do not meet commercial criteria and therefore a major constraint to the review is its application to only commercial activities.

Chapter 3.3.6: Emergent Concepts - Hints at a Method

Chapter 3.3.6.1: Dynamic, Conditional and Recursive

Assets that must perform in a dynamic, conditional and recursive economic context tend not to perform linearly unless the prevailing economic conditions are such that compensatory forces enable the appearance of stable outcomes. However this process is itself unstable especially in highly connected dynamic systems. A physical example of this principle would be a "Soliton", like the Severn Bore. The Severn Bore Soliton is a tidal event where the peculiar physical characteristics of the Severn River dilute the non-linear attributes of the flow of water to create a "standing wave" that travels downstream until the river changes physical shape.

In Commercial terms this dilution of non-linear attributes can been seen as equating to the Efficient Market Hypothesis ("EMH") model where marketplace conditions must be such that:

- Every component in the production system and marketplace is perfectly connected;
- Transduces data perfectly;
- Be in a peculiar configuration to sustain the dilution of normal non-linear forces; and
- Be subjected to a peculiar event that triggers all these attributes.

Like the Soliton these are exceptional conditions and as a consequence the EMH and its adherents, Arbitrage Pricing Theory and Capital Adequacy Pricing Models, should be viewed as special cases of a wider dynamical, and complex, system.

Commercial non-linear and recursive systems tend to be heterarchical in structure (see Noble(Noble 2012)), probabilistic not deterministic, and lend themselves to counter-intuitive cause and effect outcomes. Like Systems Dynamics the non-linearity of these relationships tends to promote emergent outcomes (see BCTD (Foreman-Roe and G 2013) and unlike the EMH's restrictions can embrace wider forms.

Chapter 3.3.6.2: State-Space Economics

The move from linear to non-linear economics has already begun by the setting a definition of Complexity Economics (See Arthur (Arthur 2013)) and although early ABMs showed only promise but no consistent forms (see Arthur/Durlauf(W. Brian Arthur 1997, Arthur 2005)) Network Theory and mixed methods have shown a different direction to a state-space model of economics and risk values (see Squazzioni et al(Squazzoni 2010, Alessandro 2011, Liu, Slotine et al. 2011, Ramanathan, Bar-Noy et al. 2011, Vitali and Glattfelder 2011, Easley and Kleinberg 2012, Saumell-mendiola and Serrano 2012, Thurner 2012, Window, Saumell-mendiola et al. 2012, Bialek, Cavagna et al. 2013)). However Beer preferred a dynamic approach using the state-space of a "viable" firm(Beer 1959, Beer 1972, Beer 1975, Beer 1979) as did Morlidge(Morlidge 2010, Morlidge and Player 2010) when considering performance metrics and budget planning respectively.

The hypotheses supporting this thesis tend to favour non-linear dynamics and state-space performance metrics over linear pricing of risk due to their "organic" structure and associated causal framework (see Causality in Conceptual Framework). Shubik(Shubik and Smith 2009)p.14 highlights this as follows:

> *"Conventional micro-economic theory has stressed production and consumption; applied macroeconomics has implicitly assumed a control role for government fiscal and monetary policies, but the change that is in the making is in the development of a general disequilibrium microeconomics with the intertwining of production, consumption and finance in ways that may even exceed the envisionings of writers such as Simmel (Simmel 1978), Schumpeter (Schumpeter and Opie 1934), von Mises (Von Mises 1980), Hayek (Hayek 1944) or Keynes (Keynes 1937)".*

NOTE: The citation numbers have been replaced to meet this thesis bibliography

Chapter 3.4: GHOST - A Gedankenexperiment and Model on ATPM's

GHOST: General Heuristic on Structure and Time aims to promote a better pricing approach for Asset Transfer Pricing Models ("ATPM") that themselves are central to deploying capital in the commercial economy. It starts with a conversation between the seller and buyer of an asset and we can understand how it will achieve this goal by disseminating its name:

- **General Heuristic**: Using the definition of "heuristic" – "to resolve a solution by trial and error according to loosely defined rules"[xl] – GHOST identifies a common set of processes that occur whenever an exchange of assets is required to promote a commercial strategy. Whilst the processes may be similar, satisfying the condition of "loose set of rules", the underlying data will change and therefore "trial and error" will be required to establish the validity of the exact processes involved within each proposal. Significantly GHOST departs from the assumption that these operations occur in response to a single level of causal factors preferring a recursive set with varying degrees of effect dependent upon;
- **Structure:** How the commercial enterprise creates and manages its endogenous and exogenous structure will have considerable impact on the dynamics of the operations. Endogenous structures encompass product (resources, fabrication and sales), management processes and how they adapt to a dynamic environment. Whilst exogenous structures (market forces, legal & regulatory frameworks, systemic economics) impart conditions to internal dynamic operations; and
- **Time:** A commercial body can be considered to be like its biological equivalent, subject to varying degrees of communication and process time lapses. As a "body corporate" the seller is defined by its constitution within which management defines the mean operational responses to dynamic internal and external stimuli. GHOST recognises that these "time frames" vary from entity to entity and are therefore similar to a biological "metabolic rate"(Beer 1959) that not only differs within comparative commercial entities but also by commercial object and their respective places within a complex, dynamic and recursive commercial eco-system. We have seen that changes in process through technology or governance affects the outcomes and, from Gillemot (Gillemot, Farmer et al. 2006), of any statistical analysis.

In brief, GHOST regards Commerce as a complex, dynamic, recursive eco-system within which component commercial structures jostle for assets to complete their strategies. These strategies are defined by the constraints set by internal and external networks that are, or will be, established according to how management put into effect those strategies. Their success will depend upon the efficacy of the strategy and the response times that operate within these networks of commercial entities and from which they must dynamically: source revenues; obtain hard and soft resources; and respond to external economic and regulatory pressures.

Chapter 3.4.1: GHOST – Setting the Framework

Context and Function change in a mutual exchange of data, modelling one without changing the model of the other invites disaster. Being dynamic and non-linear any strategy that derives a price for risk is exposed to changes in the relevant contextual structure. These changes may follow some rules of complexity being: small changes can be amplified to catastrophic conclusions. Beer analysed just such a condition in "Investment Against Disaster"(Beer and Casti 1975) on the adverse impacts of an economic catastrophe for a firm.

Minsky (Minsky 1975, p57) described Keynes General Theory, and associated work, as "drawing together various one-dimensional traditional themes into a 3D framework", GHOST tries to provide a step further by structuring a commercial heuristic (Espejo and Harnden 1989, Bingham, Eisenhardt et al. 2007, p29, Christopher 2007, p332, Bingham and Eisenhardt 2011) p333 framework that segregates a project's endogenous and exogenous component forces into: their respective levels of influence, the dynamic nature of the functional structure and their behaviour as agents under prevailing market conditions.

Agent strategies impute behaviour that should be assessed in relation to their local/global frameworks and temporal scales. As each level of influence will likely enforce its own set of boundary conditions, and hence modify the temporal scale, these effects of these should be compensated for across the systems network in order to harmonise the outcome. As temporal scaling is process dependent within and without the levels of influence any alignment to an external common time metric would therefore require a temporal scaling factor applied. This scaling factor would be sensitive to changing organisational structure and agent behaviour such that financial outcomes using statistical methods dynamically alter the required outcome values.

By identifying the various functional components, for each level of influence, a recursive structure is compiled that begins to identify the boundary conditions and governance language required at each level. By iteratively applying the same heuristic at increasing levels of influence any discontinuities may be determined by using the VSM as a viability template and alternative Network structures as proxies to acceptable performance outcomes. Whatever harmonised temporal scales are derived at each level they should modify the relevant existing financial formulae and outcomes required.

At all times it should be remembered that this is building a probabilistic functional state-space derived from comparing the dynamic outcomes of current and future strategies. In defining what become recursive boundaries we start to create a nested structure. When we recognise discontinuities in this functional nested structure strategic changes may be required at each stage of the process to achieve an optimal outcome. So we have a dual set of processes, one that acts as observer whose own model must accommodate the changing rules and the production process itself.

It might be inferred from the above that this applies solely to a single project approach: This is not the case. We saw in Beer's VSM that it is governance structure and language that is harmonised across the business in focus. It is therefore necessary to establish a reference point, a performance outcome, for the firm derived by analysing the internal structures and to which external levels of influence can be applied. Therefore any amount of projects can be analysed depending upon the initial boundary set and outcome desired. In fact it is the nature of the setting of this initial boundary, the nature of recursive structures and the iterative application of this process that makes it possible.

The system is dynamic and the variety wide so therefore the governors must absorb this variety in a changing fashion too. The Law of Requisite Variety does not stipulate a static set of tools, nor is the VSM a fixed model. The latter can accommodate a dynamically changing former by observing simple governance processes.

Most importantly this is not a hierarchical set of enterprises built upon layers of activity but, like Nature, it must use any of the available assets from individual agents to whole divisions for each functional structure to work. Noble (Noble 2006) described the heart as having no inbuilt clock but beats at a rate the resource framework allows, changing the balance of components and the beat rate changes.

The VSM was chosen because Beer had built a mature model incorporating all the aspects above. It is an ideal model to benchmark a world of varying sets of enterprises all with their own relative “metabolic rates”(Beer 1984) each trying to communicate in a vast network. We do not need to make sense of the complete network because that is impossible but we should at least know the boundaries within which our particular enterprise will operate and the relativistic temporal scales involved.

Any requirement to invest, or sell, assets would require data to inform an ATPM to derive comparative value. Following the above assumptions value is therefore: transient dependent upon context, the structure of the organisation, the resources available and the governance ability of management and its milieu. With this in mind Klonowski (Klonowski 2007) provides a conversational framework and Information Theory (Shannon and Weaver 1949, Vannini 2007, Ay and Polani 2008, Duarte 2010) a foundation by which data is effectively transmitted between the parties.

Chapter 3.4.1.1: The Methodology Behind ATPM Processing

Now we must approach a methodology by which all these considerations should be implemented. We have seen from Klonowski(Klonowski 2007) a nine step process for venture capital investment (figure 74). Effectively this procedure is the same for any asset acquisition and therefore a good one to follow for our *m*-ATPM and GHOST.

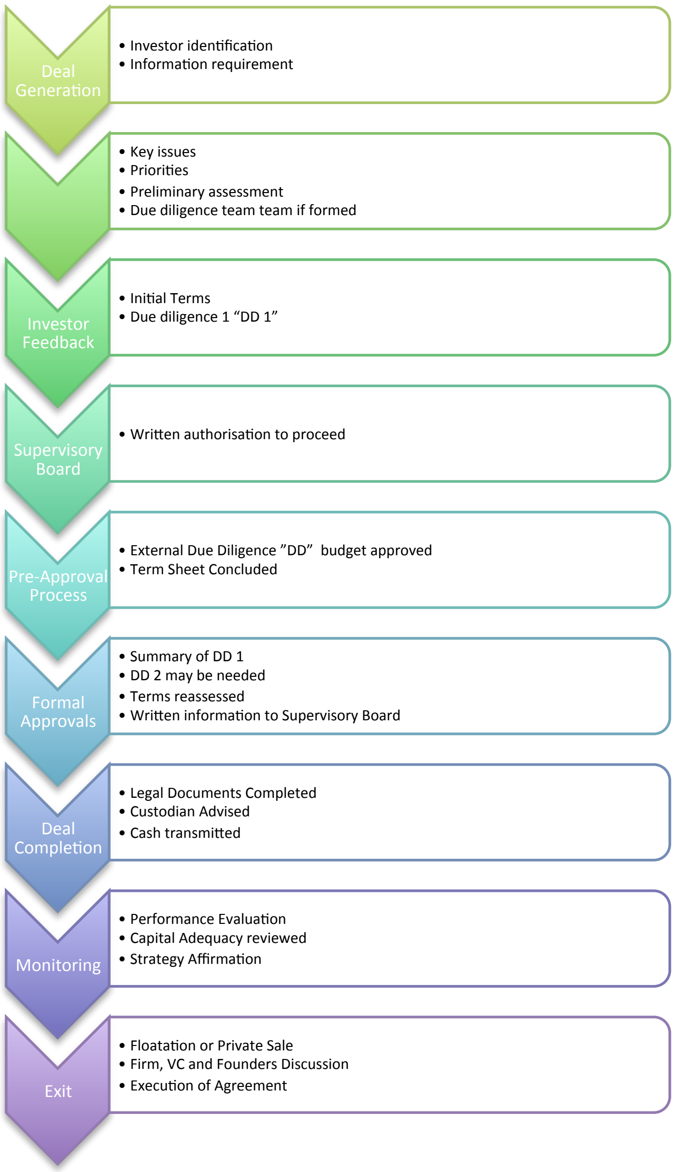


Figure 75: Klonowski Process rendered by this Author

Klonowski gives a good description of the discrete steps a well-managed investor will take. It is drawn from the perspective of an agent acting on behalf of a variety of venture capitalists but even so some of the conversations detailed can be collapsed as they may be taking place within an individuals own head.

The essential aspect of this process is its general applicability and save for opening up one or two of the individual boxes relating to elements of Due Diligence on the specific risks involved the process shall be adopted by GHOST.

Chapter 3.4.1.2: Strategy, Budgeting and Performance Metrics

One of the main aspects of Due Diligence for a complex investment would be the method by which the Issuer creates the business plan. Within this process are the scenario planning and budgeting processes. The consequences of both these elements effectively determine the value of the investment and the value of the assets to be transferred.

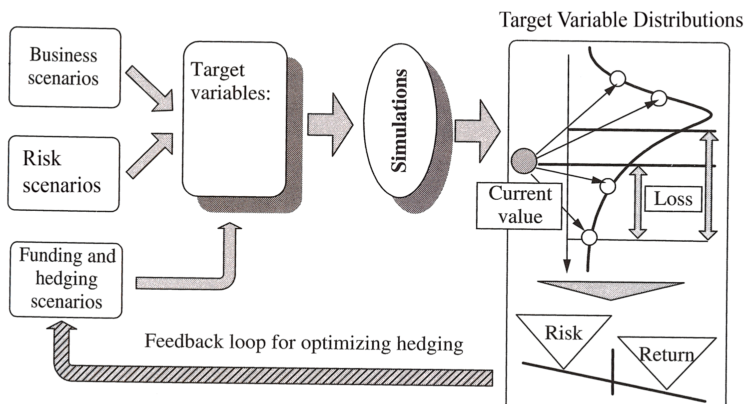
Static, or fixed, parameters metrics do not work with GHOST as will become apparent GHOST uses a dynamic set of measures that act as boundary conditions for feed-forward networks and governance. To this end Morlidge's(Morlidge 2009, Morlidge

2010, Morlidge and Player 2010, Morlidge 2012) use of the VSM and scenario based budgeting proposes a methodology that takes the ex-ante values set by initial strategies and creates a tool monitoring the on-going process of the business such that financial outcomes fit within a range of probabilistic values and dynamically budgeted. The one material ontological difference between Morlidge and GHOST is the latter's requirement for temporal scaling within recursive structures.

Chapter 3.4.1.3: Asset, Liability and Risk Management

It was noted in the Literature Review and Conceptual Framework that paradigms (Kuhn(Kuhn 1962), Lowenstein(Lowenstein 2000), Taleb(Taleb 2007)) have an inertia of their own. The proposal by GHOST is not to tear down the edifice of current risk models but to modify two significant factors that influence their own parameters: governance structures as recursive systems and the associated temporal restrictions processing places on different levels of recursion.

The following shows a good example of the Asset Liability Management ("ALM") approach (figure 75):



Original source: Risk Management in Banking, Joel Bessis, J Whiley 2002

Figure 76: Risk Management in Banking, Joel Bessis

The general process outlined here is not being challenged: it is the parameters used within the models and the absence of any temporal and governance scaling factors. The modelling process here fits into a due diligence heuristic part of GHOST (figure 76):

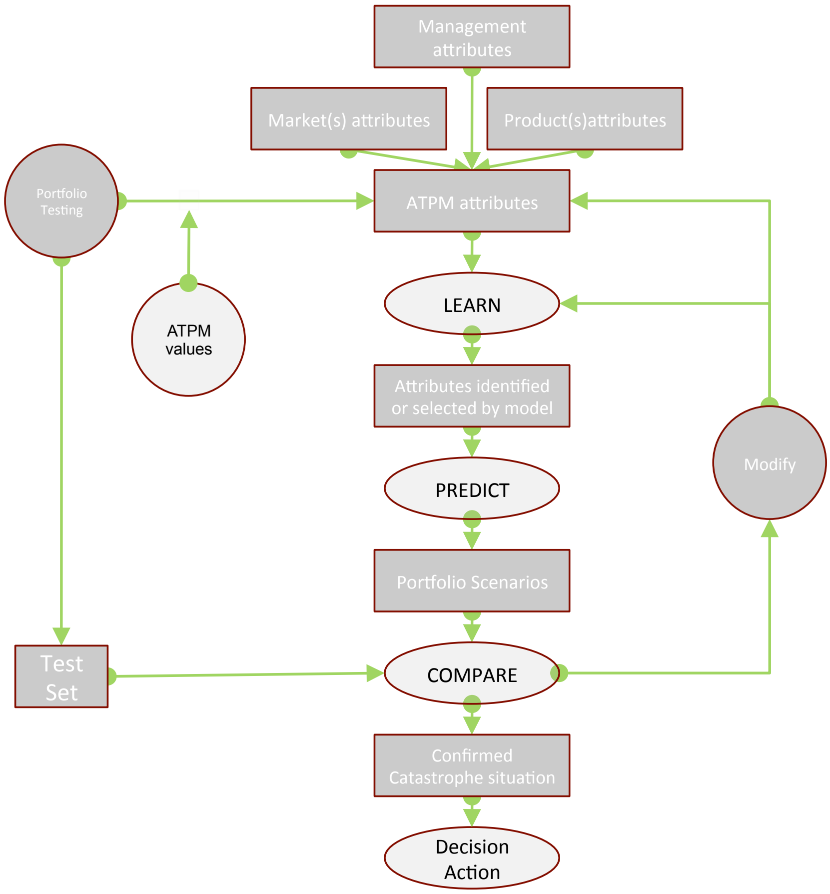


Figure 77: GHOST's General ATPM Heuristic

The Asset/Liability modelling process fits into the "portfolio testing" section (figure 77):

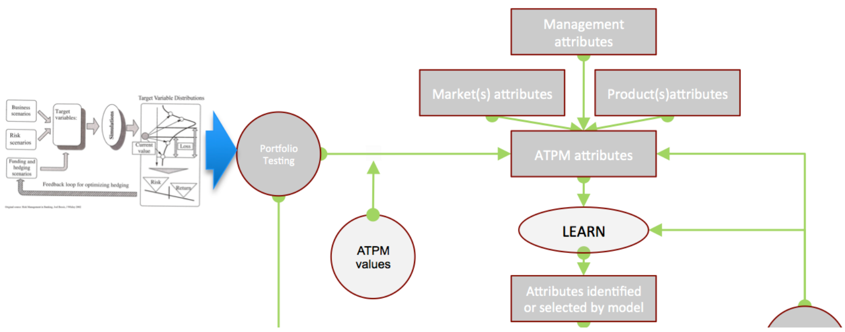


Figure 78: Inserting ALM Scenario Testing into GHOST

In order to identify temporal and structural changes a modified ATPM heuristic is used and is depicted (figure 78):

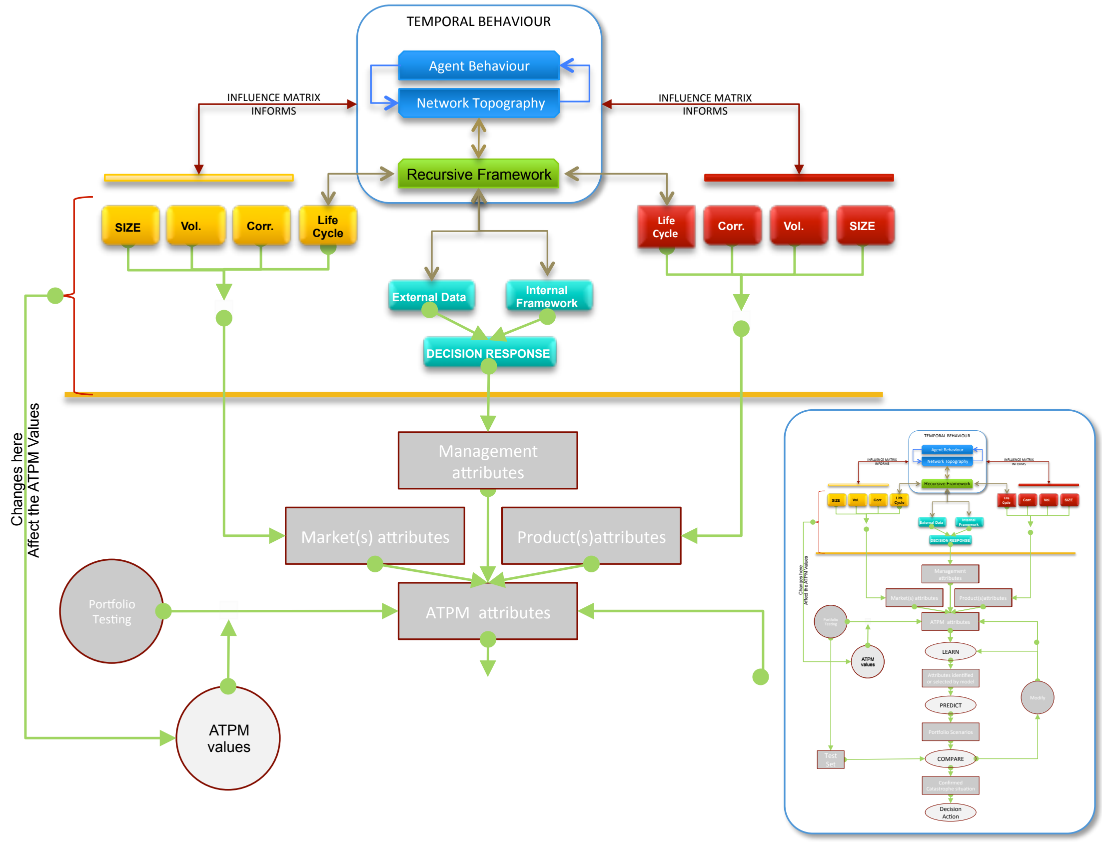


Figure 79: A Modified ATPM showing new parameter input

GHOST uses a nested set of process to determine its parameters and price acceptability: the modified heuristic is; a variation on the VSM; existing stochastic risk modelling; and a modified due diligence process within Klonowski VC outline (itself a heuristic of sorts). See "Summary" for a graphic display all three and appropriate description.

Chapter 3.4.1.4: Triangulating Metrics

Model paradigms are hard to shift and replace but easier to modify and adapt therefore GHOST aims to open the discussion rather than replace existing metrics. Therefore GHOST uses a triangulation methodology derived from due diligence processes. It uses existing financial models to bench test outcomes, Beer performance metrics embedded within a Morlidge process and adjustments to structural and temporal parameters it derives from Network analysis and Agent-Based Models that then replace the existing parameters used in both.

In this manner existing practitioners can directly compare results from existing models and formulate an assessment of the veracity of GHOST's outcomes as events unfold.

Chapter 3.4.1.5: State-Space and Budgeted Values

The objective of GHOST is not only to determine financial values from a budgetary process and therefore derive a price for the transfer of assets but also to test the conditional boundaries of the strategies that determine the operations of a business.

Determining the temporal changes and scaling within the businesses network assists in part, assessing how the perturberances affect strategy; the state-space and final outcomes vary over time will inform the investor more (figure 79).

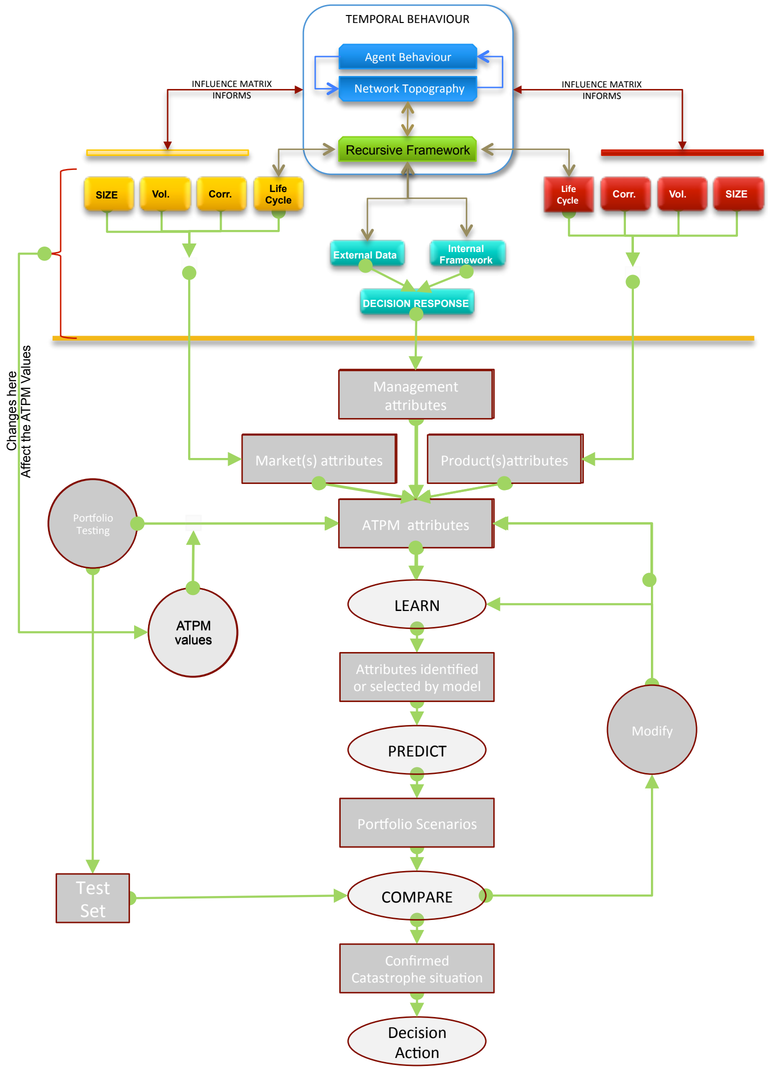


Figure 80: GHOST - Final Heuristic

The outcome of the "Decision Action" feeds into the Klonowski VC heuristic at various points of the due diligence process.

Chapter 3.4.1.6: GHOST: Commercial Application Considerations

It is noted that GHOST is a framework that uses a triangulation of three types of financial models, existing ATPMs, a Morlidge Budgetary model and a test for structural and temporal discontinuities that are then applied to these.

The model that underpins GHOST itself is subtly different from those extant in commerce at the mid-point of 2013 in as much that whilst it can use the general structure of these models it must identify where in those models structure and temporal parameters arise in order then to modify them. Neither is GHOST a deterministic model but probabilistic and so therefore a proxy must be created to satisfy a translation to existing outcomes. In order to achieve this a general taxonomy was created to guide existing modellers through the assumptions and an explanation of the framework itself.

The critical and commercial analysis can be defined as follows:

Analysis Type	**Description**
Critical	The articulation of the ontological and epistemological frameworks upon which they are based. A clear description of the processes involved and their relative application to commercial activity. Clear definitions of components and the commercial efficacy of the model.
Commercial	What commercial benefit will be had from building/using a new ATPM and what are the costs involved?

GHOST's underlying framework (*m*-ATPM) was deliberately structured to allow its use in any project by identifying the essential risks as: economic, execution and management. The temporal elements of each of these are not clear and what follows is a brief description as to how GHOST mitigates them (Table 7):

Table 7: GHOST Temporal Mitigation Processes

Timing element	Description	How GHOST Mitigates
Economic	Volatility in the local and general economy impacts the availability and pricing of liquidity and equity.	Recursive analysis of regulatory and economic agent-based models, fundamentals of local economic and network structures identify strategic vectors at variance to the project's direction
Execution	A critical path analysis of the contributory risks within the project will highlight dependencies and constraints relative to exogenous and endogenous agents. Failure of component agents impacts subsequent execution and returns of the project	Contractual commitments alone do not mitigate risk. GHOST identifies all agents and their own network dependencies for critical stress points, an agent-based model of the project is created to first identify the essential players and then monitor their likely outcomes over several scenarios. Timing impacts from these, including delays in internal management communications, inform the financial model
Management	The network structure that reflects how the project is managed. This network extends beyond the boundary of the project itself to encompass all agents, whether directly of indirectly, associated with the project. The communication channels so established have their own critical risks that can effect execution such as bad managers infecting moral, slow or failure to report problems.	GHOST maps the internal functional structure and its network then extends this to all contractual agents. Within this structure scenario-based plans are created around the processes specific to the project and GHOST ensures the internal managers are capable of handling and reporting the diversity of problems efficiently. Replicating this process for external recursive structures resolve to: uncertainty on the total market volume; competitor market shares and the resilience of their client base; and the exact structure of competitors compared to the prevailing economic

conditions. However this can be overcome if the same outcomes of GHOST's structural and temporal analysis are applied to the major competitor's results, their shareholding structure is incorporated in the network. Agent-based models of free agents can then be calculated and compared to the internal analysis allowing for modifications in the attractiveness of competitor offerings (plus a general assumptions that clients will avoid monopolies where they can).

GHOST's agent/network models aim to capture major events that alter the implementation of the project in the marketplace. There are obvious scenarios and should be catered for in the normal analysis. Even though much of the above can be model in AnyLogic 7/8™ what is not apparent is the constraints embedded within the financial networks of the contractors, the recursive structure of the causal framework and the identification, then management of, diversity within the business that the systems dynamics elements AnyLogic 7/8™ must employ (Schwaninger and Ríos 2008). These must be captured within a process that braids the two approaches later.

Temporal changes arising from any one of these risks can significantly alter the expected outcomes but most critically if the mitigation process within the governance structure of the firm, or the ATPM model itself, does not capture errors or strategic changes within the local temporal scales the consequences will reverberate across all performance metrics.

Curiously though most investors would focus on the adverse affects believing them to be the primary area of concern this is a behaviourally driven asymmetry of investing that has consequences of it own. Ignoring excess production or debt employment strains the balance sheet just as much with the same long-term effects. Beer notes this in both Cybernetics and Management and its predecessor report for United Steel(Beer 1957).

Chapter 3.4.1.7: ABM and Network Interface

Commercial entities (agents) exhibit both Agent-Based Model and Network Graphs characteristics. The former by agent develops the connections to customers and the latter by how those customers become fixed and affect the performance of the business. ABMs can develop a set of characteristics that show how an agent behaves over a fixed landscape whilst Network Theories can show how clustering and sub-graphs can influence that behaviour by changing the dynamic properties of the network. However neither truly mirrors the dynamic changes within both agent and market.

A priori at the point of connection between two or more agents a network of varying coupling strengths emerges that does not behave in the same manner as the simple rules as those applied under the single ABM. Equally neither would a dynamic model of a network exhibit the same flow characteristics found in ABM's. GHOST tries to overcome this by being a hybrid of both, a heuristic monitoring several ABM's and Complex Networks.

How the two types of characteristics are related depends upon the internal development of the agent. e.g. an ABM feedback rule may require its size to grow as it creates business but without a qualitative understanding of the agent's ability to adapt to growth the lifespan of the agent will be uncertain and any arbitrary rules applied at the initial modelling stages will eventually invalidate the model. However a priori in business when a connection is established resources are required within the agent in varying areas and amounts. The implementation of these will affect the weight of the connection (its coupling strength) to each and the emerging cluster of clients. It is this clustering data provided by the network model that informs growth parameters in the agent-based model. The qualitative nature of the network model output enters as probabilistic input to the ABM.

Chapter 3.4.1.8: GHOST – Morlidge, Cybernetics and Management

At the heart of GHOST is the same Cybernetic approach Stafford Beer took in resolving his US Steel assignment (Beer 1967)(Chapter 9). Though Beer was describing the "meta-language" that needed to be introduced in order to accommodate external change in regard to Gödel's Incompleteness Theorem it applies generally and his diagram is reproduced in Figure 80:

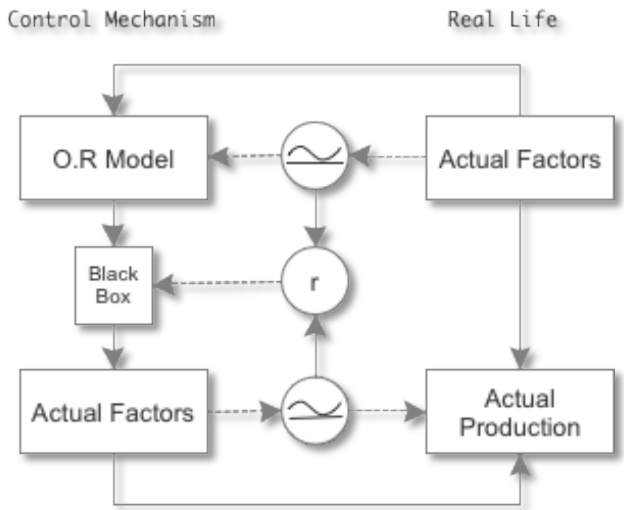


Figure 81: Beer's Cybernetics & Management p.77

In the case of GHOST the O.R. Model consists of the "commercial state space" of the enterprise embedded within a recursive eco-system. It assumes the same general model but the model's dynamics are modified by the relative structural changes in the network and agent behaviour. These mutually alter the Time scales and, in turn, the ex-ante price for the investment of assets changes.

Following Morlidge/Beer the aim is to repeat this process continually in response to material events dynamically providing feedback between the Operational Model and Actual Factors and Production. Like Morlidge the preferred approach is to set a range of performance and probabilistic values rather than a fixed target.

For Beer "r" cannot be described by parameters of the system as it measures the correlation of the governing systems'. Therefore one could say that GHOST is providing external input to a meta-language that is, in turn, governing the system in focus. This process is repeated for each incremental increase in level of recursion.

Chapter 3.4.1.9: GHOST and The Viable System Model

The Viable System Model provides a framework under which optimisation of performance can be managed according to a set of regulatory aphorisms, organisational principals and management axioms. Combined these provide a model that maintains its level and is organised in an upright position such that a mathematical rigor can be applied to individual and group performance.

The VSM is a recursive structure and as its name implies designed to identify viable systems. However it was discussed that Time is a vital element in determining what is viable and that commercial economies operate under different, but relative to each other, time constraints. As a tool the VSM provides a benchmark from which to compare an ATPM proposal in terms of its organisational sensitivities and long-term viability under stress conditions.

GHOST does not assume all business need be viable, this would obviate the concept of a market, rather it uses the VSM as a benchmark to establish probabilistic quality control levels for the organisational aspect of the ATPM proposal that then inform the ABM and Network component models to modify behaviour under certain scenarios.

The deviation away from the standard VSM structure is measured according to the presence or absence of certain VSM components and these modify the Cyber-Filter metric on a probabilistic basis. Any changes in external influences would then amplify these through the Influence Graph and Network Clustering channels.

In VSM & CyberFilter we discussed how the VSM embeds a recursive System Dynamics Reinforcing/Balancing Loop process thus combining all the benefits of Beer’s work as well. This approach gives us a natural bridge from the VSM to System Dynamics as analysis tools of the organisational structures that do not fit VSM requirements.

The VSM draws heavily on Information Theory and how it is handled within a system, where model interaction occurs and decisions made.

Beer's shorthand for the agents within the system and their role in transporting, transcription and modelling data to affect the function of the business is a simple line. Where Beer identifies the roles required to manage the variety within the business as a whole it is the variety within the agent that will determine the variety of her/his capacity to communicate.

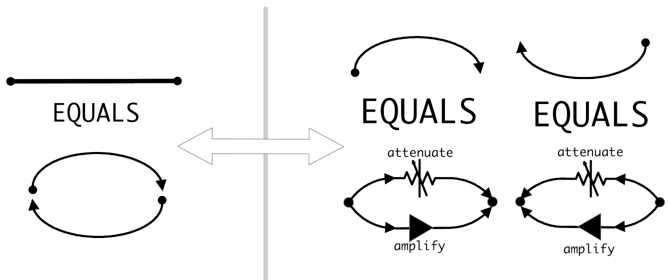


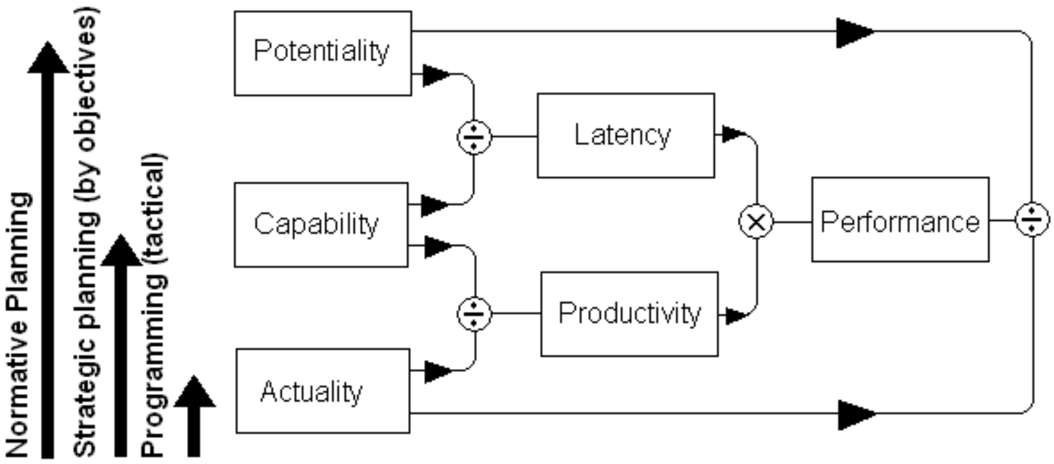
Figure 82: Beer's Communication Network Feedbacks

Many of the interrogatory approaches used to describe the aspects of macro or micro economics and taxation in GHOST were drawn from the VSM and its description of the connections to the marketplace, past, present and future.

Chapter 3.4.2: GHOST and Beer's Performance Monitoring

Chapter 3.4.2.1: GHOST and The CyberFilter

The CyberFilter presents a simple recursive approach to setting performance boundaries and is embedded within the framework of the VSM [see figure 82].



actuality: "What we *are* managing to do now, with existing resources, under existing constraints."
capability: "This is what we *could* be doing (still right now) with existing resources, under existing constraints, if we really worked at it."
potentiality: "This is what we ought to be doing by developing our resources and removing constraints, although still operating within the bounds of what is already known to be feasible."
Beer adds "It would help a lot to fix these definitions clearly in the mind." System 4's job is essentially to realize potential.
He then defines ***productivity:*** is the ratio of actuality and capability;
latency: is the ratio of capability and potentiality;
performance: is the ratio of actuality and potentiality, and also the product of latency and productivity.

Figure 83 Replicated from "Brain of the Firm 2nd edition"

In commercial terms this is the "market" but in Systems Theory terms the question is not how much but where and under what conditions. The CyberFilter's simple metrics beckon us to assess production in terms of actual, capable, total and latency with the tools available. It does not restrict change in fact it insists this will happen but how did the system cope?

Though seemingly simple in outline the CyberFilter informs us on inflation and expansion in an economy. Applying the CyberFilter across each component and recursive level allows a distinction to be made as to where potential strategies are in error if the market size at a higher level of recursion can accommodate the strategy in focus plus the sum of market competitors.

Graphic 83 also highlights the role of an expanding economy and where its main indicator must appear:

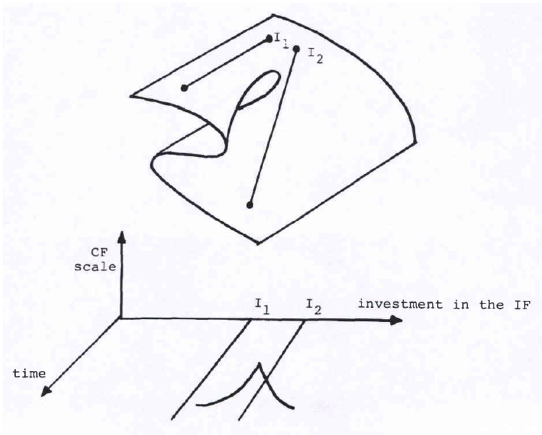


Figure 84: The Effect of State Space on Performance Measures - Source: Investment Against Disaster: J Casti/A S Beer 1972(Beer and Casti 1975)

The background to this effect was discussed in [Literature Review: The Viable System Model] and shows that, as the shape of the state-space surface changes, assumptions on strategy and performance must also change if the target is not achievable.

Chapter 3.4.2.2: GHOST and The Twins of Performance

ATPM's are essentially about optimising shareholder performance and as long as it is clear what set of shareholders are aligned to what ATPM the question is next, what metric reflects performance best dividend or value?

As discussed in the Literature Review the 2008 Credit Crisis exposed the hubris of a Capital Markets that thought themselves above natural boundaries having a market that was unlimitedly deep and liquid. The lesson learned was that without liquidity the market is essentially gambling in stocks but more importantly without wages will not be paid and pensions will not be covered.

The essential metrics for GHOST to embed is the analysis of free cash flow as well as overall value, defined as the accumulated reserves and likely 5-year forward earnings. It is important to cast forward these values in light of future probable activity and the strategy being used. The portfolio of cash flows and enterprise values create the landscape but that landscape can be "morphed" as new events occur and change the likely outcomes of existing strategies.

Future Cash Flows and Enterprise Value cast forward are therefore the Twins of Performance and form the basis of the State-Space under review. This review is dynamic and subject to exogenous and endogenous perturbation.

Chapter 3.4.2.3: GHOST and Data Resolution

Given the lack of appropriate data it would be unrealistic to assume GHOST would be born whole with a completely evolved recursive network, a clear data structure and connections across a global commercial economy.

The first objective is to properly structure the anticipated cash flows and revenue streams along the lines suggested by Morlidge (Morlidge and Player 2010) being (figure 84):

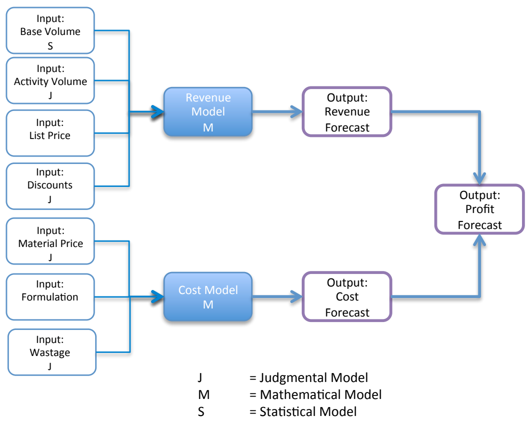


Figure 85: Basic Financial Models, Morlidge

The second objective is to assess the connections available. Bureau Van Dijk have an extensive database of shareholder interconnections that has already shown a network structure (Vitali, Glattfelder et al. 2011) [see figure 85] that has been investigated by the author and can be arranged heterarchically.

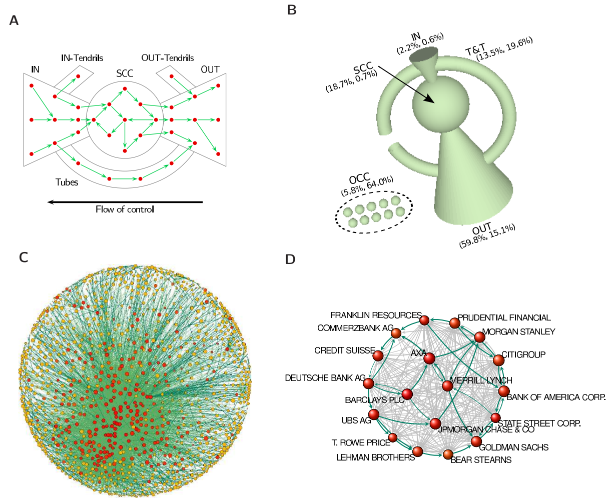


Figure 2: **Network topology.** (**A**) A bow-tie consists of in-section (IN), out-section (OUT), strongly connected component or core (SCC), and tubes and tendrils (T&T). (**B**) Bow-tie structure of the largest connected component (LCC) and other connected components (OCC). Each section volume scales logarithmically with the share of its TNCs operating revenue. In parenthesis, percentage of operating revenue and number of TNCs, cfr. Table 1. (**C**) SCC layout of the SCC (1318 nodes and 12191 links). Node size scales logarithmically with operation revenue, node color with network control (from yellow to red). Link color scales with weight. (**D**) Zoom on some major TNCs in the financial sector. Some cycles are highlighted.

Figure 86: The Network of Global Corporate Control (Vitali, Glattfelder et al. 2011)

The heterarchy referred here is the recursive structure as outlined here (figure 86):

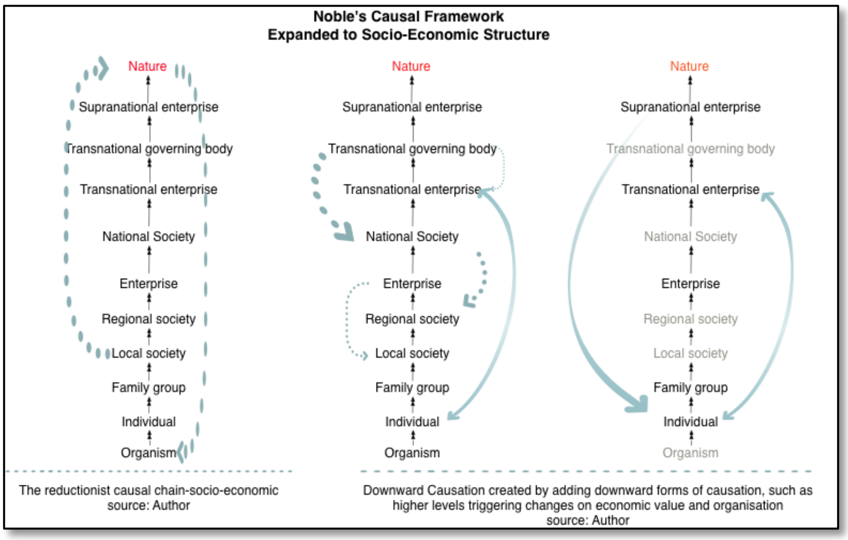


Figure 87: Adapting Noble's Causal Framework(Noble 2006)

Chapter 3.4.2.4: The Vester Method

Frederic Vester(Vester 2007) derived a slightly different approach and one leaning more to System Dynamics but it’s ability to accurately capture some of the counter-intuitive aspects of a business has been proven in many industries.

Based upon the following theme the Vester Method develops the critical dependencies maps their processes and parameters to rank them in order to derive critical negative feedback pathways, a functionality map, and most importantly scenario setting.

GHOST uses this method to establish the scenario model and modifies it to allow input of variant temporal scales and structure parameters.

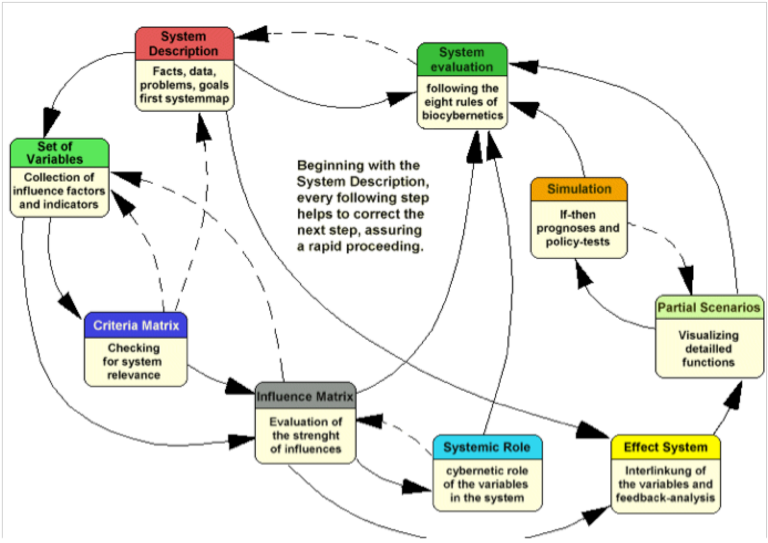


Figure 88: Vester Sensitivity Model

A major advantage of the Vester Method (figure 87) is that it can be iteratively developed from broad parameters, refining the process and sensitivity quickly.

Chapter 3.4.3: GHOST: Applying the Thought Experiment

The envisage commercial economic state-space can be considered as a heterarchy(McCulloch 1945) of inter-dependent eco-systems that have their own properties linked by dependencies between them. Co-operative and competitive characteristics of the components are embedded within each eco-system but the cross dependency relates to geographic and economic topology, in effect the topography of the state-space determines the co-existence factors between different eco-systems and their evolutionary characteristics.

It is proposed that this is structured as a recursive network open to analysis by a range of techniques being Managerial Cybernetics (Beer 1972, Beer 1979, Beer 1985), System Dynamics (Forrester 1975, Forrester 1990), Q-Theory (Li and Zhang 2010) (Jacobson and Yan 1998), Network Theory (Braess 1968, Strogatz 1994, Watts 1999, Bianconi and Barab√° si 2001, Watts 2002, Barabási 2003, Strogatz 2003, Watts 2003, Barabasi and Oltvai 2004, Barabasi and Oltvai 2004, Vazquez, Dobrin et al. 2004, Carrington, Scott et al. 2005, Nakano and White 2006, Caccioli 2009, Crook 2009, Ostrom 2009, Schweitzer, Fagiolo et al. 2009, Alessandro 2011, Vitali, Glattfelder et al. 2011) and Agent Based Models (W. Brian Arthur 1989, Arthur 1999, Arthur 1999, Arthur 2005) (Durlauf 1997) (W. Brian Arthur 1997).

The resultant set of recursive economic eco-systems exhibits the collective behaviour of Agent-Based Models but also the structural properties of complex networks. Under GHOST these are complementary in as much collective dynamics can inform what type of landscape exists whilst network structure. What was seemingly absent previously in commercial economic analysis was a causal framework linking these attributes. GHOST uses the heterarchy as an “Influence Graph” that informs parameters within both analysis types.

In the Real World the initial stages of commerce is the exchange of assets in order to purchase goods or services (Hamilton, King et al. 1795) (Barnett 2001) (United States. and Barnett 1916) (Goodhart 1985, Goodhart 1988)at which point a decision must be made as to price and terms, both related to each other. This process is enshrined in Asset Transfer Pricing Models to obtain the optimum return from the allocation of one enterprise’s capital into a new venture. The process may involve one or more of that enterprises entities between the new venture and the ultimate supplier of capital and so the optimisation process must take into account the location of the venture, the ultimate provider of capital and the resilience of the contract network created (Jensen and Meckling 1976) in order to make the commerce transaction and legal connection (Jensen and Meckling 1976).

The relationship between the Influence Graph and the component enterprises making the connections determines boundaries of viability over time for which a model benchmark is required. This is drawn from the work of Stafford Beer in the form of the Viable System Model (Beer 1972) and its associated CyberFilter (Beer 1979).

Let us refresh by illustrating the VSM in terms of recursion levels (figure 88):

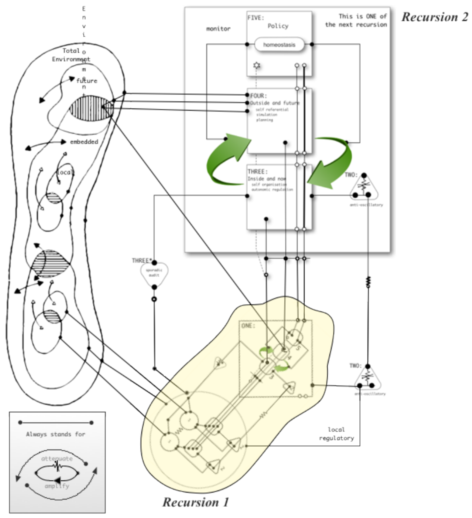


Figure 89: VSM Redrawn form Brain of the Firm

The shaded area represents Recursion Level 1 and together with external operations forms Recursion Level 2. Alone the external operations form no viable system needing the presence of a "production" or System 1 to make it complete. This diagram only shows the operations the enterprise and its senior recursion level in order to highlight the role an ATPM takes we must look at figure 89/90:

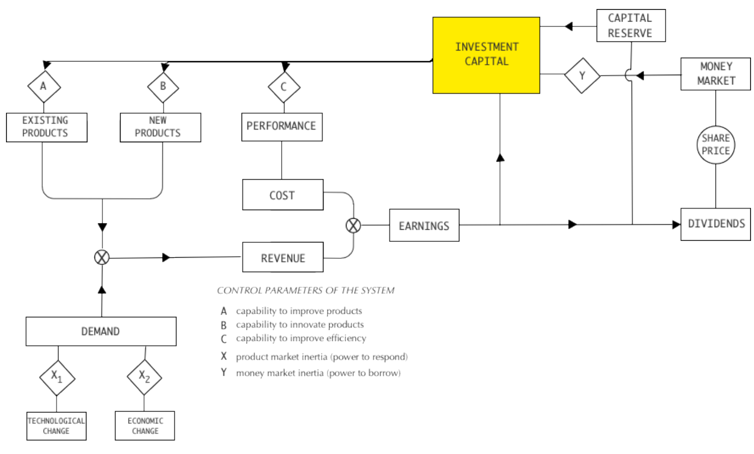


FIG.36: Brain of the Firm, p188

Figure 90: Brain of the Firm - Investment Capital Breakdown

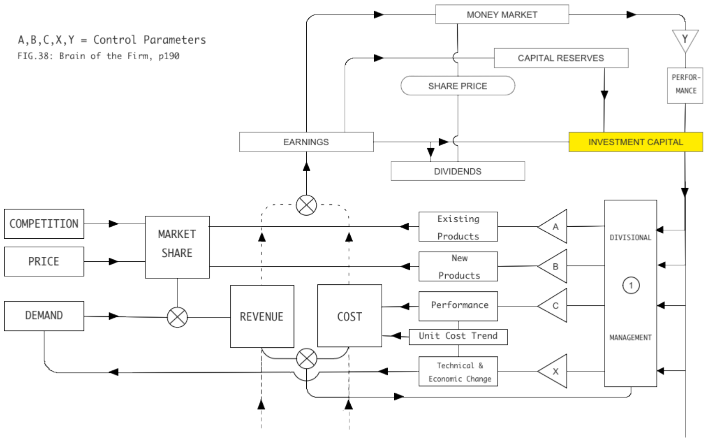


Figure 91: Brain of the Firm - Investment Capital Flow

Though general in nature they illustrate the core functionality of "Investment Capital" but a more poignant example is the simplified accounting diagram as follows:

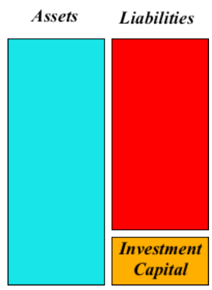


Figure 92: Simplified Accounting Diagram

Viability is expressed in terms of the enterprises ability to perform to its functional objectives over time and the CyberFilter the logical boundaries of production within the various recursive levels. Time is not assumed to be "Co-ordinate Time", that is, a common reference frame for all commercial transactions, and a convention itself, but rather relative to the recursive level within which the enterprise resides and the Influence Graph. A metaphor for time in this sense is that of "relaxation-time", "response-time" or "metabolic rate" which measures the mean rate required to execute all of the processes needed to meet the functional objective. The Influence Graph has its own differing time-scales depending upon the properties of industry and level in the recursive framework (figure 92):

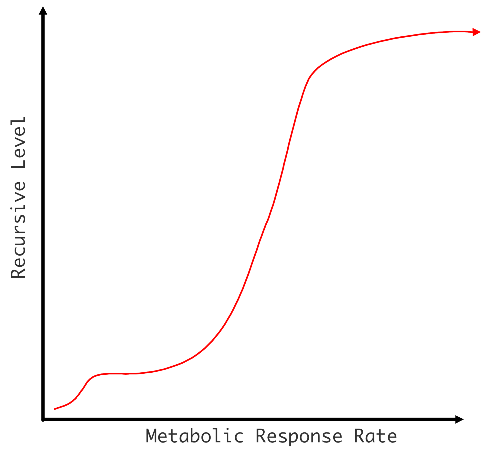


Figure 93: Authors Assumptions

The graphic infers that each product within each level of recursion has its own relative time frame with each exposed to different endogenous and exogenous uncertainties. Assuming an average rate has difficulties in itself as the true response rate should be linked to activity at each level but as data is not available for this task yet the assumption is the distance between agent determines delays and the higher the recursive level the greater the communication gap, including geographic constraints.

A product with its own lifespan of time "*T*" could therefore be produced by an enterprise with a response time "*t*". Both of these need to be incorporated within the planning process but are not currently illustrated in Beer's diagram's however can be accommodated in figure 93:

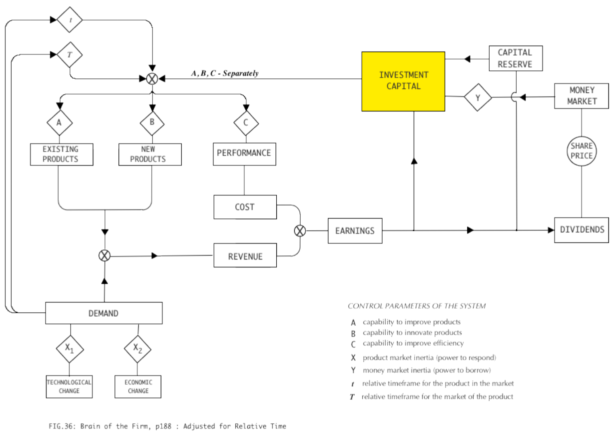


Figure 94: Investment Capital adjusted to reflect relative time

Adjustments must be made in both the feed-forward models and the type of corporate planning required to adapt to these changing dynamics but can be illustrated in figure 95:

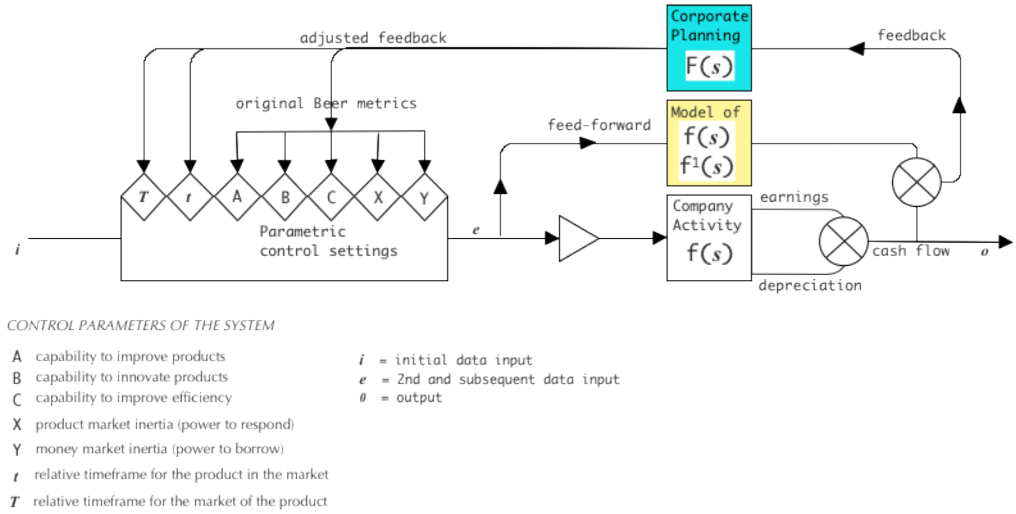


Figure 95: Investment Flow adjusted- Brain of the Firm graphic p189

This approach integrates the relative timeframes for the market and the business but does not adapt the model to reflect the fragility of the business itself. Though A, B and C reflect the “ability” to improve and innovate product and efficiency these are elements common throughout the life cycle of the enterprise, only X and Y are external parameters reflecting market perturbations. Little is said within Brain of the Firm about the scale that these parameters adjust or how the feedback from the businesses own fragility would affect them.

In 1972 when the Brain of the Firm was first published the level of sophistication of the Capital Markets did not include complex Credit Derivatives and the Shadow Banking Market. However since 2008, the start of the current Credit Crisis, it has become clear that the same underlying core issues remain: liquidity and equity capital.

Of the two parameters X and Y we can say that Y, being subject to the “money market”, will share exposure to Uncertainties emanating therefrom. The affect on the Enterprise will depend upon its financial strength and perception in the eyes of investors however extreme market conditions will still affect the enterprise regardless of relative strength.

We could modify the feedback model as follows:

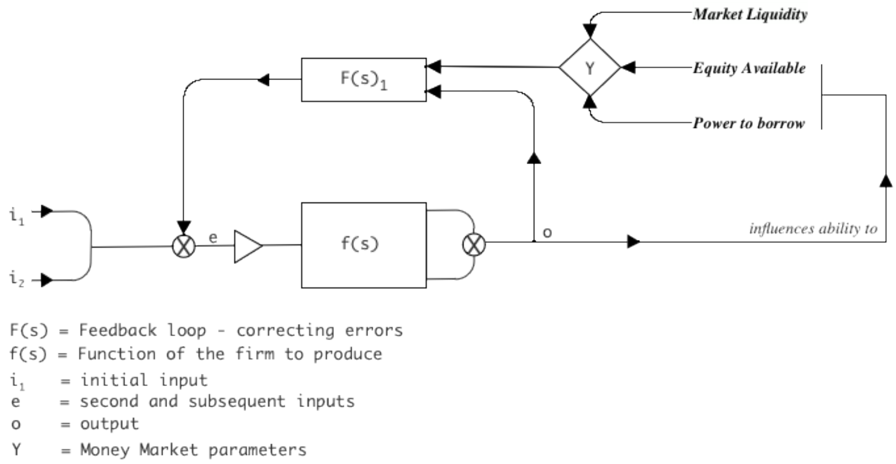


Figure 96: Brain of the Firm - Modified Feedback Loop

The investment capital graphic can then be modified in figure 96:

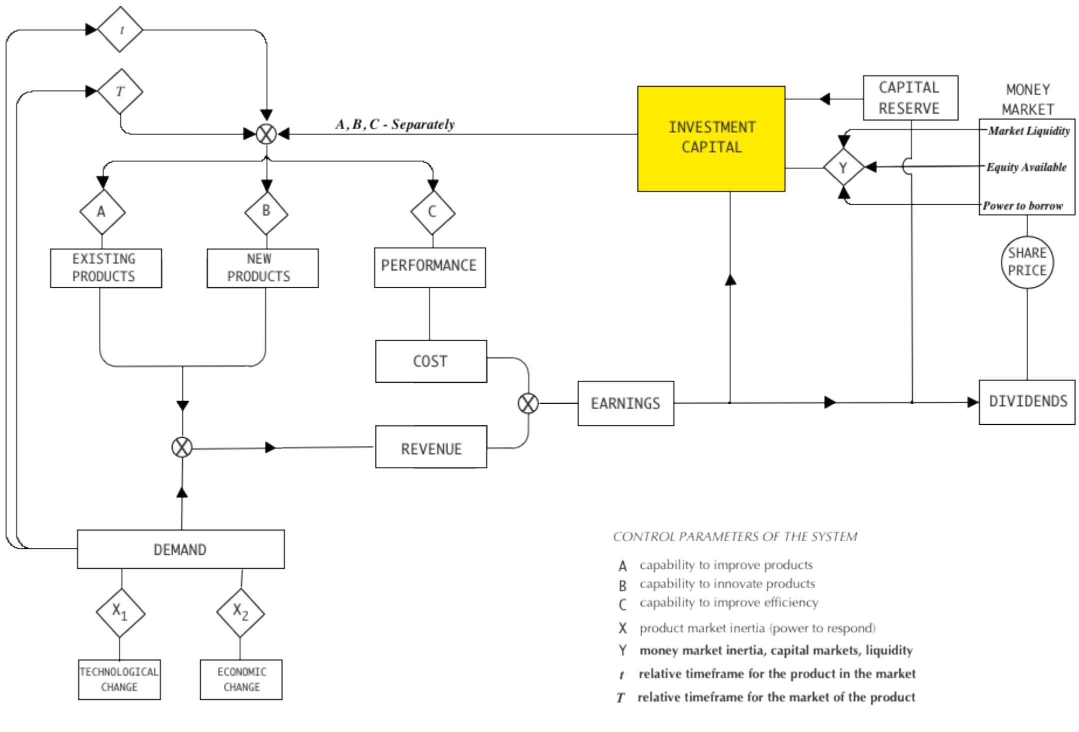


FIG.36: Brain of the Firm, p188 : Adjusted for Relative Time & money market parameters

Figure 97: Brain of the Firm - Modified Investment Capital

Having brought the "Y" parameter into better perspective we need to examine the "X" parameter that is in fact two "X_1" being technological and "X_2" economic change.

"Change" infers a comparison to a "time" scale and care should be taken here to ensure that "X_1" and "X_2" are properly compared to "relative" timeframes "*T*" and "*t*" from the data that is produced. It may be that "X_1" and "X_2" are proxies for changes in timeframes alone but this again is a data-driven concern. Incorporating the above into the full diagram from Brain of the Firm, page 190, we get (figure 97):

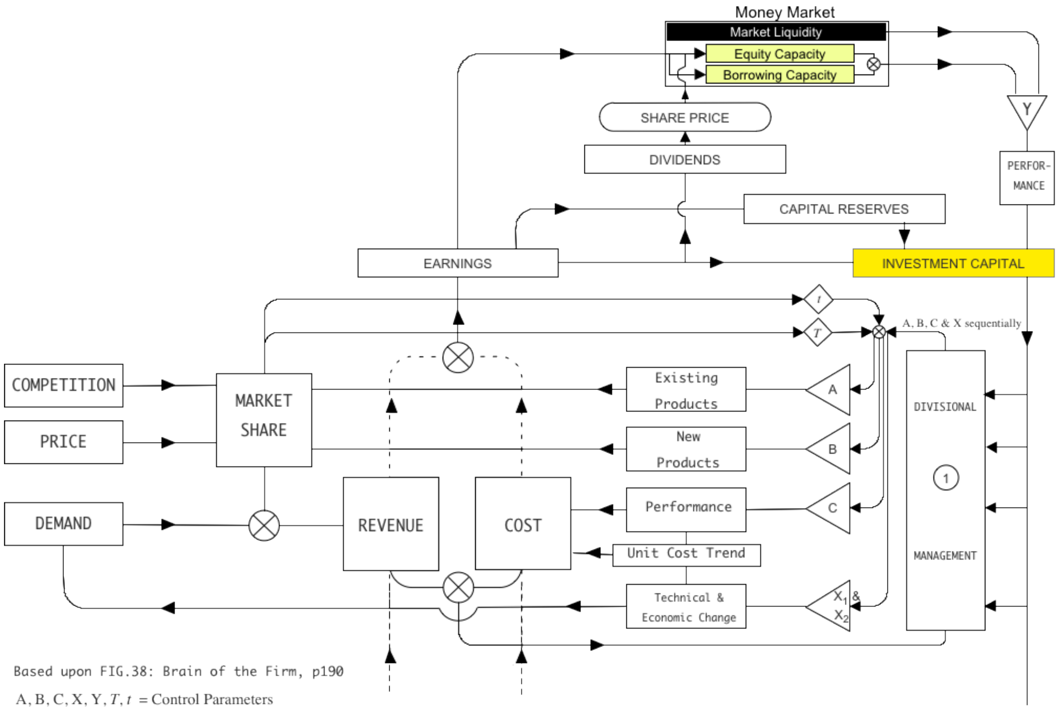


Figure 98: Brain of the Firm - Integrated Modifications

Note that Earnings inform the equity and debt markets separately and that Share Price informs only the Equity market. Time frames *T* and *t* modify A, B, C, "X_1" and "X_2" sequentially.

Beer's model assumes a particular type of viable framework however what happens if the enterprise or recursive structure is not "viable" according to Beer's definition? We have noted that any meta-system[xli] is not in itself a viable system without a properly formed lower recursive structure or System One in Beer's terms: this equally applies within the enterprise itself where the absence of a functioning "production" department renders the enterprise redundant.

REMINDER: Commerce, as an emergent function of Human Society, intrinsically serves that Society. This does not necessarily mean it serves Society fairly, equally, or indeed some parts at all. In the first and second instances the profit motive can overtake human frailty and divide created value disproportionately whilst the third technology at one time provides service to some at the expense of others. However it does mean that, eventually, the beneficiaries of commerce are the agents of that Society and, until they wish to redefine it, are "Human".

We noted in the Conceptual Framework that the system, and its governance regimes, is sensitive to the type of organisation. Any disruption alters the "response time" to events whether this is a delay in communication of current adverse conditions, new strategies or bad data formed through inaccurate analysis. This disruption must be factored into the model and incorporated into the business plan.

First a "causal framework" is identified with factors appropriate to purpose of the relevant agents and enterprises activities. Beer gives us five component systems within a VSM and a connection to the relevant "Environment", itself in three parts past, present and future. This can be structured as a matrix in Table 8:

Table 8: Temporal Aspects of the VSM's Systems

R_0	VSM System Level					
System	S1	S2	S3	S3*	S4	S5
Environment						
Past						
Present						
Future						

R_0 represents the initial recursive level upon which we are focused. From here the strength of connection to higher or lower levels can be mapped. Ideally this matrix should be completed for each recursive level to build an idea of the coupling strength between the orthogonal and recursive levels including awareness of each to the other and to the environment. As this is a heterarchical mapping it starts to take the form of a network whose nodes have internal and external connections. Let us start with a representative causal framework, a hypothetical relationship and co-ordinate time relationship (figure 98):

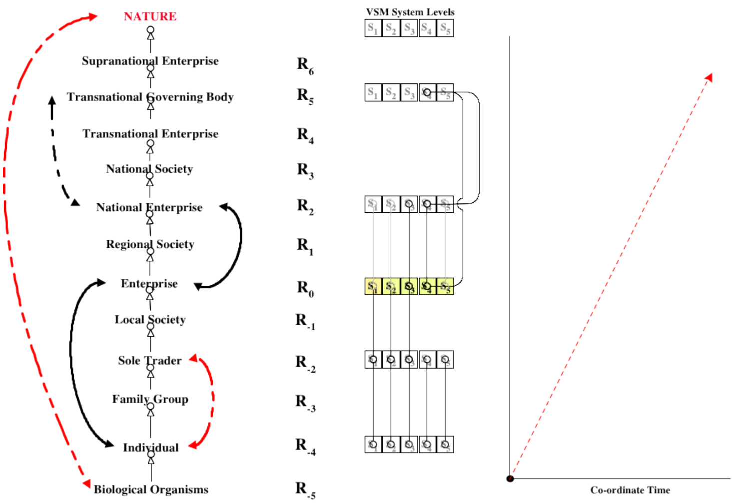


Figure 99: Drawing Up an Influence Map from Recursive Levels

R_0 is the starting point of the process and sells a product to a "sole trader" R_{-1}. In this instance R_{-2} is owned by an individual R_{-4} and therefore the mapping between them is assumed to be one-for-one on each System Level. However the mapping between R_0 and R_{-2} does not include the System 4 & 5 levels, as they may not share the same meta-views and vision. This does not mean that R_0 is ignorant of the relationship as it's own internal mapping should provide such data.

A choice between wholly owned subsidiary and partner is illustrated between R_0 and R_2 by shading lines differently, black only being a partnership and full mapping including grey as subsidiary. In this case both are subject to the same "Transnational Governing Body".

Co-ordinate time is deliberately shown here to illustrate convention response time assuming a biological allometric[xlii] scaling factor. In this case the allometric scaling factor is a linear increase in time as a consequence of increasing recursive structure. However scaling is dependent upon structure within the organism as is grows which in this case relates to the complexity of the organisational structure and a full complement of VSM systems.

In the absence, or incomplete structure, of one or more VSM systems the performance of the enterprise will degrade. This degradation will not be linear as to the type of structure nor proportional to the degree of perturbation the enterprise suffers but a permutation of both. Such degradation in response time can be catastrophic if the meta-systems above are compromised, an example of which was seen in 2008 as the 2007 Credit Crisis became clear and financial regulators did not have a coordinated response to a sudden loss of faith in government debt – the Economy was a common pricing factor to all ATPM's being the so-called "risk free rate".

The example mapping is for a singular relationship for our "enterprise" which is unlikely and therefore this process should be carried out as far as is practical for all such relationship. If there is a bias in mapping complexity around the enterprise it will likely be towards the lower levels where increased clients outnumber involvement with higher meta-systems.

The practicability of mapping every client is low however proper due-diligence at the point of introduction and take-on could include a simple questionnaire with a VSM score sheet based upon the above matrix. This should be done in any course for a regulated business but is good practise for all enterprises.

Structural Viability through governance capability is not the sole indication of stability. Aggregation of exposure to clients by type of contract, share ownership and market conditions account for a few on the Liability-side of the balance sheet that can equally apply for the Asset-side. Implicit in all ATPM is the Asset-Liability aspect of the model that strives to ensure a matched performance between the two. Understanding common shareholdings and how different market forces affect them would also indicate viability of the business (figure 99):

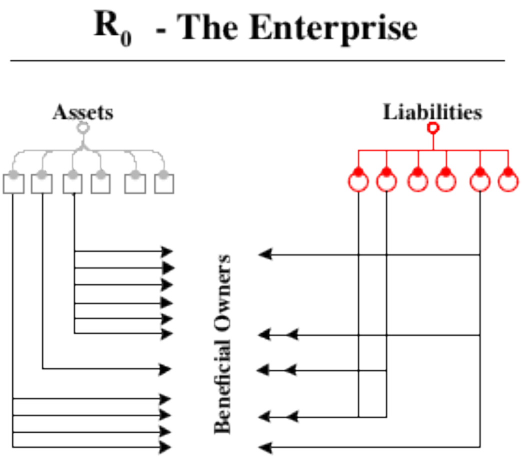


Figure 100: Identifying Common Ownership in Assets & Liabilities

Viability of the enterprise is therefore deemed dependent upon it having the complete structure of the Viable System Model present. The assumption being that as the VSM requires the internal variety of the firm to be such that it can cope with the external any variation as to the benchmark alters ability and the timeframe under which the enterprise can respond to events and therefore the volatility of future values and cash flows.

Each link to other component enterprises develops the network and sets resilience of the connections. These are important, as scenario testing will determine performance as the state-space is dynamically changed as along with it the connections.

GHOST therefore sets, but does not mandate, an initial entry point in the recursive structure dependent upon its relationship to the Influence Graph. The main objective is to test the temporal parameters under which the model maker operates but also to ensure that these are harmonised across the system correctly. As a dynamic system scenario changes that test whole system are designed to ensure the returns on the assets employed by ATPM's reflect the strategies being proposed under certain boundary conditions and that management can execute them.

Following the 2008 Credit Crisis banking regulators have established as a series of regulatory points of control determining the well being and on-going nature of an institution as illustrated in figure 100:

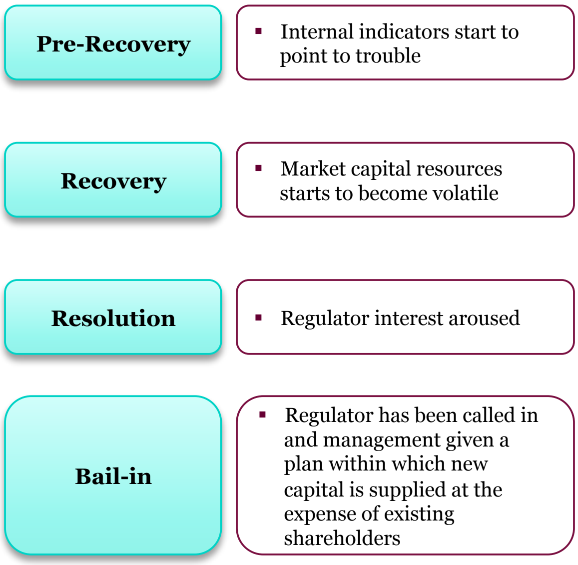


Figure 101: Regulatory Intervention Steps for UK Banks - 2012

Whilst applicable to financial institutions the method is viable for all ATPM's and intuitively included in any business that holds receivables or outstanding debts. In fact this is the basis upon the "factoring" business where a credit supplier will price a discount to current receipts and buy the portfolio from the enterprise for cash thereby improve the enterprise's liquidity level. As an aspect of risk management "Factoring" can work well but the "trade-off" is internal understanding of the client for a drop in likely profits.

Both the factoring company and the enterprise are operating ATPM's, the former pricing the risk to transfer its liquidity and the latter pricing its view of the client's default against the factoring company's for a marginal drop in profits on the probability that it occurs.

This process is a discounting approach and can be illustrated (figure 101):

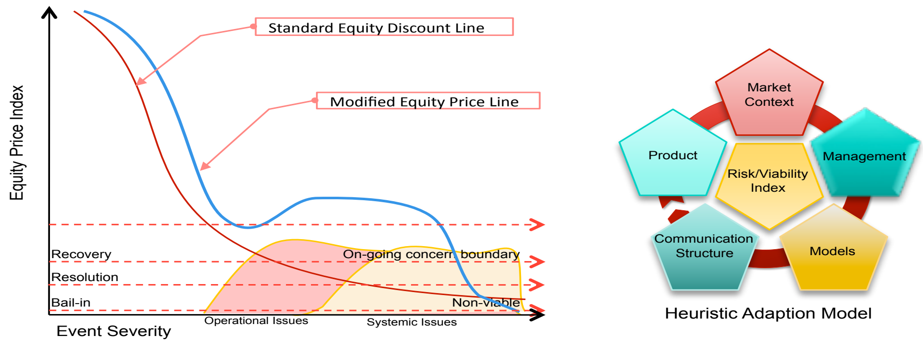


Figure 102: Factoring/Equity Discount Line

Factoring essentially looks at whether the portfolio in focus can pay the bills marked against a set of event probabilities of increasing size. In pricing the transfer of assets both the enterprise and the factoring company are pricing the discount to the probability level of the event: though the factoring company is dealing with a more complex being a range of internal issues. Shown alongside the graph are the factors each should be assessing.

An ATPM that does not take into account internal operational issues and exogenous systemic issues and follows a normal discounting process is following the red-line whilst compensating for the uncertainties of both would see the blue-line dominate pricing. The blue-line drops dramatically at the end as the event-severity could be so large systemically that no possible remedy is available.

Chapter 3.4.3.1: Managing Variety, Observing Meta-Behaviour and Structure

Pricing a few clients volatility to events is computationally possible but more than this the cost of doing so would be prohibitive for business. In addition the ATPM needs to know "market liquidity" which is similar to a universe of uncertainties that physics faced at the turn of the 20th Century and exemplified by the three-body problem.

From Schwaninger (Schwaninger 2006, Schwaninger and Ríos 2008, Schwaninger 2009) we see the need to employ alternate system approaches to identify specific parameters and processes for each business. Though Schwaninger offers Systems Dynamics as a tool it is not alone as Jackson (Jackson 2003) points out each have their advantages in specific circumstances but none actually manage variety in an organisational sense as the VSM being primarily process driven and non-recursive in nature: Beer's use of an external governor for the system is not possible within classical SD frameworks.

The owner of an ATPM needs to know that execution risks are identify and managed in order that the outcome is highly probable notwithstanding external events. Using the approach above may ensure that at a discrete recursion level the operations are identified but the market is dynamic and the parameters are constantly tested. Even though we may have identified the variety of risks and compensated for them within the enterprise we still need to identify the activity and constraints of the meta-systems above the enterprises level of recursion. The metaphor here follows Mandeville (Mandeville 1723) and the change in properties of higher levels of recursion and their feedback effects on lower.

The solution could be found in dealing with a portfolio or market as a set of "Agents" with certain characteristics operating under a set of modelled market conditions. How the "agents" act is usually derived from a set of "pay-off" conditions establish with strategies based in "game theory". The characteristics of these strategies are similar to those outlined by Beer but applying them to each client or a market differently would not solve the computational problem. However aligning them to known characteristics of dominating shareholders of each client would reduce the variety considerably especially in consideration of work showing the likely number of controlling shareholders to be less than 100.

Establishing an agent-based model with characteristics of competing agents set to the profile of the underlying dominating shareholders of the portfolio would inform the ATPM of the likely shape of portfolio's pay-offs but this must be moderated by the relative timeframes of the marketplace, the influence framework and product life-cycle.

The clustering process within the Network will also inform the ATPM of the relative strength of the existing portfolio as to continued ability to pay and hence cash-flow implications.

Clustering to dominant shareholders using agent-based models to predict future activity based upon current characteristics of those clients can create a set of values within a current state-space model that would inform the next iteration of strategies for the “agents” and the entropy changes.

This heuristic process would therefore combine modelled current value and future market structure with existing cash flow models to highlight changes in the market place and inform the pricing of new investment opportunities and strategies.

Essentially the combination of agent-based models, network clustering and variety management are setting the boundaries and alerting the enterprise of how data within the system is flowing. Changes in data inform the feed-forward parameters in the strategies so timely decisions can be made appropriately.

Rationalisation of this process could occur in future but the following is a temporary view of Beer’s diagram on page 190 of the Brain of the Firm modified to accommodate all of the above (figure 102):

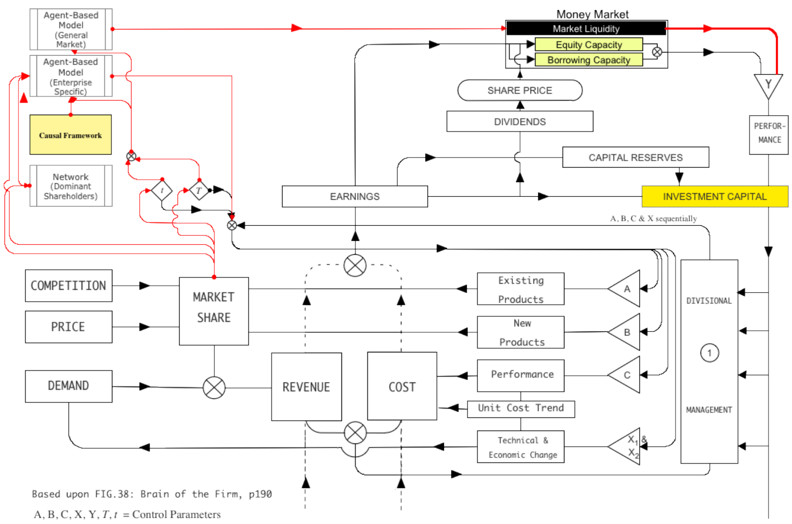


Figure 103: Modifying Beer's Page 190 Diagrams

Using a modification of Beer's diagram on page 189 "Brain of the Firm" we can restate this model as figure 103:

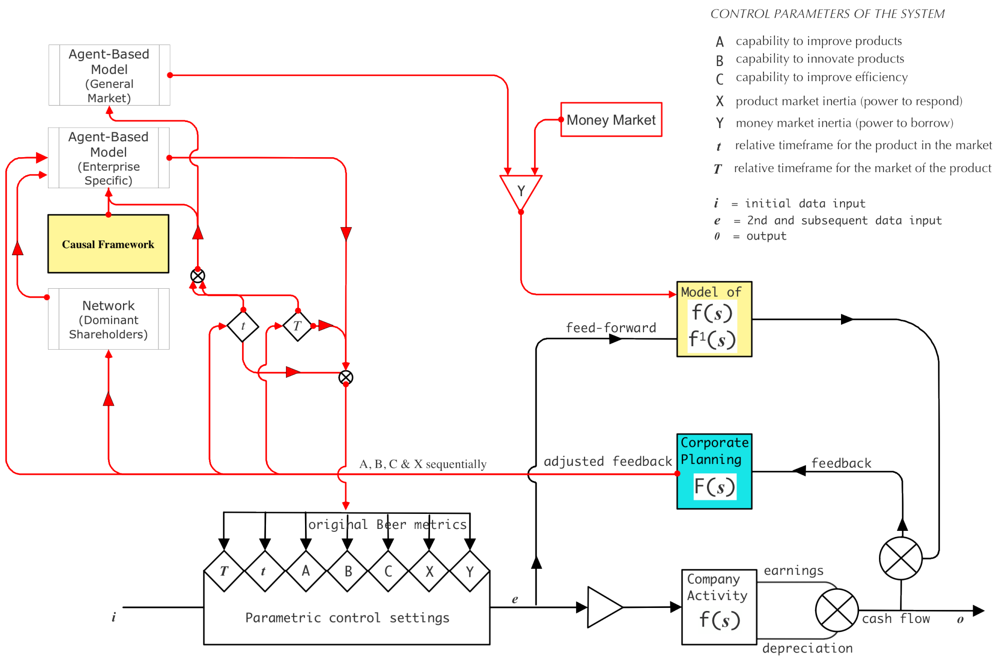


Figure 104: Modifying Beer's Page 189 Models

The original diagram has move around a little to make the flow more accessible and the additions in red. Articulated verbally, the market feedback into "corporate planning", being the practical responses to feedback, identifies the relative timeframes for the product and market ("*t*", "*T*") that then inform the respective agent-based-models. The parameters A, B, C, X_1 & X_2 are sequentially assessed with relation to relative timeframes and then input to the Enterprise specific Agent-Based Model, along with the updated network of dominant shareholders and Causal Framework changes, to modify the state-spaces for both cash-flow and value. All the revised values are the fed into the feed-forward models along with the "money-market" parameter Y, itself modified by new data from the market and the "General Market" Agent-Based Model.

The objective here is to incorporate the differential timeframe and structural aspects of the market changes into the new ATPM. What remains is an assessment of the firm itself as a viable enterprise and uses that model to modify the recursive structures accordingly by informing the Causal Framework Model of changes. The following is a simplified drawing of the process showing the Enterprise as an "agent" (figure 104):

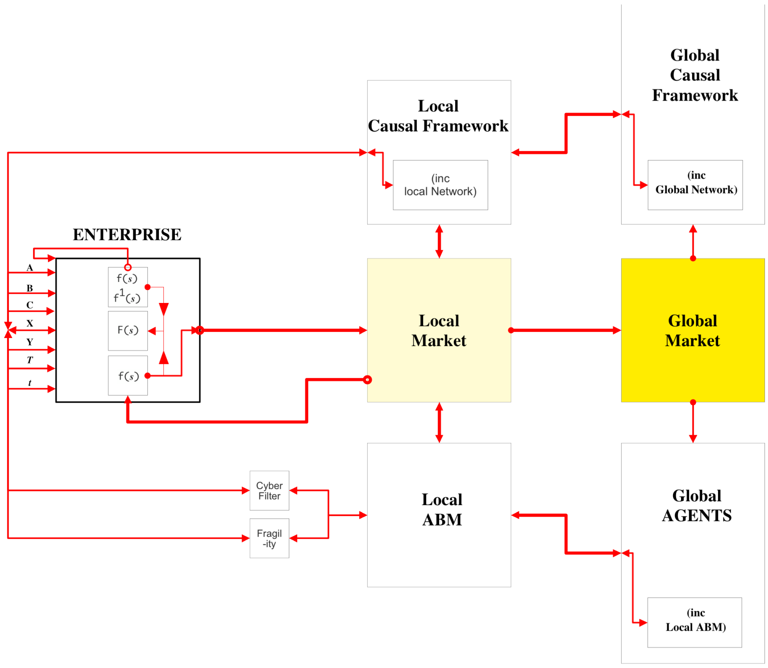


Figure 105: Reduced Complexity Drawing: Enterprise as an Agent

In this case the agent, the enterprise, is given a strategy that must be executed across a changing market state-space. This state-space is a topographical simulacrum of known variables and assumptions of the current network structure and changing behaviours of local and global agents. The network informs the agent of causal changes and, together with the agent behaviours, the relative time factors.

Chapter 3.4.3.2: Agents, Collective Behaviours and Network Topology

To accommodate the differences between individual behaviour and collective behaviour the influence graph will have its own internal recursive structure modelled along the same lines as above. This graph will determine clustering and temporal coefficients that will influence scenario testing on an Agent Based Model approach.

The influence Graph/Network informs the interaction between agents as well as the overall state-space structure. This is a core element of GHOST. It is posited that a link between recursive structures is more than a hierarchical structure, it is heterarchical: but upon what basis?

We have seen from Noble and Barabasi (Wolfram 1986, Waldrop 1992, Wolfram 1994, Laszlo and Krippner 1998, Clippinger 1999, Walleczek 2000, Johnson 2001, Laszlo 2001, Barabási 2002, Barab√° si and Oltvai 2004, Barabasi and Oltvai 2004, Noble 2006, Vannini 2007, Vazquez, R√° cz et al. 2007, May, Levin et al. 2008, Noble 2008, Crook 2009, Barabási 2010, Easley and Kleinberg 2010, Noble 2010, Noble 2012, Vattay, Kauffman et al. 2012) that Nature does not observe pure hierarchy when building components for the heart and metabolic pathways. Therefore the Influence Graph/Network tries to replicate this process by providing a pre-set recursive structure as an initial framework which can be modified as the complete ATPM evolves: performance can be "influenced" from any part of this Graph/Network in varying degrees.

Kuhn (Sunzi, Cleary et al. 2003) and Schumpeter(Schumpeter and Opie 1934) that different models evolve at different rates and paradigm change can exhibit a Catastrophe Theory type approach as the state-space of behaviour folds at a tipping point(Gladwell 2000). To model this within a pure ABM or Network model approach would be complex but modern software now allows concurrent modelling of ABM's at different levels of recursion and the exchange of values for differing parameters. This approach is an attempt to mirror different evolution rate within models and the sudden change between prevalent commercial models at individual and collective behaviours.

Both the Influence Network Graph and the feedback between agent-based and Market Agent-based models will be handled through matrix manipulation techniques and listener nodes within the software see figure 105:

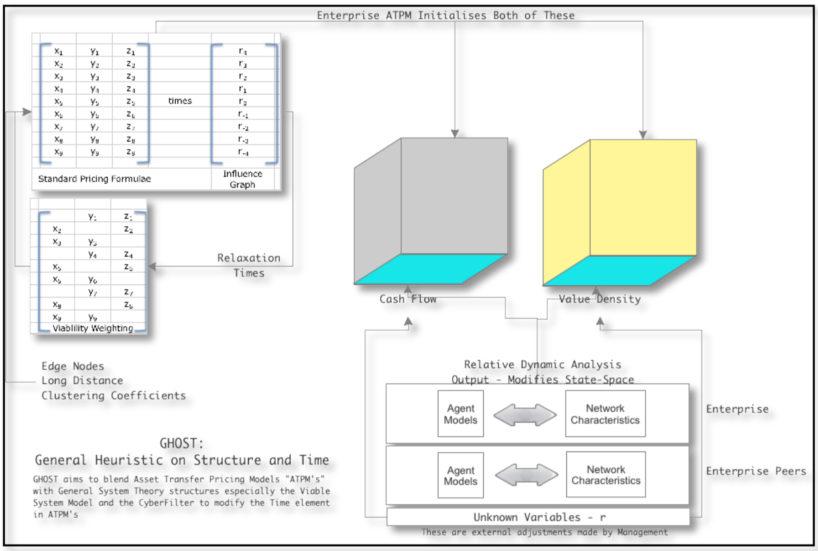


Figure 106: Combining the Influence and Agent Behaviour Maps

Chapter 3.4.3.3: GHOST: Parallels in System Biology

GHOST considers a state-space of a commercial economy whose current value can be expressed as comprising a network of co-dependent components. The coupling between these components groups them by type, geographical location, ownership, customer and an influence graph relating to social, legal, accounting and regulatory structures that is itself considered a nested graph much in the same way biological processes are governed by certain sub-graphs of protein interactions taken from Albert-László Barabási & Zoltán N. Oltvai: NETWORK BIOLOGY: UNDERSTANDING THE CELL'S FUNCTIONAL ORGANIZATION Albert-László (Barabasi and Oltvai 2004) as figure 107:

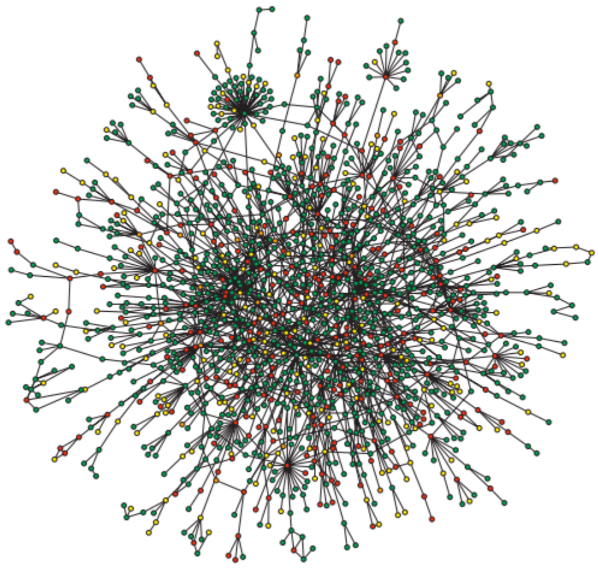


Figure 2 | **Yeast protein interaction network.** A map of protein–protein interactions[18] in *Saccharomyces cerevisiae*, which is based on early yeast two-hybrid measurements[23], illustrates that a few highly connected nodes (which are also known as hubs) hold the network together. The largest cluster, which contains ~78% of all proteins, is shown. The colour of a node indicates the phenotypic effect of removing the corresponding protein (red = lethal, green = non-lethal, orange = slow growth, yellow = unknown). Reproduced with permission from REF. 18 © Macmillan Magazines Ltd.

Figure 107: Illustration of Sub-Graph Nodes in a complex recursive structure

Note: the domains, for illustration only, that govern the network integrity.

Each component is considered as a sub-graph whose internal processes can be viewed in terms of the VSM. The resilience of the component will depend upon the presence and coupling strength of these processes, when they are arranged into a VSM form: The external coupling strength being a reflection of bonding strength either side of the firm's boundaries.

From Luis Mendoza and Ioannis Xenarios (Mendoza and Xenarios 2006) we see a similar approach to understanding commercial networks and described by them as:

> "*Modeling of molecular networks is necessary to understand their dynamical properties. While a wealth of information on molecular connectivity is available, there are still relatively few data regarding the precise stoichiometry and kinetics of the biochemical reactions underlying most molecular networks. This imbalance has limited the development of dynamical models of biological networks to a small number of well-characterized systems. To overcome this problem, we wanted to develop a methodology that would systematically create dynamical models of regulatory networks where the flow of information is known but the biochemical reactions are not. There are already diverse methodologies for modeling regulatory networks, but we aimed to create a method that could be completely standardized, i.e. independent of the network under study, so as to use it systematically*".

A description of their approach is graphically represented as figure 108:

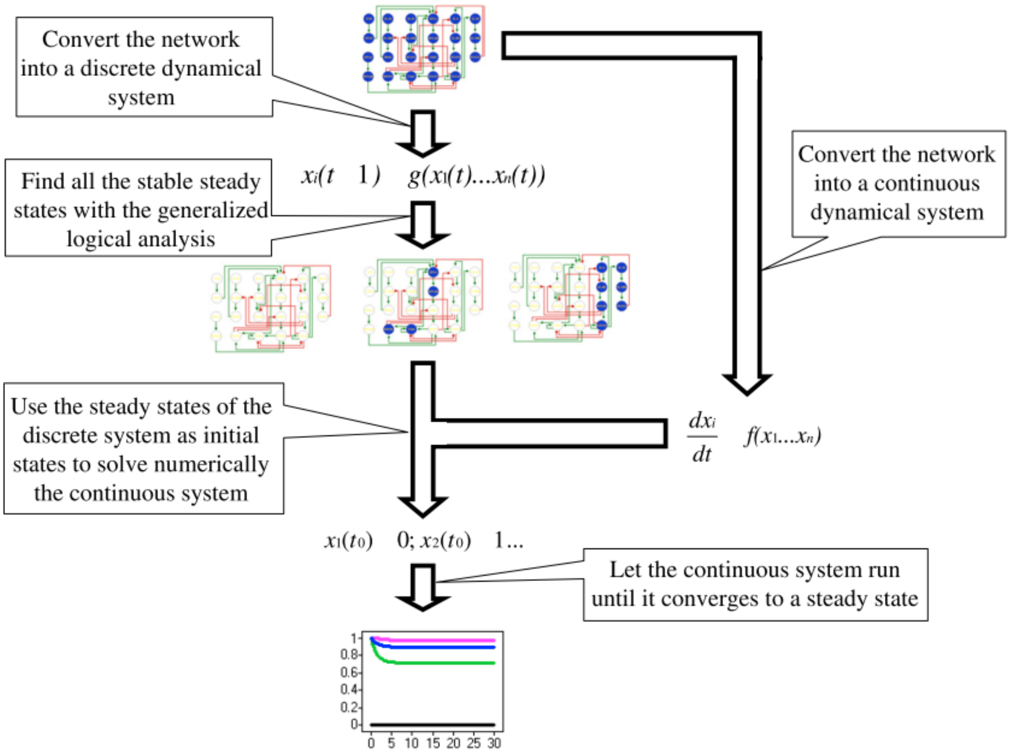


Figure 108: Mendoza & Xenarios Methodology to capture the dynamic properties of molecular networks

Diagrammatically this presents the same approach suggested in modelling the characteristics of the commercial dynamics of an ATPM. Whilst applying Systems-Biology to commerce is not new, the tools to make the outcomes realisable in real time have only just become widely and generally commercially available. A review of the possible software applications will follow.

Chapter 3.4.3.4: Earthquakes, Tensegrity, Q-Analysis, Rigidity & Constructal Theory

Hiroshi Saito, Spatial Design of Physical Network Robust against Earthquakes, (Saito 2014) may seem an unlikely candidate for providing a proof on commercial sustainability:

> *"This paper analyzes the survivability of a physical network against earthquakes and proposes spatial network design rules to make a network robust against earthquakes. The disaster area model used is fairly generic and bounded. The proposed design rules for physical networks include: (i) a shorter zigzag route can reduce the probability that a network intersects a disaster area, (ii) an additive performance metric, such as repair cost, is independent of the network shape if the route length is fixed, and (iii) additional routes within a ring network does not decrease the probability that all the routes between a given pair of nodes intersect the disaster*

> *area, but a wider detour route decreases it. Formulas for evaluating the probability of disconnecting two given nodes are also derived. An optimal server placement is shown as an application of the theoretical results. These analysis results are validated through empirical earthquake data*".

The proposal by GHOST that a commercial entity can be considered as a recursive governance network that can be explained in terms of communication theory and viable systems offers analysis of the connections between agents and within recursive structures in terms of their bandwidth and transduction capabilities. If one replaced these concepts with the transmission of forces between and along components of a commercial enterprise then not only can we bring information theory into play as Beer presents us, but also a range of other tools such as Q, Rigidity, Tensegrity and Constructal Theories.

What Saito has offered is a link between the topology of the network, assumptions on repair costs relating to size of connections, and formulas for deriving the probability of disconnection. It is not difficult to see that performance metrics offered by Saito can be adapted to meet the likelihood of failure of a commercial network if one knows the changes in forces being applied (figure 108).

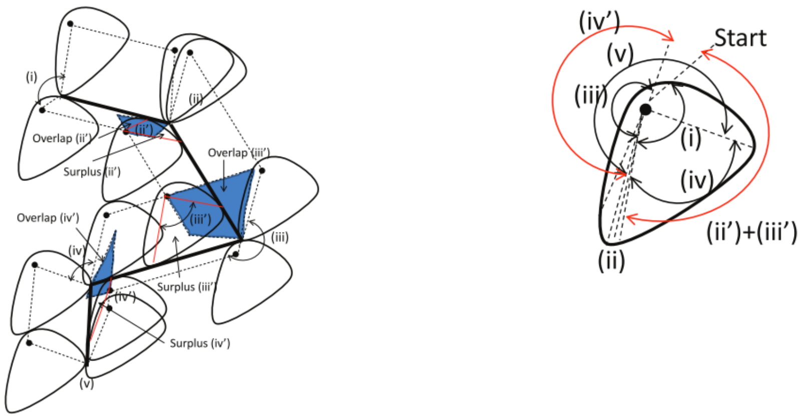


Figure 109: Saito Spatio Design Framework – Forces at Work

If this approach is linked with GHOST/Mendoza methodology of acquiring dynamic parameters from agent behaviour Saito's approach may be very useful especially if the iteration process is applied across several levels of recursion within and around the focus of the ATPM's investment target.

Chapter 3.4.3.5: GHOST: Predicting Adoption Probabilities in Social Networks

On many occasions, whether internal to an organisation where a new product is being considered or external where investors wish to predict the same adoption process discerning the probability to capture a critical mass of earnings and/or the likely demise of the current products.

Xiao Fang, Paul J. Hu, Zhepeng Li and Weiyu Tsai, Predicting Adoption Probabilities in Social Networks(Fang, Hu et al. 2013), offer an insight in how a locally-weighted evaluation method for Naïve Bayes Learning may be applied. It would be suggested that Saito and Mendoza can also contribute to this approach in developing the strength or weakness of ties (see Granovetter(Granovetter 1978)) as well as incorporating the recursive structure of the business to take account of cross dependences between products and regulatory requirements.

Chapter 3.4.3.6: GHOST Monitoring Internal Health of the Enterprise

Though not specifically relevant to all ATPM's an enterprise operating an internal ATPM will want to know the likely viability of their subsidiaries under times of stress. This is one of the reasons why the VSM was chosen as a framework as it dynamically monitors a state-space of the systems various subsidiaries.

If structure is essential to good governance, using Beer's VSM as a structure and knowing the dependence upon its component "agents" then, ensuring each agent is aware of the functional structure of the enterprise and their role in maintaining it, monitoring the communication and decisions made according to the 5-System model is one way of acquiring this data. Though not complete by any means it will improve oversight and guide management to where critical faults may occur.

Chapter 3.4.4: GHOST: Software Considerations

Chapter 3.4.4.1: GHOST Software Overview

The development of high specification processors and graphic software has provided the owner of a Personal Computer access to computational abilities previously restricted to mini-computers. Prior to this reliance on spread sheet technology for business modelling extended into very large organisations as late as the early 2000's.

Large portfolios of risks or investments that required complex models to derive pricing had access to larger processing power but even then they had to find computer time on transaction-based platforms. This usually meant that the larger firms were the only ones capable of developing complex models. However a computer is merely a complex calculator executing the rules of a model and if it is the model that is at fault then the processing power is only relevant if the new model requires it.

GHOST is fortunate that software design and computational ability has converged in two respects to allow more users to intuitively understand the mechanics and evolution of their risks. Modern Systems Dynamics software has changed significantly allowing packages like AnyLogic™ and InsightMaker™ to provide a combination of Agent-Based Model, Discrete Event and Systems Dynamics. The former may seem expense to the latter "free online" service but is only €36,490 for the 4-license Professional version and €9,897 for the Advance; this is well within a medium-sized firms budget which, when taking into account the cost of hardware of €20,000, means a combined cost of approximately €60,000 over three-years.

However there are other routes to take that though not seemingly built for the task have in-built models of great complexity which are located in the Computer Graphics Software domain. The following table lists a range of products available for both dedicated and graphics systems:

Program	**Main Features**					**Single License Cost**
	Topology	Ecosystem	Agents	Dynamics	Python	Approx. ex-Taxes
Lightwave 3D	✓	✓	✓	✓	✓	US$1,500
MODO 701	✓	✓	✓	✓	✓	US$1,200
Realflow	✓(linked)		✓	✓		US$4,000
Cinema 4 R13	✓	✓	✓	✓	✓	US$3,700
Vue 11.5	✓	✓✓	✓	✓	✓	US$1,500
3DS Max 2014	✓	✓	✓	✓	✓	US$3,500
Maya	✓	✓	✓	✓	✓	US$3,500

Softimage XSiD	✓	✓	✓	✓	✓	US$3,000
Blender 2013	✓	✓	✓	✓	✓	Free

Figure 110: Existing CGI Software with Agent/Topology Facilities

Source: Google Data from software developer's own websites – April 2013

Most of the graphic packages use a node-based process to develop complex topographies and those reviewed later include sophisticated particle-based emitters that can be controlled by weight-maps on topological surfaces and subject to physic-like forces whose parameters are set by the user [see figure 111].

Figure 111: Lightwave 11.5 - Node Control With the addition of new node controls, it is now possible to control flock agent behaviours such as banking, locking agents to an object or have agents corkscrew along their trajectory.

These surfaces can be generated by a range of iterative fractal equations [see graphic], interact with particles representing agents with their own parameters and collective activity can "morph" the underlying topology (figure 112).

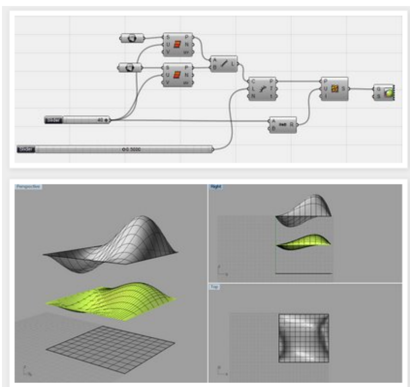


Figure 112: http://btlb.blogspot.co.uk/2009/03/grasshopper-surface-morphing.html

“Morphing” is a process common to topology and its software spin-offs and is the process of changing the underlying surface discretely or according to programmed forces. This is useful as a visual aid because the folding of surfaces in a state-space can depict the risks a particular strategy may face in the future according to varying scenarios, as is the changing of density when considering aggregation.

The ability to automate and programme through a common language, Python, adds to the interconnectivity and benefits of using a work pipeline to integrate input and output across different software platforms. The following is a brief list of dedicated agent-based modelling software where interaction can be made available (figure 112):

Agent-Based Model Toolkits and Libraries			
Toolkits (with environment)		Libraries (without environment)	
ABLE	AgentBuilder	Aglets	A-Globe
AgentSheets	AnyLogic 7	Ajanta	Brahms
Ascape	Breve	Cougaar	deX
Cormas	D-OMAR	EcoLab	FLAME
JACK	JAS	FAMOJA	JADE
Jason	LSD	JADEX	JAM
MAML	MASON	JASA	MadKit
MASS	MIMOSE	Omonia	SimAgent
Moduleco	NetLogo	Soar	Spark
Ps-i	Repast	Tryllian	Zeus
SeSAm	StarLogo family		
Swarm	VSEdit		
VisualBots	Xholon		insightmaker

Figure 113: Agent-Based Modeling/Mixed Methods Software

Source: Design of Agent-Based Models, Tomas Salamon (Salamon 2011) (insightmaker added by author)

Insightmaker™ was added because like AnyLogic™ 7 it is capable of integrating systems dynamics and discrete modelling into the environment.

The advantage of using graphics-based product is that visual translation of data is more intuitive to the user than complex algorithms and number-based charts. This is the reason “dashboard” software from SAP has evolved in the engineering and financial sectors that can be linked to their proprietary database product but also as a Java-based platform.

Chapter 3.4.5: Commercial Analysis and Delivering the Product Language

What follows is a commercial analysis of GHOST, as out of necessity this will have to be a pithy rendition of the short and long-term benefits users gain by employing GHOST and augmenting existing pricing methodologies.

Experience will inform the presenter of new concepts that the ideas must be encapsulated with a "lift-speech" lasting no more than 2.5 minutes after which, should more time be granted, the core benefits should be highlighted with clear direction as to supporting resources. The following are mock slide presentations illustrating the above along with a usual verbal accompaniment (figure 114/115:

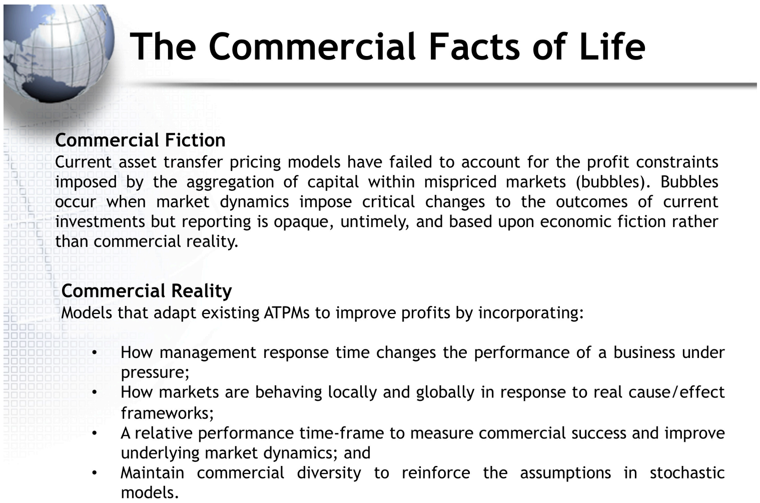


Figure 114: Commercial Facts of Life

"The rational objective of any investment is a suitable, or better, outcome than that targeted. However current models assume unrealistic market conditions, data transparency and absolute faith in consistent management performance even under pressure. Only under dynamic programming are portfolios actively managed but even then with severe constraints. What is need is to understand the current forces surrounding management performance, the changes in market dynamics and what time frames in which products must return the expected outcomes – few models provide this".

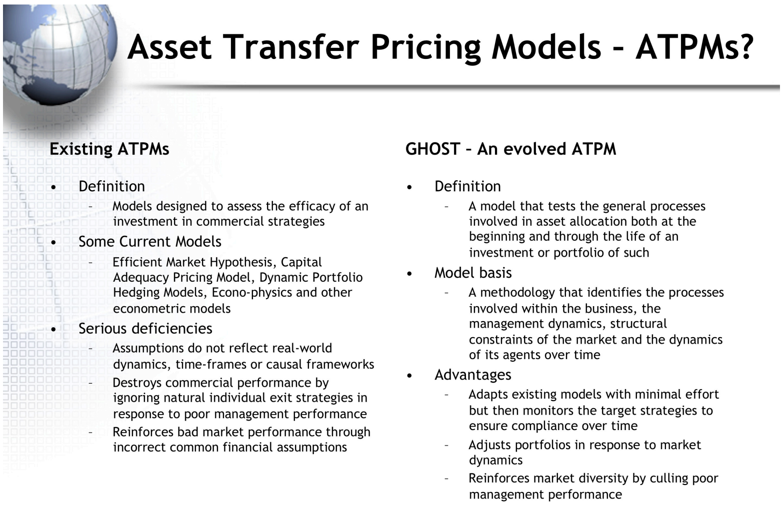


Figure 115: commercial ATPMs Approach

"If a single parameter change could prove better outcomes then GHOST's focus on adapting returns to differential time-frames would be the chosen focus. By simply adjusting the real-time horizon of an investment according to GHOST's methodology the explicit discounting of time and risk rates would show that, in a fast moving economy, current prices are woefully incorrect and by reset expectations accordingly outcomes would be more aligned".

"The cost factor of implementing GHOST can be structured in ways familiar to management, either as a flat fee or performance related, in both situations the benefits would be a fraction of the increased yields".

Time affects several components of the financing structure as follows(Gillemot, Farmer et al. 2006)(figure 116):

Component	Description
Project horizon	The period over which the strategy would be implemented
Return Rate:	The following are sub-components that derive the final annual, or total, returns required:
Liquidity	A price required to allow for temporary illiquidity in returns, this is different from "default risk"
Inflation	A factor reflecting the exposure to market financing costs relating to economic inflation risk
Default	The probability of total project failure
Project Risk	A reflection of the level of equity risk assumed. Different to

default risk and usually related to the amount of principal repaid in the return.

Figure 116: Affect of time on Financial Projects/Risks

Note: There is no "risk free" rate: The concept of "risk-free" was discussed before but should be repeated here – benchmarking underlying market risk separate to project or equity risk is fraught with danger as the 2007 Credit Crisis showed, uncorrelated exposures buried within deeply discounted sovereign risks expose pricing to significant errors.

In the modern business much of the communication and supporting client acquisition data is transmitted via emails, mobile telephone and even telefaxes are now digital. An application of the above would need to be expressed in terms relevant to human understanding and so a simple trans-mapping of the 5-System functions would be as follows (figure 117):

VSM	System 1	System 2	System 3	System 3*	System 4	System 5
New Map						
Production	X					
Planning and Control		X			X	
Audit & Learning			X	X		
Vision & Ethos						X

Figure 117: Remapping the VSM to a Different Nomenclature

These four elements can be embedded within employment contracts and communication software to ensure correct allocation between points of contact for each "human agent". Depending upon the core responsibility of the "Agent" the allocation of estimated time per function could be illustrated thus (figure 118):

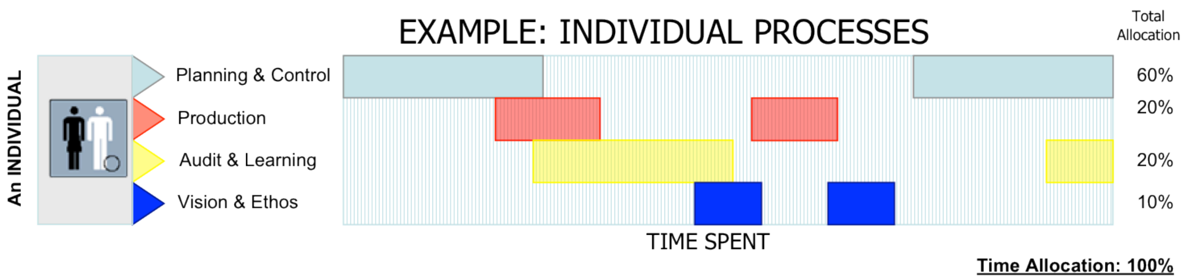


Figure 118: Allocating Time Spent within Functional Roles

The process equivalent may also look like the following (figure 119):

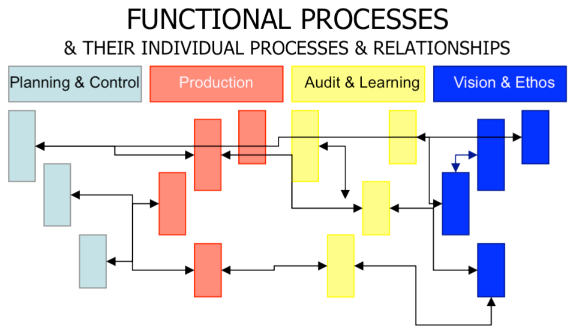
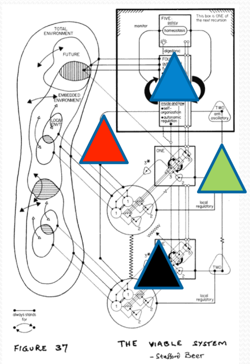


Figure 119: Adding Process Flows to Functional Roles

The language of System Theory is seldom easily translated into everyday actions without a fundamental language in common usually gained through an introductory course. However the central concepts behind the mapping above can be explained as follows (figure 120):

What do the Functions Mean?



Stafford Beer: The Viable System Model

Function Roles and focus in time

FUNCTION	VISION & ETHOS	PLANNING & CONTROL	AUDIT & LEARNING	PRODUCTION
	Someone is, or has started the enterprise with a sense of purpose and direction. They are the drivers with the map.	In the beginning some thought (the longer the better) went into detailing the path to be taken and how to control events that arise in the processes and market place.	In order to know what is going on within the business we need a way to get information about the status of things, traditionally called an audit process, but it is more than this for as we audit we must learn about what is going on.	Whatever the product there is a set of processes transforming raw materials into it, a sales process of acquiring and managing those who want the product. *This is why there seems to be another set of the other functions within it.*
MARKET PLACE FOCUS	FUTURE & PRESENT	FUTURE & PRESENT	PRESENT & PAST	PRESENT & PAST
	When you're driving you know where to go as well as where you are	Giving the driver directions and also the risk that are there	It's just happened but do you know it and what can you learn from it	The engine doesn't need to know where it's going but does the resources to do it

Figure 120: Rationalising the Language of the VSM

The method of allegory is common in story telling and anchors concepts in everyday terms yet visually connecting to a deeper truth. The comparison between the complex diagram on the left and the reduced functionality in the table is designed to start the general process of education. There is a science here if you want to explore it?

The state-space of this communication network can be created by mapping each agent to each side of a tetrahedron, each side representing one of the four-functions.

Communications between parties therefore become lines between these faces and the network so created a density map.

First mapping decision makers to an inner tetrahedron and then repeating the process to the core, or centre of gravity, representing the board of the business can recreate the governance structures typical of the VSM. The combined may look like (figure 121:

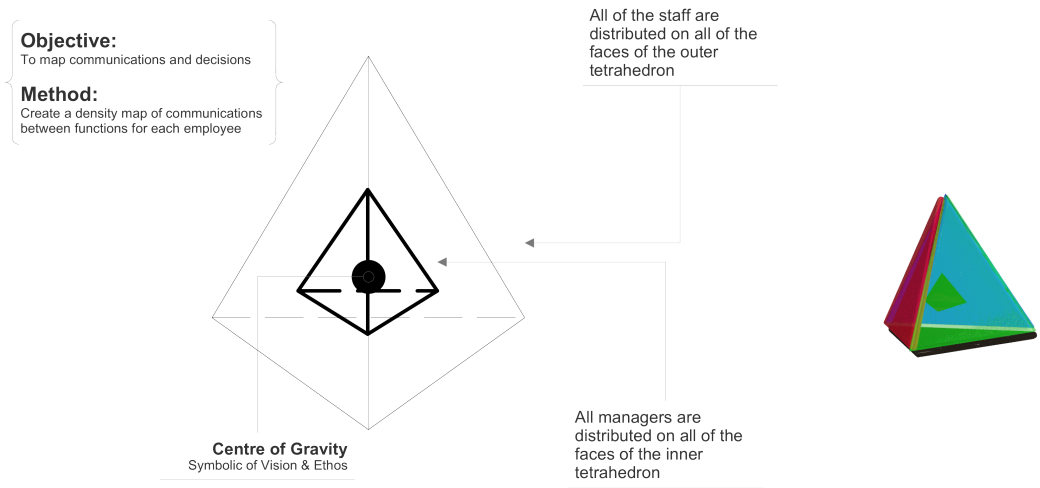


Figure 121: Mapping the Communication Network onto a Tetrahedron

The density of communication, absence of decision-making or the delay between decisions can be monitored automatically and only the review of those in audit need know the full details of the threads.

It could be assumed at this stage that current pricing processes within project development and management are to be abandoned, quite the contrary. Existing methods establish critical paths and timeframes that set initial values. It is the testing of these values and their resilience that is at issue. Each component of the general state-space will have unique characteristics but behaviour will be determined by derived evolutionary rules, its place in a recursive network and resiliency factors to identify behaviour in extreme dynamic conditions.

Evidence from the 2008 Credit Crisis showed that accumulated mispricing had exposed a majority of commercial economies to catastrophic loss without the revenue to absorb it with consequential effects on Society. The objective of introducing relative timeframes into existing ATPM's, and testing for management's ability to perform relative to this and an Influence Graph, is to set boundaries that more accurately underwrite the risks involved. In doing so individual and collective pricing will naturally adjust the flow of capital to well managed enterprises, increase the capacity for equity risks and balance the whole within more realistic commercial boundaries without altering individual freedom of choice.

An essential element of GHOST is that is available to a wide variety of users. It is one of the largest criticisms of the pre-2007 era that only very large enterprises could afford the processing power and intellectual resources to model critical mass portfolios. By providing an open-source recursive Influence Graph and modifying readily available software a wider audience will have access to the model at a lower cost and, with the natural outcome of better pricing, portfolios can be created more ably and strategies scenario tested to ensure on-going value creation and liquidity supply.

Chapter 3.4.5.1: GHOST: Agency, Fairness and Governance

GHOST, as the *m*-ATPM, does not enjoin the argument about "fairness" as the definition at the outset of this thesis restricted the operational boundaries to the model that defined the potential exchange of assets. Fairness as a concept is a relative perceptual issue, dynamic in its boundaries and contextually sensitive. It is embroiled in personal and social mores and adjudicated upon by the system external to ATPMs – the legal framework local to the agreement's participants or set out in the contract.

Neither is it sensitive to the concept of Agency as any agent paid from or acting on behalf of the owner of the assets should be arriving at a value consummate with the general parameters set out by the investors. Any deviation from those parameters is a matter for the "fairness" argument that becomes reflexive herein.

As far as both Agency and Fairness are concerned the investor themselves should be doing at least the superficial due diligence on any agent and assessing the initial fairness of the proposal to comply with their own objectives. Recursive analysis in the method proposed would resolve any discrepancies between the component values and expected outcomes.

GHOST's prime-facial objective is to align the governance regimes within a recursive structure, identify the weak links and probability of breakdown so that temporal scaling can be added to the value creation method.

Chapter 3.4.5.2: GHOST: Outsourcing and Trading Exchanges

A particular bi-product of the early-2000's was the growth in Shadow Banking as traditional credit and other commercial contract for difference were traded outside the banks and their high regulatory capital. A resultant issue for regulators following the crisis is the correct level of capital for the exchanges that clear these trades known as Central Counter Party or "CCP"?

The argument is complex depending upon the legal structure of the CCP however a common structure involves: the core capital of the CCP; the amount of and contributions to a Default Fund; and the terms/collateralisation under which any offsetting by parties liabilities in a contract is arranged.

This issue is not particular to CCP's because on deeper review the method/models of trades that would be considered between parties and cleared by the CCP have a general form that could apply any insurance, reinsurance or indeed outsourcing arrangement: all of which are in fact ATPMs.

As such the general form applies, the strategy of transfer provides a benefit and certain risks are exchanged. In the case of the CCP the trades impart business risk and operational risk between the trading parties and the exchange. The exchange retains the operational risk and any undiversified business risk not taken care off by the collateralisation process on a one-to-one contract basis. In the case of reinsurance: the reinsurer accepts the risks according to the contract; the insurer retains undiversified risks; and the insurer accepts the solvency risk of the reinsurer.

This is a classic “black box” issue (figure 122):

Figure 122 CCP "Black Box" Capital argument

Within the “Black Box” are the operational risks of the CCP and its capital base must meet the probable drawdowns that the risks accepted impart. If the risks are not transparent and the regulator is concerned about the central importance of the CCP then the Black Box will have to be opened but at this stage there is one definite risk that remains unaccounted for and is one shared with all the commercial entities: liquidity risk.

Before investigating the core issues it could be assumed that, like most businesses, trading distributes excess liquidity and equity is left in the form of operational assets. This illiquidity was at the core of the 2008 Credit Crisis and arose because at the time of a catastrophic adverse event the exposure to business risk increased and borrowing ability dropped for the institution.

How does this affect outsourcing in the same way? Engaging a call-centre to handle sales, claims or legal processing is an ATPM process much like the Black Box above. Whilst the call-centre accepts performance risk and the firm lowers or manages employment costs the firm also accepts reputational risk from the consequential actions of the call-centre whether it be cultural or financial.

Chapter 3.4.5.3: GHOST: Co-operating Systems

To many “Keiretsu” and “Chaebol” would mean little but as Granovetter, Business Groups and Social Organisation, (Smelser and Swedberg 2010)p429 pointed out:

> *“That theory was slow to address this reality should not surprise. In economics, there was little sustained attention even to the question of why such an entity as a “firm” should exist at all until Ronald Coase wrote his pathbreaking 1937 paper* “The Nature of the Firm.””

Granovetter challenged accepted theory by attributing

> "*my definition is not endlessly inclusive: because it specifies that the for-*
> *mal and informal ways in which a collection of firms is bound together must be "persistent," networks of firms with shifting ties, and without clearly persistent subsets, should not be considered "business groups." Thus, sets of firms in industrial districts, connected to one another by a dense network of ties, may or may not be classed as groups, depending on whether clearly identifiable cliques of firms persist over time*".

Using the concept of recursive structures we can now include Granovetter's definition to augment that of commercial recursive systems but also point out that Granovetter's definition should mainly apply to the governance structures only and not the actual component firms.

In this way any cooperating firms of all scales can be embraced by a VSM-like structure even though individual component firms may not be "viable" over the same temporal scale as the larger system. Upon their demise their position and function in the whole would either be replaced or the system augmented to achieve the continued functionality of the larger entity.

Chapter 3.4.5.4: GHOST – Macro or Micro Economics?

Chapter 3.4.5.4.1: The Price at Transfer not the System

GHOST is a model that accommodates a different causal structure and definition of Time into a bilateral pricing model for the transfer of assets. Whilst it recognises a particular type of systemic structure it does not dictate it by assuming it static, rather, as a heuristic, it adapts to changes in structure to inform decisions on strategy. The initial systemic structure it adopts is recursive [see below] but the point at which the particular ATPM enters this will determine the initial model parameters but thereon it requires enquiry of the higher and lower recursive levels in order to confirm their structure and adapt the parameters.

Chapter 3.4.5.4.2: What is Macro and Micro?

GHOST does not bifurcate between two sets of economic approaches "Macro" and "Micro". Its principle assumption is that in order for a transfer of assets to occur parties must agree mutually acceptable terms and is able to carry out those obligations. The process is therefore the same at all scales although the parameter values may change as properties of the recursive level determine them, the following is a sketch of the different levels and parties involved figure 123:

Higher Recursion		Lower Recursion
National/Federal Government		Local State or County Level
Federal/State/County		Enterprises
Federal/State/County		Agents

Figure 122: State Governance Recursion Levels in Influence Maps

and is not a hierarchical but heterarchical structure, for instance the relationship between federal taxes and the agent/enterprise is the contract to supply assets and services within a defined set of boundaries. Who sets the level of services and types of assets is relevant to the ATPM as a process only in as much the structure of the higher level of recursion determines the Time parameters and ability to deliver the returns required.

In this sense Macro or Micro is more a sense of from which perspective is taken; macro being top-down whilst micro is bottom-up. The issue will be from what levels of recursion these respective views points start, as they will alter the properties of the parameters.

Chapter 3.4.5.4.3: The State as a Viable Recursive Structure?

Systemically it was noted that a timeframes were required in order to determine stability, the first being the elapsed time the system cycled through its processes and then the resilience that the process has over a longer return period to prove it was not a fluke but a repeatable independent entity. Commercially this was paralleled to the development process of an enterprise through initial stages to development and then its transition into another venture or dissolution – The Life Cycle.

Viewed as a process The State likewise has a Life Cycle and though emphasis may change the sustainability of the State depends upon the persistence of the collective shared views of its supporters. Viable could therefore be considered a bounded condition but that may, or not, persist longer relative to individual enterprises and agents.

The defining condition between an agent, enterprise and higher levels of recursions is the increasing aggregation of components from lower levels into sustainable entities that meet the condition of “Autopoeitic Closure”. If the State exhibits these requirements then one could say it is a viable recursive structure, if not then its structure may well perform certain functions but its viability is in question.

However it is part of the heuristic processes embedded within GHOST that the properties of both higher and lower recursive levels are determined in order to establish their relative timeframes.

We shall see in Chile and Bankers Trust a distinction made between The State, The Legal Framework and Government, the latter being the organisation established to implement the strategy of the State. We also noted that of its own the State is a recursive level but relies upon its components, individual agents and enterprises, to ensure its survival therefore the separation of its active components from the operations of The State does not make it a system of its own and therefore not viable: Deconstructing the cybernetic aphorism “The Purpose of a System is What It Does ‘POSIWID’” a “System” is described with “purpose” and “activity”, therefore without the activity the purpose is redundant.

Chapter 3.4.5.4.4: The ATPM and The State

As previous mentioned GHOST is primarily focused on adapting existing Asset Transfer Pricing Models to correctly identify structural and Timing properties of the recursive structures that surround and are within the strategic focus of a transaction. This approach will have individual and collective ramifications.

The individual objectives concern the proper pricing for risk and the consequent development of adequate cash flow to form an optimised liquidity base for the transaction. Collectively this approach impacts the market by changing the market dynamics each time a transaction is consummated and gradually improving the success of portfolio returns with consequent pricing improvements for future transactions: The latter can be explained as follows. A simple pricing approach to portfolios of risk is to add the mean probable default value to the individual risk price of transaction in focus or the default of some is paid by the success or the rest. In essence this is an insurance approach (the premiums of the many pay for the claims of the few) but the balance between probable default value and aggregate returns vary significantly between insurance, equity and debt portfolios.

Embedded within this concept are the issues of: value, time and discount rate because they can change significantly by recursion level: the main being the relationship between Time-Scale and Discount Model as noted by Axtell (Axtell and McRae 2008). These have material impacts on the debates in monetary philosophy regarding inflation and deflation that will be discussed here and under Taxation and Timing.

An important debate recurring in most mature economies is the management of value(Goetzmann and Rouwenhorst 2005) and comparative wealth(Beinhocker 2006) of which there is one aspect dealing with the supply of money that is unique to the State and worthy of being addressed here as the State is not the highest in the recursion framework. The strategy used will depend upon the degree of current value destruction, the strength of political will and the average ability of the population to understand the choices being made.

Chapter 3.4.5.4.5: Value, Money Supply and Time

It is generally held that expansion and sustained inflation are respectively good and bad for an economy as the former has relatively little effect but the latter can intrinsically destroy value. How to redress the problem in crisis situation has exercised governments post the 2008 Crisis. For our purposes here it may be worthwhile reviewing one aspect of this dilemma as it relates to feedback loop between Money Supply, Time and Recursion Level.

In a global economy a single State is no longer the highest level in a recursive framework however it does possess the ability to print money in a fiat economy. The main problem arises when considering how to redress the imbalance between existing liabilities, current and future assets. In short how fast can liabilities be devalued and new asset value accumulated to rebalance the accounts? History has supplied a simple approach being the Talmudic tradition of the Jubilee Year where debts can be written-off or down once in every 50-years.

This is useful in a simple agrarian but perhaps not in a complex secular society, especially if the average life span is increasing beyond an average 50-years and the inflation rate has been geometric over the period. In addition there are feedback loops between calculating the value of assets and liabilities principally the discount rate chosen that embed Time as a constant but which we show is in fact relative in a granular network economy.

Let us propose a simple example. Sustained inflation has caused a bubble that has left an economy weak, a strategy of increasing the amount of money in the market is proposed but there is a dilemma as to how to raise the level of tax flow in order to redress the State Balance Sheet. Some questions are as follows: What amount of money supply should be considered to create mild inflation through a government subsidiary buying the bonds; can inflation be controlled; should deflation be allowed; and what taxation should be considered?

The detailed analysis of this example is outside the scope of this thesis but there are certain aspects of a structural and temporal nature that arise when considering it from GHOST's ATPM approach, especially the feedback loops on taxation mentioned below.

When considered as coupled oscillators the State and its components, from which taxes are collected, the strength of the network and its links determine the optimum performance achieved. In a recursive network the relaxation rate, or perhaps the response rate, when implementing changes in revenue generation will determine the timeframe and the number of connections the complexity of collection. If the lower level components were performing sub-optimally then a natural local behaviour would be to keep as much cash within the system until a balance is reached. This has all the characteristics of a chaotic system.

The objective of increasing money supply to injection mild inflation into the system can be likened to weakening the bonds between components, which in a dynamic system, increases the level of potential chaos, as coupling within the components is not distributed evenly if at all. The effect may be achieved on average but skewed to those components that have a higher imbalance between assets and liabilities: They absorb the energy. This does not seem favourable to lower levels components where primary production occurs.

The manner in which the above is executed through a State owned subsidiary is interesting. The State is a system only because it executes the shared views of the components through a contract with those components. On its own any subsidiary of the State is merely a management company operating under the auspices of a higher contract and wholly owned by the State. To achieve the stated aim of devaluation the accounting rules governing conglomerates would have to allow non-consolidation of the debt issued.

In consideration of whether inflation or deflation is more preferable the timeframe under which any inflationary impact would be felt depends upon response rate or take-up within a wide set of producing components, the level of the gradually rising inflation rate and the degree of adjustment required. The latter would only be materially influenced if the internal discounting rates on both assets and liabilities fuelled by the inflation rate is high enough, but we have seen these are also dependent upon a complex relative timeframe.

On the other hand deflation is an overt austerity measure that directly affects the entire network in proportion to the density of imbalance within local components with consequences on liquidity flow if the larger components also happen to be the lending gatekeepers.

The difference between the two timeframes in effect is the decision fulcrum. If an efficient taxation regime can be created to spur repair then this may influence the choice but this is a liquidity issue and solved by the efficient distribution of liquidity within the network.

Returning to the State as a lower level of recursion within the global economy begs a question as to whether this problem is isolated to this State? In reality the depth of the problem would be proportional to the extent of the wider economies woes, which is the case in the 2007 Crisis. Then only by the intervention of external buyers of liquidity instruments would the strategy above potentially work and only then if these buyers were convinced that the returns would be achieved.

Chapter 3.4.5.4.6: GHOST, Tax and Timing

The “disconnect” discussed in “Philosophical Economics and Reality” exposed the failings of Classical and Neo-Classical economic models. The reliance on assumptions of behaviour and perfect communication meant that timing difficulties occurred between the request for and the actual receipt of revenue for the State.

If one considers the relationship between the State’s management, government, and its revenue components as a loosely coupled pair of oscillators (each have their own cycles) then in System terms it is not surprising that discontinuities can arise as the timing between internal “states” becomes chaotic. Further energy input by government to repair seeming shortfalls actually amplifies the problem by increasing the variety of taxation links to components. Consider them nodes, as this is an issue raised next.

GHOST, with its focus to correctly price the transfer of assets ab initio, takes into consideration the network structure of components (both above and below) and the time taken for data to travel between and within them. This elapsed time benchmarks the response time, or metabolic-rate, the State should consider when deciding changes to or new strategies. The fragility of the network also depends upon the number of connections to the “nodes” and their coupling strength, remembering that this is a set of coupled oscillators.

If GHOST's objective is achieved, regardless of recursion level, and the correct adjustment for component "relaxation time", capacity to pay and structural performance then the outcome should be a "balanced budget" and liquidity flow: It being assumed that only viable contracts are undertaken. In this case the natural liquidity flow, including any contingency account, has a collective effect in stabilising timing miss-matches and the natural response in government to perturb the network with more initiatives if liquidity dries up.

The technical manifestation of this issue arises in: the network timing calculation; the structure of cash flows for strategic purposes; and any discounting calculations used in the valuation methods.

Chapter 3.4.5.4.7: GHOST, Braess and the Proliferation of Taxation Instruments

Returning to the State as a coupled oscillator and the links being between component nodes of a network we could see parallels between traffic and taxation planning, each wishing to optimise flow.

Braess's Paradox addresses a situation where the reduction in the links between nodes of a network, reduce the roads available to traffic, may seem a local restriction but has a collective benefit. Researchers are becoming increasingly aware that this is a pervasive characteristic of social (Apt, Markakis et al. 2013) and financial networks (Caccioli 2009, Caccioli and Marsili 2010) and GHOST's response should be to look closely at the optimisation of any network where product proliferation increases the fragility of the system in focus.

A potential issue for the State is that the proliferation of taxation avenues reduces overall collection by: increased time lags; arbitrage arising from the definition of the target boundaries; and natural production business cycles making the revenue uneconomic through unintended feedback effects.

Some of these feedback effects already exist in as much high corporation tax lowers the incentive to produce, as does high personal taxation reduce the desire to earn more. These are both amplified when the discussion on inflation and deflation are considered particularly in the field of pension fund deficits if the gap between assets and liabilities is higher than either strategy sustain over a long timeframe.

Chapter 3.4.5.4.8: Signalling as a Method of Economic Control

Signalling as a method of economic control is not new in commercial circles but suffers from several drawbacks especially when fast but not high bandwidth communication is available. Essentially the theory goes that instead of the central bank actually setting rates or publishing reports on actual data they send signals to the market of likely positions in the future thus through behavioural economics the market will adjust strategies and through the various market feedback loops adjust inflation or set boundaries to market activity and therefore prices like mortgages.

Firstly, what is meant by “fast but not high bandwidth communication” and why is it important? Fast communication does not mean, nor need, telephonic or computer technology, it occurs naturally in societies where an evolved language is shared in a densely populated environment. Financial bubbles have usually occurred in societies where individuals, or families, keep the network of available resources to invest to a low degree of freedom. High bandwidth is another Information Theory term relating to the amount of data that can be carried at one time. It could also refer to the amount of information being circulated.

We know from the assumptions in Efficient Market Hypothesis dependent economic models that to work both of these conditions have to work across the entire market but we also know from experience that this does not prevail.

Signalling, from an information theory perspective, means that data is sent, hopefully received in the correct form, applied to an internal model that then instructs strategies to act. If we assume this process is at work in economics the signals could indeed be fiction but over time this fiction will form a pattern compared to other signals from real events. This comparison process informs the internal model of the receiver and opaque to the sender until the market itself starts to ignore false signals.

A second problem is a human dynamic. No boundary is impervious and to some extent leaks. How this leak is transmitted depends upon the medium of the boundary but in commerce usually formed by human components corporate secrets are seldom secure for long and in a high turnover of staff industry the ontological framework supporting a governor sending false signals will rapidly be revealed.

Chapter 3.4.6: Noise in the Conversation

Whilst Klonowski provides a framework for the conversation an important element to be aware of is noise between the buyer/seller. As Duarte (Duarte 2008, Duarte 2010) illustrate this can come in various forms as follows (figure 124):

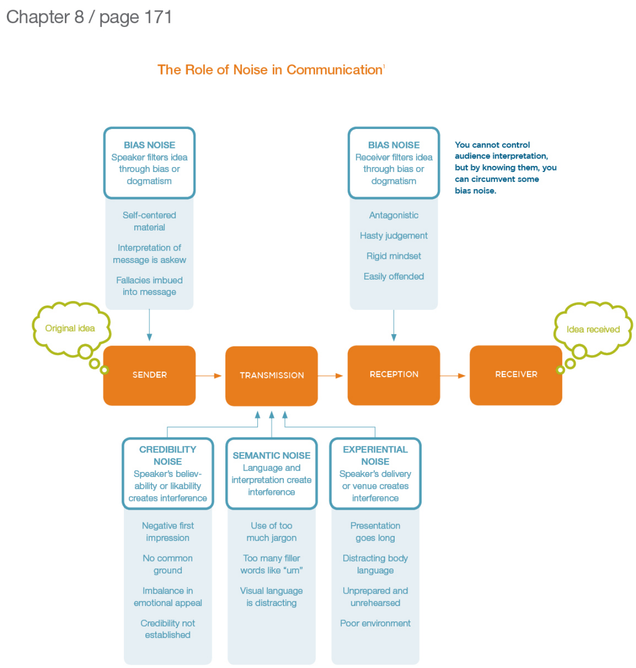


Figure 123: Duarte - The Role of Noise in Communication

GHOST adapts this model to include a self-referential duplicate before the "receiver" as a reminder that recipients have their own internal model that may compete with the data and GHOST's objective as follows – figure 125:

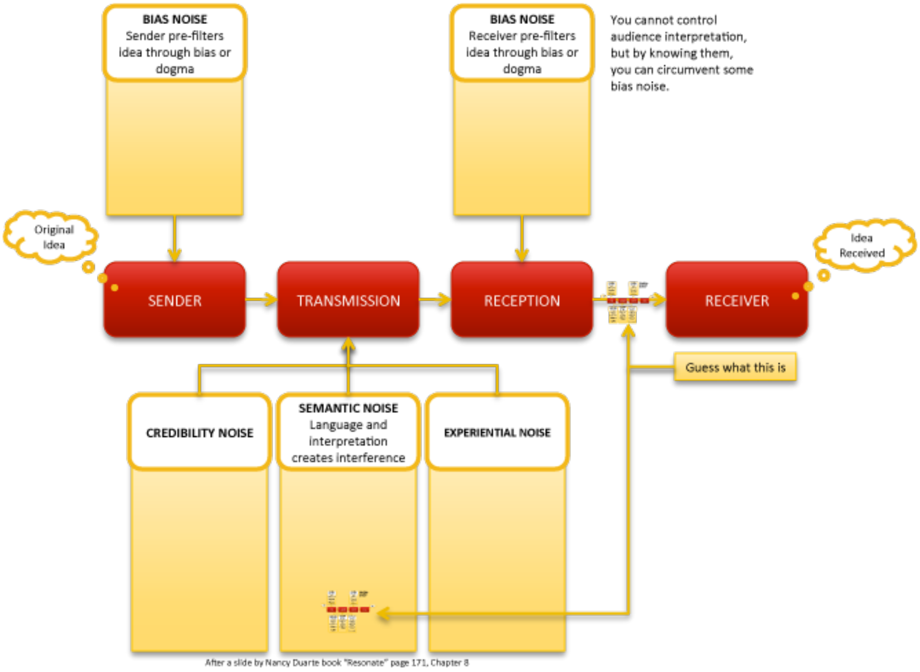


Figure 124: Duarte Drawn as a Template for Conversations

Chapter 3.4.7: Applying the Cellular Potts Model

Having derived the structure of the seller's operations and commercial embeddedness within its environment the benchmark VSM now becomes the topographical structure against which that structure can be tested.

Using the parameters derived from the Network created by the Agents (the Seller's) to modify the VSM according to a set of test scenarios the CPM derives a set of outcomes in a similar manner suggested by Beer/Casti (Beer and Casti 1975). These outcomes are probabilistic and vectors by nature that are then compared to the sellers expected returns by the buyer.

GHOST is a Thought Experiment that can be used in either a factual or counter-factual manner in line with the historical use of these devices.

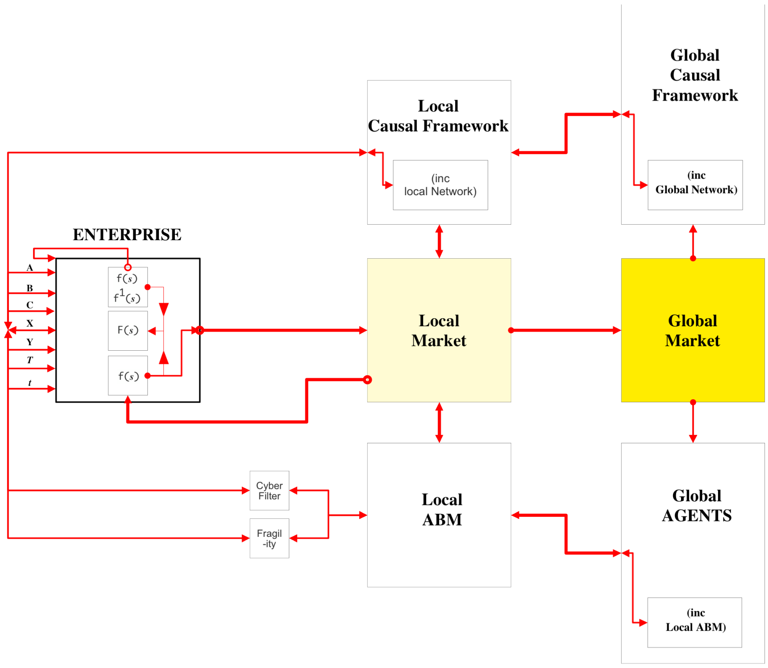


Figure 125: C&M Amended for Recursive Structure & Causality

Chapter 3.4.8: Summary

The objective was to create a framework by which insights from Complexity Economics and System Theory may augment critical parameters within Asset Transfer Pricing Models.

The first step was to identify a common framework for all ATPMs then establish as abstraction, a meta-ATPM or *m*-ATPM, such that from the resultant model one could build a taxonomy and methodology. This was done by identifying the common elements to all investment processes and risks using Klonowski's process for venture capital as a guide and rationalising the component risks from first principles and how they interacted.

The next step was to identify material differences in the traditional approaches using the derived taxonomy and literature review. This highlighted the exclusion of recursive structures as causal frameworks and temporal scaling in existing quantitative analysis as two significant elements to accommodate. In addition these questioned how structure influence governance and communication of market activity were handled within and without the target investment opportunity.

As pricing of asset values is currently heavily dependent upon non-standard methods to identify how these and the relative business risks are determined a method was required by which they could not only be incorporated into existing asset/liability pricing models but done so in a cost efficient manner.

The result was the creation of GHOST, a General Heuristic on Systems and Time, which would identify the functional structure of the enterprise using a recursive benchmark model and then to incorporate structural imperfections as temporal variables on the sustainable performance of the enterprise. Competition and structural resilience were to be measured using a Network Theory model sourced from developing theories in biology and catastrophe modelling. Each would be coupled to the other in order to develop a recursive rest of co-dependent variables – the agent-based model providing guidance for structural topology and the resultant Network the topology for the agent-based models.

As these are dynamic models outcomes can vary according to future activities and at variance to the expected investment result. GHOST would therefore be designed to run continuous using a budgeting process similar to Morlidge and provide a set of boundary conditions that would act as feed-forward alerts for the investor. The only variance from the Morlidge benchmark would be the incorporation of the temporal scales used in the budgeting process.

GHOST would capture changes in structural dynamic through the use of the Viable System Model by using an influence framework designed to capture the recursive structure of the firm. As the VSM has a mature and dynamic performance model included this was deemed suitable to use as the basic performance metrics with the same modification as to temporal scale and dynamic topology. The latter prompted by Beer's own use of catastrophe theory in "Investing Against Disaster in Large Corporation" wherein strategic changes would be necessary dependent upon the state-space of the enterprise. It being noted that in 1975 when that paper was written agent-based models had little general publicity and the ability to model their emergent behaviour severely limited to large and costly computers that can now be replaced by cheap available hardware and software capable of braiding the different aspect of GHOST processes.

It is proposed that this is structured as a recursive network open to analysis by a range of techniques being Managerial Cybernetics (Beer 1972, Beer 1979, Beer 1985), System Dynamics (Forrester 1975, Forrester 1990), Q-Theory (Li and Zhang 2010) (Jacobson and Yan 1998), Network Theory (Braess 1968, Strogatz 1994, Watts 1999, Bianconi and Barab√° si 2001, Watts 2002, Barabási 2003, Strogatz 2003, Watts 2003, Barabasi and Oltvai 2004, Barabasi and Oltvai 2004, Vazquez, Dobrin et al. 2004, Carrington, Scott et al. 2005, Nakano and White 2006, Caccioli 2009, Crook 2009, Ostrom 2009, Schweitzer, Fagiolo et al. 2009, Alessandro 2011, Vitali, Glattfelder et al. 2011) and Agent Based Models (W. Brian Arthur 1989, Arthur 1999, Arthur 1999, Arthur 2005) (Durlauf 1997) (W. Brian Arthur 1997).

The resultant set of recursive economic eco-systems exhibits the collective behaviour of Agent-Based Models but also the structural properties of complex networks. Under GHOST these are complementary in as much collective dynamics can inform agent behaviour on the current landscape whilst changes in the network structure can inform the topology for the agents. Both are informed the ATPM’s causal framework and temporal parameters that iteratively modifies the project’s outcome in real-time. What was seemingly absent previously in commercial economic analysis was a causal framework linking these attributes to produce changes in temporal scales. GHOST uses a heterarchy generated by Viable System Model as a template for optimal performance and an “Influence Graph” that informs parameters within both analysis types. By identifying only those parameters that need modifying it is not necessary to change the bulk of existing ATPMs.

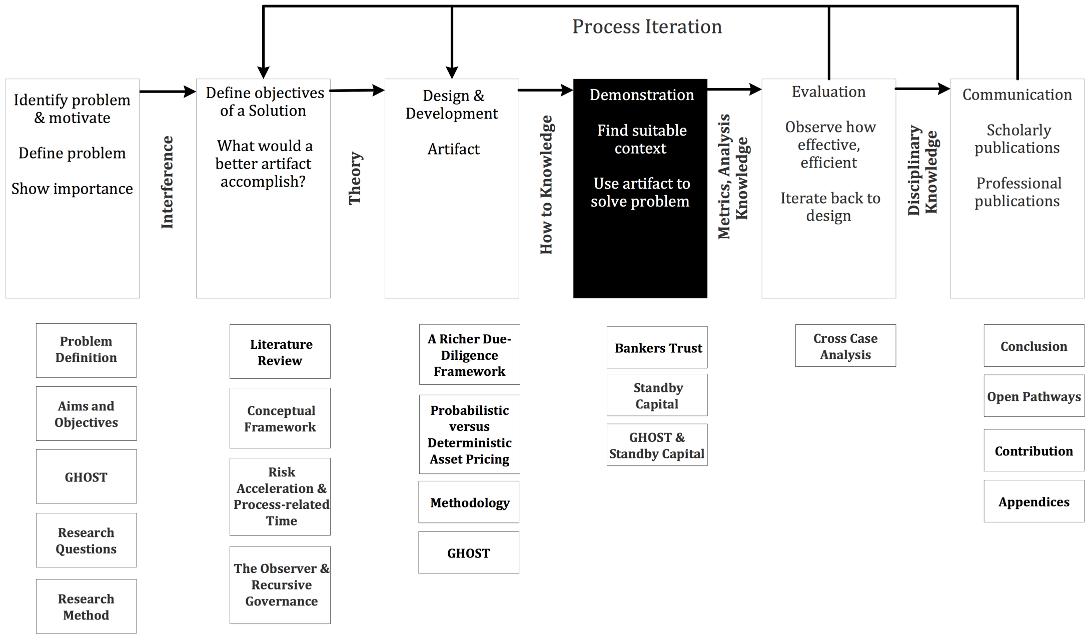


Figure 126: Chapter 4

Chapter 4 – Demonstration and Context

Chapter 4.1: Bankers Trust

Chapter 4.1.1: Introduction

To understand how GHOST would be applied it is first necessary to understand the reflect on the genesis of the VSM, provide a critical analysis of a past application for Bankers Trust USA ("BT") and then illustrate how that application highlighted the benefits of not only the VSM, the deficiencies of data to provide the correct model parameters but also where GHOST advantages.

Like Chile for Stafford Beer (Medina 2011) BT started with a conversation by the insurance risk manager of BT, Douglas G Hoffman, investigating BT's exposure to weather losses in the West Indies. Discovering that various field offices of BT had debt and derivative exposure to property in the general area the question posed was "what other unaccounted accumulation existed that may expose the balance sheet?"

Chapter 4.1.2: Accounting and Risk – 1997

As discussed in the Literature Review the development of Financial Reinsurance had been followed by regulatory reaction to accounting abuses triggering insurer fraud and failure starting with the Kenilworth Insurance Fraud in 1982 but more recently by the Lloyds of London "spiral" issues (Stanard and Wacek 1991, Bain 1999). In 1997 the relevant regulation for BT and the proposed Contingent Capital product was FAS113 (NAIC 2004, FASB 2008, Ernst 2012) and with that regulations definition Guill (Guill 2007) also notes BT's definition of risk as Knightian (Knight 1921).

In order for the proposed contract to be approved as risk transfer and accounted as such ex-anti drawdown the ruling benchmark for risk participation was at least 10% of principle forgiveness. Ex-post drawdown the two portions, insurance-like and debt/equity, would be accounted for in the normal fashion.

Along with the accounting and regulatory bodies the three major credit rating agencies (Moody's, Standard & Poor's, and Fitch) would also be consulted as they had a major influence on the cost of capital for BT.

Chapter 4.1.2.1: Why was the VSM to be considered?

Being aware of the impending law suits from Gibson Greetings and Procter & Gamble, and seeing a major hurricane imminently about to hit a range of BT financed properties, Douglas Hoffman requested precautionary measures before another major financial loss occurred. Prompted by the concept of portfolio contagion Hoffman searched for Balance Sheet protection. This solution needed to be cost effective especially because existing financial instrument such as equity, preference shares and debt was being economically denied in the marketplace. The proposed solution was to address the two issues adverse commercial catastrophes have on enterprises, being a sudden loss of liquidity and capital, by designing a Standby Capital instrument that met the then regulatory capital rules.

Chapter 4.1.2.2: A Description of their Objectives

As noted in the case of Chile Bankers Trust also needed to find solutions to sustaining their balance sheet. For BT the explosion in the derivatives market fuelled by an inflating global economy had exposed its balance sheet to increasing volatility from Russia[xliii] and the property markets. Though their models had been sound so far a new appreciation of the risks involved had brought the realisation that their core capital was under threat. BT's objective was to obtain an efficient supply of capital by which they could weather economic storms. More importantly they needed the marketplace confidence in their governance and risk management programs as previous placement of capital had seen increases in price following the Gibson case.

In terms of Game Theory (Binmore, Kirman et al. 1993, Binmore 2007) both were in the Prisoners Dilemma, Chile with the USA and Bankers Trust the US Regulatory Banking Authorities. The pay-off profiles for these games did not look good so both had to change strategies.

Chapter 4.1.2.3: A Balance Sheet view

One cannot directly compare a nation to a business but if each is modelled in terms of their complexity using the same modelling language then it may be possible to infer as to their relative influence in a larger system modelled along the same lines.

This is the process that GHOST applies by using the VSM as its methodology. When choosing the metric with which to infer relative influence further complications occur if that metric is economic in nature and a large time gap separate the two entities. For instance if we were to compare Chile's Balance Sheet, as a nation within its global economic milieu, to that of BT twenty six-years later, what common reference point should be made and what currency used?

In international trade this issue has surfaced each time an investor (of whatever form: individual or government) uses an ATPM to assess the potential of investing in a government bond. Thankfully the Geary-Khamis, otherwise known as the International Dollar or 2000 US Dollar, was established to achieve this in the international community first by Roy Geary in 1958 and then developed by Salem Hanna Khamis in 1972. Based upon the twin concepts of "purchasing power parities ("PPP") and international average prices for commodities it was developed to overcome the inherent flaws of GDP and exchange rates calculation.

The following table illustrates the process by using the United States as a common reference point in each milieu and comparing Chile for the respective period of 1970 – 1973 and 1992 - 1995: The former to gain perspective on the relative countries own development and the latter to then enable a comparison to Bankers Trust whose main development period was in the 1990's.

Taking BT, an example analysed later, as a component of the US Economy we could infer that BT's assets under management grew from being 38% to 95% larger than Chile's GDP for the period 1992 - 1995. Though an imperfect comparison the scale indicates the comparative influence a potential adverse economic catastrophe may have on a business – figure 127:

Geary-Khamis dollars	**GK$**			
	1970	**1971**	**1972**	**1973**
Chile				
Population '000	9,369	9,540	9,718	9,897
GDP percap	5,231	5,597	5,429	5,034
GDP 'm	49,011	53,400	52,752	49,816
USA				
Population '000	205,052	207,661	209,896	211,909
GDP percap	15,030	15,304	15,944	16,689
GDP 'm	3,081,900	3,178,106	3,346,554	3,536,622
Chile/USA %	1.59%	1.68%	1.58%	1.41%
	1992	**1993**	**1994**	**1995**
Chile				
Population '000	13,573	13,788	14,000	14,205
GDP percap	7,483	7,869	8,182	8,910
GDP 'm	101,564	108,507	114,544	126,577
USA				
Population '000	256,894	260,255	263,436	266,557
GDP percap	23,298	23,616	24,279	24,603
GDP 'm	5,985,152	6,146,210	6,395,858	6,558,151
Chile/USA %	1.70%	1.77%	1.79%	1.93%
Bankers Trust				
Total Equity US$	4,121	4,534	4,704	4,984
Leverage Ratio	6.05%	6.28%	5.26%	5.12%
Assets Managed US$	68,116	72,197	89,430	97,344

Figure 128: Balance Sheet Comparison Between Chile & Bankers Trust

the volatility surrounding the associate liabilities of Chile's assets from Nitrates, Forestry, Copper, Brown/White Goods Manufacturing and Tourism would be considerably lower than Bankers Trust who had a large exposure to highly leveraged derivatives and a common economic trigger (The full exposure was not fully disclosed in its balance sheet due to the nature of accounting practises at the time).

Chapter 4.1.3: Deriving then Applying the VSM and CyberFilter in Bankers Trust

The genesis and development of the VSM has been described but the diagrams used in Chile and BT differs in a subtle but material manner. Though Medina (Medina 2011) offers us two VSM diagrams the following is a replication of Stafford's diagrams from "Brain of the Firm"(Beer 1972, Beer 1985) used as their basis – figure 129:

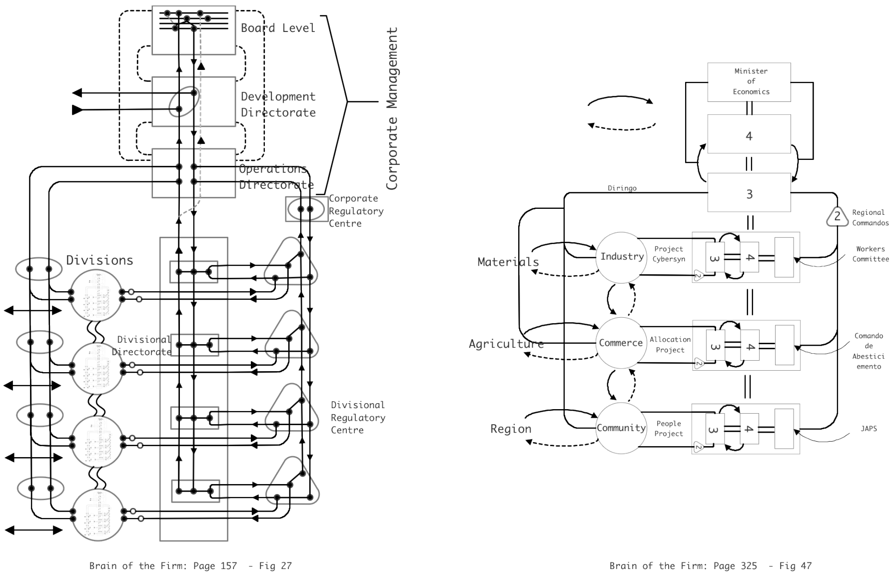


Figure 127: Replication of the VSM from Brain of the Firm - A Stafford Beer

Compared to the version used in Bankers Trust here – figure 130:

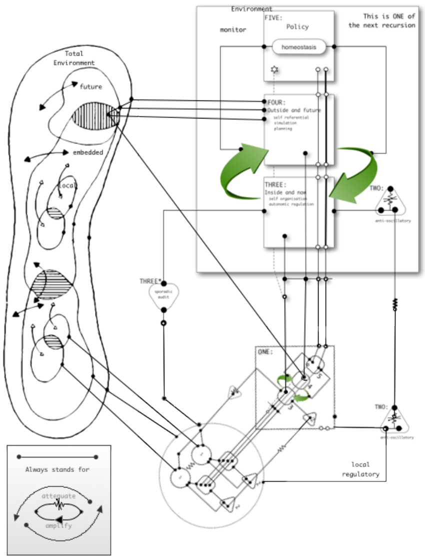


Figure 128: Replication of the VSM - Diagnosing the System

The variation concerns the explanation of the connecting lines as discussed in Conceptual Framework and the inclusion of a new “System 3*”, this first appeared in “Diagnosing the System”(Beer 1985).

Though seemingly a small change the explanation of the lines (box bottom left) concerns the position that each individual within the network has an internal model that would either amplify or rectify signals on a bilateral basis. As mentioned within the Literature Review and Conceptual Framework the complexity of monitoring communication networks is geometric unless an adequate governance system is applied to manage the variety of states within the system.

As the BT project began it became obvious that the complexity of a rapidly expanded global investment presented problems of communication both in governance and culture. Developing a VSM styled map of BT for variety management was therefore necessary as was an implementation method.

This conversation naturally led to the concept of and application of the various models within BT and how their outcomes were consolidated.

Chapter 4.1.4: Bankers Trust Risk Management Approach

Guill (Guill 2007) delineates the development of Risk Adjusted Return On Capital (“RaRoC”) which, being a per contract capital calculation, assisted with the request for granular data but, as equally observed in Guill, the credit rating per contract/client was still a subjective matter applied by internal management. Although Guill goes on to describe a personal view of BT that the author would agree with the principle difference between Guill and the team was that the latter had come from a Lloyd’s of London reinsurance background with experience of how discounted pricing and uncontrolled (re)hypothecation of assets/liabilities could rapidly mock capital calculations (Bain 1998, Briys and Varenne 2001, Banks 2005). The latter also bred a distinct lack of respect for statistical confidence levels and correlation assumptions as databases extant at the time only showed experience of derivative trades with any volume for the previous 10-years at best (as Guill notes) but as reinsurance practitioners the team also knew that underlying risks seldom homogeneously follow the terms of hypothecated portfolios as the U.K. mortgage crisis in 1991/2 would show and the difference between U.S. and U.K. mortgage markets would attest in the 2008 Credit Crisis.

Data and organisational structure had therefore become a major set of critical factors facing the advancement of a VSM framework. In addition to which, as Guill outlines, the marketplace in 1996-8 coincided with the development of a globalisation process and the demise of LTCM at the heart of which was the types of discounted risk models in credit and equity that was repeated in the 2008 Credit Crisis. Model risk was therefore added as a third criteria.

The last of the major issues facing the team was the size of the contract to price: $1,000m. Given that two previous traditional placements had seen an increase in pricing, and BT's reputation had not changed from Guill's candid retelling of RaRoC's development, the structure of the Contingent Capital product had to show a remoteness of trigger but along with it the team's confidence that the VSM approach would overcome unknown aggregation risk: Essentially investors would want to known the outcome of low probability of trigger and price was achievable through good governance of the whole.

The following is a reflection of BT's performance until 1997 when the team was placing the Contingent Capital Product (Guill 2007) page 41 – figure 131:

Year	Net Income (after-tax, in millions)	Return on Equity (%)	Year	Net Income (after-tax, in millions) [3]	Charge-Offs for LDC Loans (in millions)	Return on Equity (%) [3]	Return on Equity - Excl Charge-Offs for LDC Loans (%)
1966	30.3	7.71 [1]	1983	261.2	0	14.59	
1967	43.2	10.62 [1]	1984	306.8	0	15.70	
1968	41.0	9.61 [1]	1985	371.2	0	15.83	
1969	41.0	9.31 [1]	1986	427.9	0	15.73	
1970	55.5	12.26 [1]	1987	1.2	636.0	0.00	21.05
1971	52.0	10.98 [1]	1988	647.7	0	20.27	
1972	67.6	13.57 [1]	1989	-979.9	1600.0	N/M	25.99
1973	60.6	11.48 [1]	1990	665.0	0	26.74	
1974	70.7	12.26 [1]	1991	667.0	0	23.10	
1975	63.2	8.94 [1]	1992	761.0	0	23.10	
1976	56.5	7.80 [1]	1993	995.0	0	26.33	
1977	61.3	7.47 [1]	1994	615.0	0	13.38	
1978	81.8	9.56 [1]	1995	215.0	0	3.98	
1979	113.7	12.78 [2]	1996	612.0	0	12.90	
1980	213.8	17.26 [2]	1997	866.0	0	15.60	
1981	188.0	15.52 [2]	1998	-73.0	0	N/M	
1982	239.0	15.78 [2]	1999 (Q2)	-1948.0	0	N/M	

[1] Calculated from reported Net Income and Shareholder's Equity
[2] As reported, including redeemable preferred shares
[3] As reported

Source: Bankers Trust Annual Reports, by year

Figure 129: Bankers Trust Financial Performance 1966-99

Chapter 4.1.5: Due-Diligence – Operational Approach

BT's advantage of central risk data also allowed the team to draw upon the department structure within business lines. This started the development of the VSM layout, discussions upon the recursive nature of the products sold; that would then provide the basis for a conversation on variety management.

Given the primary organisational structure of BT had hubs in London and New York that reflected the team's own meetings with BT's management was optimised through video conferencing. This also allowed the team to source investors in the major financial centres of London, New York and Bermuda with travel time kept to a minimum.

Chapter 4.1.6: Outline Contingent Capital Structure – Bankers Trust

With the premise that a programme was to initiated the reinforced the operational viability of BT, aggregate asset/liability values were to be developed across a recursive model framework and that variety management was to reinforce both a contract was constructed with the following strategic aim:

> As the net performance of BT dropped by more than 80% liquidity was to be supplied at an overall cost that would not impact future performance and was regulatory acceptable.

The major issue was the supply of liquidity and its approval according to the accounting/risk criteria above. To this end a contract structure with at least 20% principal forgiveness was deemed suitable.

At the time, 1996/7, the U.S. authorities had allowed a special type of Trust Preferred Product (Zuckerman 2011) ("TRUPs") to be allowed as capital for a bank (previously it had only been available for corporates). This product offered a structure suitable for Contingent Capital as a bankruptcy remote trust could hold the contract in return for the fees paid by the bank.

On its own the TRUP is a conventional financial product that is on-balance sheet although with certain tax advantages on the fees (interest) paid. The bank would traditionally have drawn it down ab-initio placement. The strategy however was to place an obstacle to drawdown that rendered the whole contract off-balance sheet in the form of the trigger. The next objective was cost.

The obvious costs associated with Contingent Capital are the ex-anti fees prior to drawdown, the ex-post drawdown interest and the ultimate redemption of the outstanding principal. In order for the second part of the strategy – "*would not impact future performance*" – to be effective the net interest cost upon drawdown would have to be close to or below zero which seems counter-intuitive. However if an element of the drawn principal were to be forgiven, like insurance, its net effect on the contracts returns would be to render the interest cost "close-to or less than zero" depending upon the amount placed in that fashion. This would mean that there were two types of investor working contemporaneously: a traditional TRUP investor and an insurer.

Given that TRUPs were regulatory acceptable the penultimate objective was to find an audit opinion that confirmed the whole contract "off-balance sheet" until drawn according to ruling accounting convention (see above) along with an acceptance by the three major rating agencies of its merit as capital. This work was carried out successfully in both London and New York.

The final objective was to place the contract given its unique nature. The team considered Merrill Lynch the best agent to place the TRUP given their ability to finish large US-based client debt and, given their collective experience in placing reinsurance globally, retained the insurer portion to themselves. An outline term-sheet was constructed and investors targeted with success.

The following is an outline of the term-sheet's main points[xliv]:

Client:	Bankers Trust plc		
Contract Type:	Contingent Trust Preferred		
Initial Principal:	$1,000,000,000 split		
	$ 800,000,000 Trust Preferred		
	$ 200,000,000 Insurance		
Annual Cost (ex-Anti):	Trust Preferred	0.85 %	
	Insurance	4.502%	
	Combined	1.580%	

See Appendix IV for a flow diagram of the whole process.

Chapter 4.1.6.1: A Devastating Blow and Market Collapse

By the end of 1997 the VSM map had begun, the contract investors targeted and a meeting set to official start placement when market sentiment turned on the news of LTCM''s impending demise and the Russia crisis began to accelerate. The net result was to end in BT's sale to Deutsche Bank and the projects close. However the following expands upon the VSM work and its comparison to Beer's own development in Chile.

Chapter 4.1.6.2: Chile, Bankers Trust and GHOST

In the Conceptual Framework a recursive influence map was created to model the levels of complexity involved between the target enterprise and its environment. Comparing Chile and BT the table below shows each as the start $\mathbf{R_0}$, a negative sign represent an endogenous level and positive an exogenous – Table 9:

Table 9: Comparing the Recursive Complexity of Chile & BT

Recursive Structure	Chile	Bankers Trust
Supranational Enterprise	R_{+3}	R_{+4}
Transnational Governing Body	R_{+2}	R_{+3}
Transnational Enterprises	R_{+1}	R_{+2}
National Society	$\mathbf{R_0}$	R_{+1}
National Enterprises	R_{-1}	$\mathbf{R_0}$
Regional Society	R_{-2}	R_{-1}
Enterprises	R_{-3}	R_{-2}
Local Society	R_{-4}	R_{-3}

Sole Traders	R_{-4}	R_{-4}
Family Groups	R_{-5}	R_{-5}
Individual	R_{-6}	R_{-6}

The complexity model shows the levels of interaction above and below the target and may be useful if we infer that temporal delays in communication are increased in some non-linear way due to inefficiencies in governance that decreases the available bandwidth for the messages to get through. It was previously shown that the variety in a system has the following relationship:

> **States of a System:** e.g. the total variety of states in a system is $g = S^n$, where g is the variety of states, S is the number of states per element, and n = the number of elements;
>
> **Communications:** e.g. the total variety of states in a dualistic (two-way) communication is $r = n*(n-1)$

This is the Influence Map that is generated within the VSM's structure and applied to the CPM. It also supplies the basis for developing the Network each develops from its agents that subsequently derives parameters influencing the state of the system. In Chile Beer derived these from first principles whereas (with his assistance) the work at BT built upon this work.

The following – Table 10 - compares each with the GHOST components, their availability at the time and how they would currently have been applied. The objective is to criticise the existing models and show where elements of GHOST's ATPM model would possibly have assisted in governance and pricing issues.

Table 10: Comparing Chile/BT VSM/GHOST Applications

Criteria	Chile		Bankers Trust	
	VSM	GHOST	VSM	GHOST
GHOST Structure				
ATPM Models Used	Various undisclosed Anderson non-linear models, CyberFilter approach	Triangulation basis, Recursive governance network, non-linear econometrics, agent-based	A range of VaR and RaRoC models discretely applied to each of the 144 risk cells and globally for treasury management of the balance sheet. Includes insurance risk models.	GHOST is an integrated model and therefore the 144+ models would have been mapped to identify common influences and parameters. The same models would be benchmarked against non-linear models derived from a Vester-like analysis. Recursive structure and accounting issues would have defined overlapping product boundaries and consequent leverage issues. Being a mature market with known agent parameters the local and global markets would have been analysed for temporal activity based upon the products issued and the markets freely available. Effectively imputing a CyberFilter production scenario.
VSM/Recursive Structure	Beer derived model	VSM benchmarked Influence Diagram and Network derived from regulatory governance, shareholding data of the business within the country and their external investors	Beer's Decision and Control model with the extra 3* audit function.	VSM benchmarked Influence Diagram and Network derived from regulatory governance, shareholding data for each product and client. Regulatory influence diagrams would identify liability mismatches and capita adequacy issues
Information Theory	VSM based application of Shannon's work	VSM based but adapted for entities that fail "Beer viability". Exogenous and endogenous structures would be identified alongside the network model to map communication strength, transduction and bandwidth	VSM based application of Shannon's work	The dynamics of a capital market's bank are such that Information Theory approaches would assist greatly in determining the correct level of human interaction for a given position in the state-space of the business. Insufficient focus is put on the

				dissolving of problems by proper levels of expertise in management and separating the languages effectively.
Networks	N/A	Networks are created from Influence diagram and actual data on country demographics	N/A	Network structures are seldom used in banking to calculate the strength of markets and loads being applied. Equally the level of connectedness within the marketplace is not measured and therefore the true maturity of product presentation unknown. This would be identified along with the type of networks staff inhabits to judge collusion.
Systems Dynamics	N/A	Topographical information would influence a Vester-type model	N/A	Seldom is SD used in a bank to model scenarios and yet in this case discrete SD analysis is a useful tool if done in conjunction with local recursive structures and market regulatory inputs.
Agent-Based Models	N/A	Agent models would be created for the prime country: imports and exports; currency; and capital. These would be connected to a set of rules identified for external political influences and internal inflationary factors	N/A	As with the Network comment Agent-Based models are seldom used as a scenario-modeling tool because they require a topology upon which to act upon. The current topologies are not dynamic to changes in network structure, which is where GHOST does adapt. ABM models would inform the discrete RaRoC models of both temporal and structural changes in parameters, and on a recursive iterative basis.
Parameter Comments				
Temporal Criteria	N/A. However it was assumed that a CyberFilter type approach and Beer pragmatism would have alerted	Any Systems Dynamics/Vester model would have identified a structural weakness in the timing of data throughout the country	No temporal adjustment or scaling was applied explicitly as Bankers Trust's model assumed volatility calculations	Bankers Trust is a large corporate and its complexity high but not equal to a country but what is more important is the financial

	production sensitivities but the communication network would have degraded the implementation of such. Likewise no specific adaptive process for capital, interest rate or currency flow would have been activated	especially externally. Supply/Demand characteristics would be in the Vester-Type and Recursive Network-type models therefore alerting the econometric variables to changes in temporal horizons	would cater for such. This was singularly in error as cross department data was not included in each and no direct correlation between products added into the overall models: Volatility parameters or martingales were therefore wildly off. We could not see any account taken for changes in market dynamics or recursive structure, partly because of the secrecy wrapped around the exact models but also the political pressure on the team to implement the placement in light of regulatory concerns on market rumours	innovation creates assets & liabilities that need to be dynamically managed and in real-time. Modeling the temporal horizons for such require a scaling factor related to markets and product not one that comes through a volatility parameter. Differing products may be linked and operate at different scaling factors recursively so collapsing the recursive structure anywhere creates temporal problems for stochastic models. GHOST would identify these through its Recursive structural analysis and Vester Model created for the agent/network models
Structural Parameters	Little structural governance was available at the time as businesses largely ran independently of the government who lack cohesive structure and planning	GHOST would not be influencing the political structure but looking at the influence of that structure on the price of a government instrument is which largely reflected in external networks and markets views	By 1997/8 the impact of several insurance and property crashes had created a string of accounting changes for recognising assets and liabilities in bank's accounts. The repeal of Glass Steagall had major effects on the types of liabilities taken and products offered and liquidity had begun to derive from the money markets and not retail deposits. International cooperation had increased as governments recognised a highly developed networked capital market and major differences in regulatory structure offered plenty of arbitrage opportunities with consequent opacity	144 product cells is far too many for human communication to adapt into a viable entity without a functional overlay map. Therefore GHOST would compare existing structural positions with a functional map but insist communication lines are added to maintain variety management at each new functional product level. This would not have been possible within the Bankers Trust ethos.

			issues on balance sheet results.	
General Comment	It is hard to consider what the country dynamics would have been and moving from a disorder state to even a Beerian recursive order was a feat of modelling but practically the lack of foresight to anticipate the US reaction to a business deal was really what pushed the organisation over. Systemically the country was dynamically un-balanced and would have shown chaotic tendencies, which is what resulted.	GHOST is an Asset Transfer Pricing Model and not a macro-economic, political tool. However in pricing a government instrument the dynamics of repayment include the ability of the country to manage currency reserves and balance of payment, in effect their asset/liability and liquidity management process. GHOST would have identified dislocation in the endogenous/exogenous network but given the immaturity of the global network and its polarisation of political influences it would be hard to say whether a different outcome would have ensued.	The team was charged with identifying a capital instrument that would stand as capital but be priced at an efficient level to allow the board to change its strategy and adapt to new circumstances. Whether this would have “played out” is doubtful because of shareholder pressure on earnings and regulator capital charges. The team was successful in identifying the instrument and the pricing/placement appetite from the marketplace as long as over-sight of operations improved: Sadly too late and with severe difficulties in getting data.	GHOST would likely not have fared any better given the external market and regulatory pressure. The difference between this exercise and the current process is the gathering of temporal data and structure topology to make pricing better. The important difference between GHOST and the work done in Bankers Trust is that the state-space elements are now more mature and agent-based modelling is now available. This brings emergent behaviour as a part of parameter definition where no emergent behaviour was possible before.

In this instance the VSM has been used to recast into a recursive set of levels operating on a functionally diverse basis with the objective to preserve resilience, or as Holling (Holling 2001) puts it (page: 22):

> “………..*Each level is allowed to operate at its own pace, protected from above by slower, larger levels but invigorated from below by faster, smaller cycles of innovation*”.

In the case of Chile it may be a priori that, as it is more complex and driven by socially oriented governance regimes, it would be slower than BT’s. However that may not be the case if the latter’s own governance system was grossly inefficient.

Chapter 4.1.7: Lessons Learned From Bankers Trust

BT had been at the forefront of applying financial models (RaRoC 2020)(Guill 2007) to derive risk adjusted return on capital. However like J. P. Morgan’s Credit/Risk Metrics (Morgan 1997, Gupton, Finger et al. 2007) and LTCM (Lowenstein 2000) arriving at a credible/tractable database from which to extrapolate meaningful ATPM prices would prove transitory and eventually lead to regulatory intervention for both BT and LTCM as the Russia Crisis 1998 worsened affecting BT's capital reserves. 1998 saw the demise of both LTCM and BT as meaningful enterprises the former being rescued and the latter purchased by Deutsche Bank AG. Whilst CreditMetrics™ still persists it changed its underlying model more than once in the late 1990's and post 2008 the impact of credit default losses from the crisis highlighted the issues with such models.

In 1997 much of the work on Agent-Based Models and Network Theory had not been available publicly. Had it been so then the problems of monitoring the agent network within BT would have been considerably easier. As it was the major issues confronting the team in creating the performance metrics became the complexity of organisational structure, model risk and management's misunderstanding of the eventual goals.

Had the aggregation of assets/liabilities program started then the variety management project would also have begun which, with the advantage of the 2008 Credit Crisis now available, would have shown a peak exposure to property on all recursive levels and smaller peaks in leveraged products with a high probability of loss. Sensing these but not alerting the management accordingly may have secured the final programme.

Chapter 4.2: Standby Capital

Penner is quite candid about liquidity: "*Liquidity is an illusion. It's always there when you don't need it and never there when you do*" (Penner 2016). In addition he points to prudence "*Relying on an exit to make money, especially with the use of large doses of leverage, places investors in a highly compromised position. Every investor needs to maintain ample liquidity, in the form of cash or U.S. Treasuries, to pay their bills and survive through cyclical downturns. Ideally, they should hold enough to cover two to three years of expenses/liabilities*". This approach is central to the ontology of Standby Capital: Loss bearing liquidity when it is really needed. So what is Standby Capital?

Standby Capital (previously known as Contingent Capital (Culp 2002)) is an insurance-like financial contract that can come in a variety of forms but whose strategic objective is to supply additional liquidity at the point that endogenous/exogenous events potentially threaten the viability of the business.

Prior to the placement of Contingent Capital Contracts ("CoCo's") (AFME 2010, Pennacchi 2011, Nouri 2012, Committee 2014, Cline 2015, Taleb 2015) Contingent Capital had evolved from a hybrid insurance/debt product placed by Nationwide Mutual (USA) in 1995[xlv] which, as a mutual, has structural issues with debt and no equity. The author modified the product structure by establishing a meta-format that applied to all forms of businesses in 1996.

CoCo's, like the Nationwide Mutual's (USA) early contract, suffer from two substantial drawbacks: the complexity of the trigger mechanism and the nature of debt as a capital instrument. The former being designed to be remotely probable as to draw down and the latter a liability that gives little balance sheet comfort unless the business is regulatory supervision where all assets have been sequestered. In addition current CoCo's are drawn at inception leaving no additional liquidity at the point of trouble.

Chapter 4.2.1: Accounting and Risk - 2015

Since 1997 and Bankers Trust accounting and risk regulation has been transformed since the 2008 Credit Crisis as noted in the Literature Review. FAS113 gave way to IAS39(ICAEW 2015) that is being revised to IFRS9 (IFRS 2015, IFRSBox 2015). In addition to these financial institutions face additional requirements from global regulators as to what level and type of capital is recognised under Basle III/CRD IV/TLAC (England. 2015) (Settlements. 2015, Basel 2016).

To be fully effective this would mean that Standby Capital contract should be executed upon a simple trigger, with no probability that investors can renege or cause a delay in payment of the intended liquidity, in return for which they receive ordinary shares at a pre-agreed discount to the price ruling at the time of call. To differentiate this product from CoCo's and other Financial Insurance products it was called Standby Capital (or Standby Equity) ("SCC").

The SCC proposed meets the criteria of TLAC's being a simple call to the investment managers who exercise a standing request to transfer the assets held in trust and the issuance of the shares by the client.

Chapter 4.2.2: Standby Capital Objectives

SCC's financial objective is to satisfy any regulatory and accounting body that the business has acquired additional un-encumbered liquidity with which it may repair potential losses or alter strategic course such that the value of the business is optimised under a broad range of events and why it was chosen as the contract herein.

These events can be generally described as follows and post the 2008 Credit Crisis financial regulators have established these as a governance process their terms being as follows – figure 132:

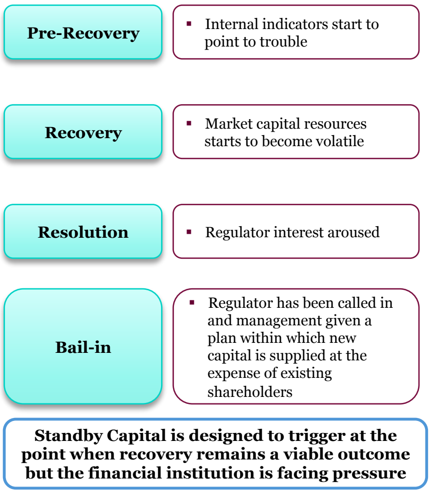


Figure 130: Regulatory Intervention Stages

The prime risk boundary for management is between Pre-Recovery and Recovery as before Recovery is enacted, which is a well-defined regulatory process, events can be managed within the confines of the business[xlvi].

These transition points can be mapped to a pricing line as follows – figure 133:

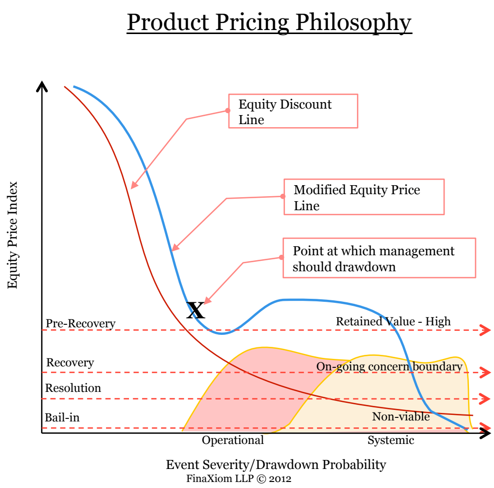


Figure 131: Pricing for Standby Capital 2012

Contractually the contract process appears as follows – figure 134:

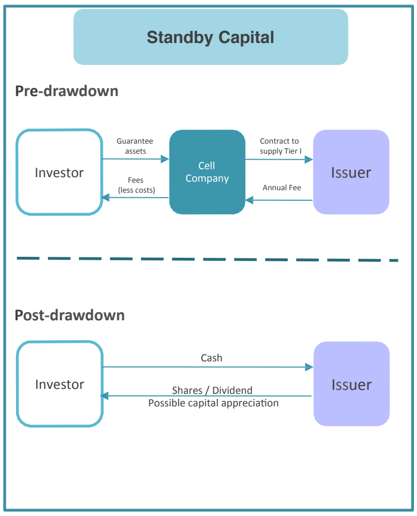


Figure 132: Standby Capital Structural Outline 2012

Most insurance pricing models are based upon Risk Ruin Theory (see Literature Review) or the probability of default and its associate loss of principal. Though equity pricing takes a slightly different approach by searching for a likely "pay-back rate" any assumption that imputes a mean default across a portfolio of homogeneous risks is reverting to this process (Spiegeleer and Schoutens 2011).

As Spiegeleer (Spiegeleer and Schoutens 2011) and Penacchi (Pennacchi 2011) illustrate the predominant approach is the debt contract priced upon a credit risk default mechanism. Although Spiegeleer offers an alternate "equity-based" discount model each suffer the same drawbacks. The models assume market homogeneity upon which a risk discount process can be applied.

None include the probable effects of operational failures from endogenous or exogenous factors both of which are illustrated in the Pricing Philosophy above whereby a credit-based discount process is modified by operational and systemic events post the Recovery process. The evidence of the impact of these events was illustrated by Beer (Beer and Casti 1975) whereby the probable state of the business is on a completely different vector than that proposed by management.

Chapter 4.2.3: Current Standby Capital Contract Structure

The principle differences between the BT Contingent Capital Contract and Standby Capital is the latters simple call by management to access the liquidity and the conversion to equity at a pre-defined discount.

The recent publication of the G-20’s/U.K. Financial Stability Board “Total Loss Absorbing Contract” (“TLAC”)[xlvii](Basel 2016) highlights all of the relevant issues that the contract now satisfies except for the link to an ATPM due-diligence programme suggested herein.

Chapter 4.2.4: Ethical Structures

As mentioned elsewhere ethical structures are a matter of conditionality that determines what type of project is acceptable and in what form the asset, and in some cases the services provided, must take.

This aspect of ethical, Islamic, strict Judaic or indeed any conditionality should be done in consultation with the appropriate experts: It being accepted here that the majority of Christian faiths will accept “traditional” financial structures without modification.

Chapter 4.3: GHOST and Standby Capital

In order to assess the value of GHOST a series of projects were considered that would test the recursive structure and temporal nature of the pricing method. In order to further test its applicability to any type of financial business Standby Capital was proposed as the asset type.

A common characteristic of all businesses is the dynamic nature of its strategic aims. As an *m*-ATPM GHOST considers all strategies to achieve a particular outcome as a process that embeds a “critical path” essentially a central set of consecutive outcomes that follow the development of the project along with their effect on the project’s outcome.

The corollary of this concept is that all investments, the transfer of assets to a project, should require continuous monitoring due to the dynamic nature of the world in which we are all embedded. Major perturbations, as considered by Beer in “Investment Against Disaster in Large Corporations” (“IAD”) (Beer 1975), that adversely effect the liquidity of the business can push it into insolvency. We know from Jankensgard (Fishburn 1977, Jankensgård 2008), Spiegeleer (Spiegeleer and Schoutens 2011) and Pennacchi (Pennacchi 2011) that this effect has been stochastically reviewed but the mathematical dependencies still rely upon static temporal parameters within their core calculations.

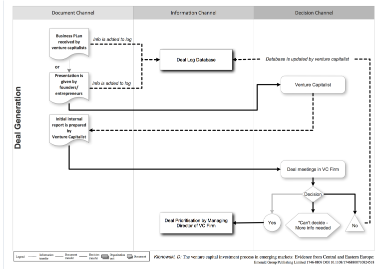
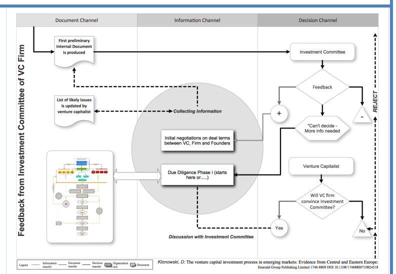
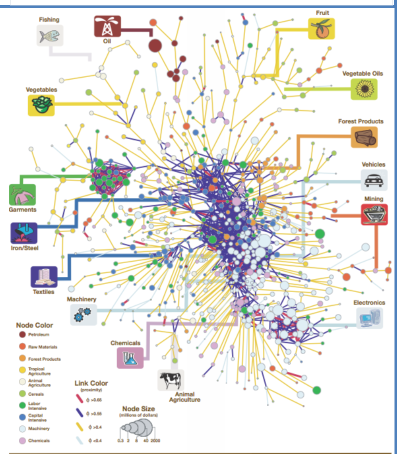
GHOST aims to provide a probabilistic set of financial outcome vectors correlated to changes in strategic direction and endogenous/exogenous events. GHOST therefore modifies the traditional pricing line, e.g. Spiegeleer, by accounting for failures within the business and changes in market forces represented by the network and actions created its agents. It also ensures, through its due-diligence process, that the parties understand the requisite risk variety being managed and organisational structure at hand.

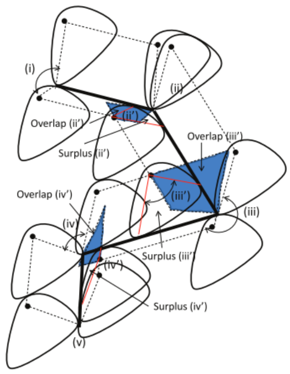
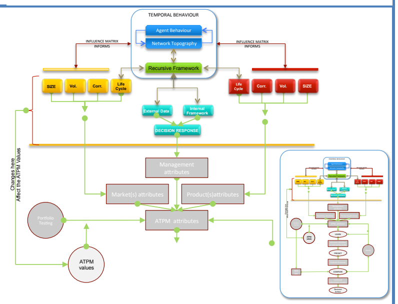
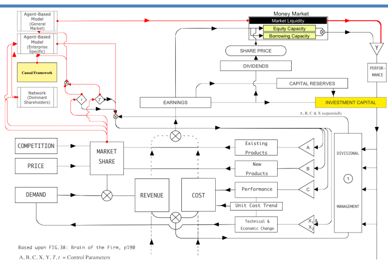
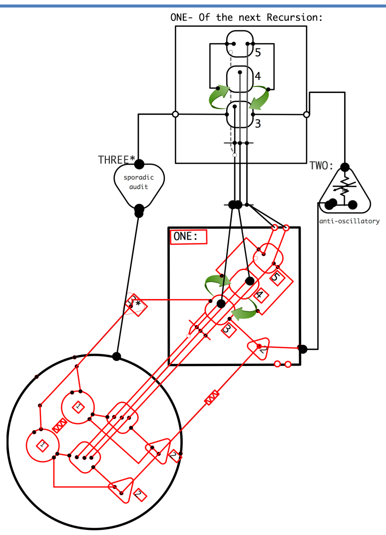
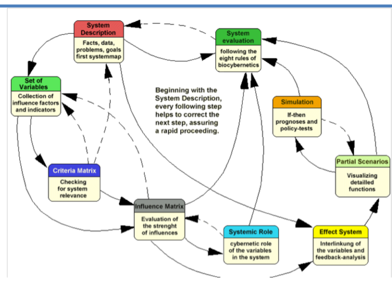
As Standby Capital requires a similar analysis approach presented by Beer’s IAD it was chosen as a test asset for pricing purposes: to take into account not only the standard risk factors surround all the assets and liabilities within the business but also the effects of endogenous/exogenous events considered as "operational" and "systemic".

Chapter 4.3.1: GHOST: Embarking on the Heuristic

The following process outlines the flow from initial conversation through the due diligence items to the input of the data into the various pricing models effected by the evolving Cellular Potts Structure ending with the conversation with investors as to the acceptability of the outcomes – Table 11:

Table 11: GHOST as an ATPM Due Diligence Process

Process	Description	
Product Assessment process	This is essentially the opening of the Klonowski process; a proposal is suggested for the project. Is it Ethically acceptable i.e. is it Shariah, do the parties need cleric involvement?	
Due Diligence: Phase I	Preliminary research on: • Organisation • Regulatory structure • Markets • Performance • Technology	
	Either develop or compare to an existing Network Map of Project Product distribution: • Extract market share as separate nodes and grade size • Apply customer turnover as a bonding parameter • Isolate Industry as sub graph analysis	

	• Test dynamics of the system • Isolate areas needing additional input	
Due Diligence: Phase II	Secondary research & modelling structure: • General business model • Identify recursive structures • Develop network model • Identify agent parameters	
	• Develop basic business model • Identify, current & complementary capital markets for project • Assess strategic cash flow issues	
	Map current organisation onto a VSM model to verify: • Functional structures for all S1-5 • Test for Variety attenuators if available • Enquire after management movements in key positions over last 4-years • Test for audit plan and reports	
	• Sketch a Vester Sensitivity Model looking for: o Product line performance dynamics o Resource discontinuities o Emergent essential parameters	

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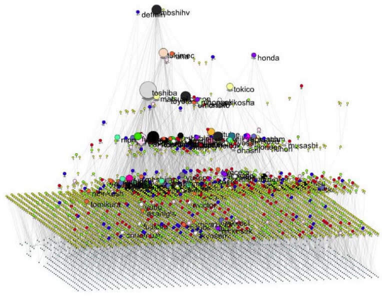
- Map Network of Influence Framework (and customers if possible)
- Assume competitor influence by taking latest project data as a guide to their distribution and market capacity
- Re-Run Hidalgo-type graph of market capacity by product and set agent models running to note competition results
-

</td><td></td></tr>
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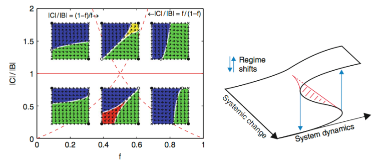
- Determine changes in landscape and strategy values

</td><td>
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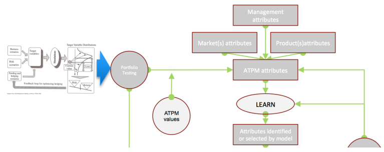
- Run Asset/Liability Models based upon VSM, Network and derived Temporal Parameters

</td><td>
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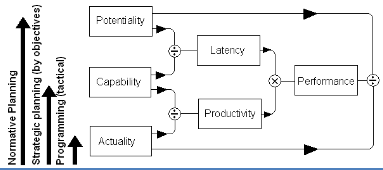
- Derive CyberFilter output
- Test resilience of business governance

</td><td>
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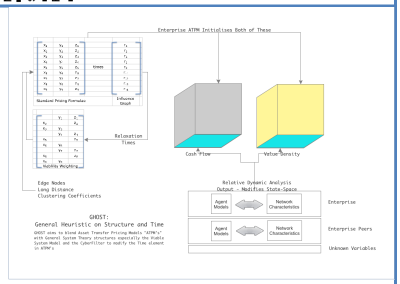
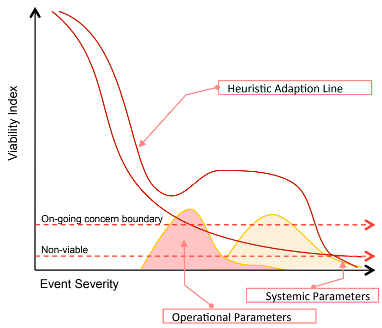
- Finalise Cash Flow, Value Density and State-Space models
- Create Influence maps and
- Re-run ALM model
- Test Ethical contract structure: Shariah components?

</td><td></td></tr>
<tr><td>Derive Cellular Potts Framework</td><td colspan="2">

- Create Topographical structure from derived VSM model
- Input ALM/CyberFilter & Network Structures into parameters and Business Framework

</td></tr>
<tr><td>Derive First Pricing Range by running CPM strategies</td><td>

- Estimate industry market discount line
- Develop Project-specific discount line
- Overlay governance and regulatory conditions
- Overlay systemic issues
- Derive first Price

</td><td>
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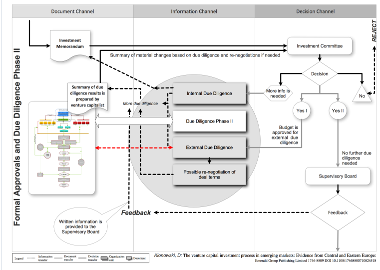
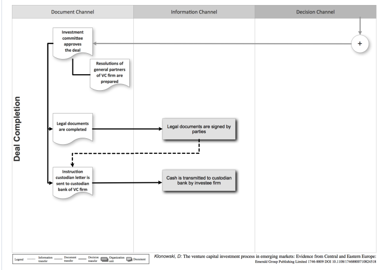
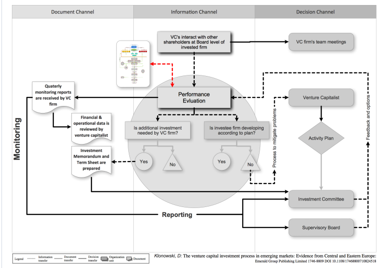
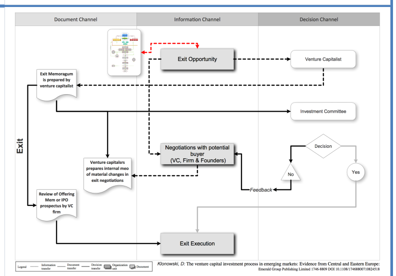
Investor, Firm & Stakeholder Discussions (Klonowski stage 6)	• Alert Investment Team of pricing structure and/or possible need for more information • Start discussions with Project Managers and stakeholders • Ethical sign-off i.e. Shariah Board	
Deal Completion (Klonowski stage 7)	• Establish final price • Mutual decision to invest: o Yes: Create legal structure and Transfer assets o No: Store data anonymously and update industry pricing structures	
Investment Monitoring (Klonowski stage 8)	• Throughout the period of investment all of the due diligence work results are updated with as much information derived as possible to ensure changes in risk dynamics are captured	
Exit Route (Klonowski Stage 9)	• Assess market capacity and appetite for sale of assets • Does market purchase fit within ATPM overall portfolio existing strategy? o Yes: Sale o No: Retain o Concern: Consult Management	

GHOST is designed as a “general” learning process and therefore pathways spur and return at different points depending upon the basket of risks and the waterfall of asset type being discussed. In the example above the ethical consideration was Islamic and therefore Shariah Law pertains. Symmetry of belief systems for all the parties is not a requirement in most cases however where there are defined rules for the type of business at hand and relationship structure as in Shariah Law then the level of legal complexity will increase: It is often the advantages of accessing a certain investor pool that determines the reason to submit the ATPM to the stricter ethical structure but all cases a cost-benefit should be conducted.

Chapter 4.3.2: Standby Capital Pricing and GHOST

We established that existing methodologies to pricing capital risk involve the same underlying models that failed to predict the changes in application of leverage and market activity. Jankersgard also notes that the proposed Cash Flow at Risk model suffers from severe limitations (p.10) and it was shown that many of the assumptions made in the example on exit of a major catastrophe are not valid. Some of these were: conditionality of the hedge would prove difficult to enforce; the market would not act rationally to catastrophic changes in underlying balance sheet strength; and especially under systemic conditions. The same requirement for liquidity can be assessed in GHOST's methodology and involves measuring market governance structures and temporal dislocations: In essence this is the same set of conclusion as in Beer's IAD paper.

Chapter 4.3.3: Summary

From Bankers Trust the initial conversation considered the immediacy of a catastrophic storm and the potential impact on the balance sheet from unaccounted for liabilities. This led to a deeper investigation of how the bank built its Asset/Liability Model across all departments and started to stress test the wider implications of a lack of governance. With the introduction of the VSM a coherent picture of the business's structure evolved and its marketplace position however, even though a targeted Contingent Capital product was placed the conversation was stalled in 1998 by the demise of LTCM and its ramifications across the globe.

Although the Bankers Trust project was not fully complete it did open the possibility of placing a Contingent Capital product in a more suitable form supported by a risk management programme that accounts for a wider set of parameters notably endogenous/exogenous governance structures and a causal influences that had different parameters in a recursive framework.

By abstracting the common objectives of the business, regulatory and accounting bodies, and potential investor appetite the original bond-based Contingent Capital product became Standby Capital (Equity) an asset-backed contract with a simple trigger mechanism void of potential investor conflict.

Drawbacks seen in the Bankers Trust programme of monitoring agent activity and establishing whether their network structures were resilient are potentially overcome by GHOST's inclusion of ABM and Network models. Combining the whole in a CPM offers an integrated performance metric that is probabilistic and not deterministic in nature whilst accounting for a wider set of causal influences in governance structures.

In a similar fashion to Beer's (Casti 1975) approach Standby Capital uses GHOST as a conversational tool to evolve a pricing range that both buyer and seller might agree.

GHOST supports the due-diligence conversation that should appeal to regulators and auditors alike as it records the changes in time and price/value on a probabilistic basis but does not upset the current reporting conventions or formats.

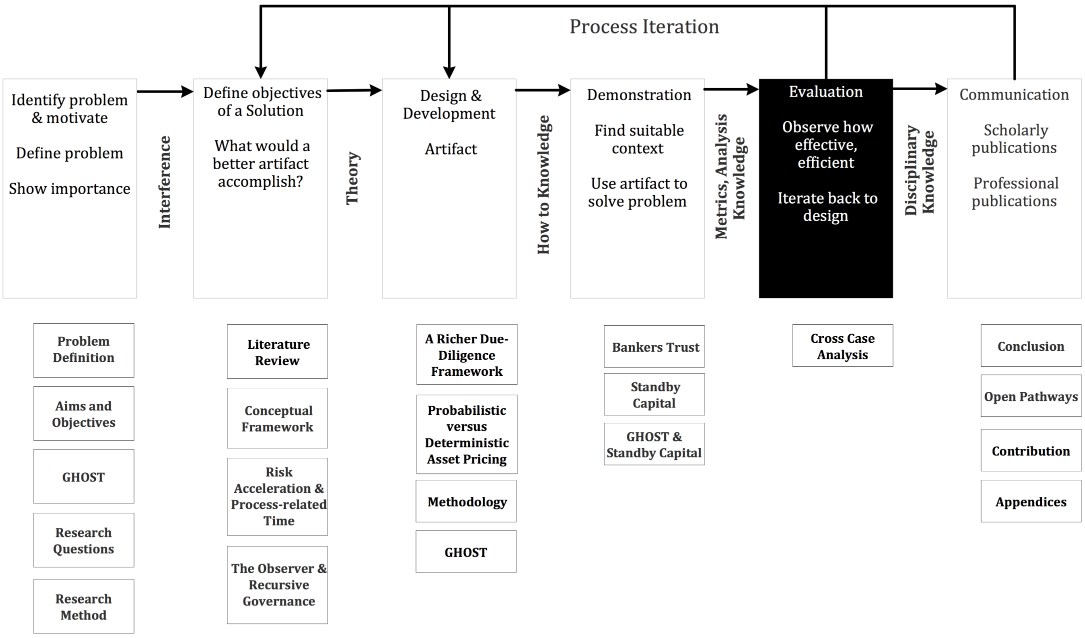


Figure 133: Chapter 5

Chapter 5 – Evaluation

Chapter 5.1: Cross Case Analysis

Chapter 5.1.1: Introduction

In order to gauge the similarity of operation across a variety of industry forms the following sets out to compare GHOST's application to the following types of business:

> **An International Bank:** Chosen because of the radical changes in regulatory requirements for financial institutions since 2007, the Bankers Trust review provides a platform from which GHOST's advantages may be seen the on-going debates over Contingent Convertible Bonds (Co-Cos) as a regulatory capital instrument and their place in the waterfall of capital tests GHOST as a *m*-ATPM;
>
> **An International Insurance Company:** Changes in regulatory requirements and limits on the type of investors allowed within financial institutions likewise test GHOST as it does the bank. Though the risk exposures are not superficially the same as a capital markets bank and need separate consideration, the practical

issues surrounding the pricing of the Standby Capital product are similar to all projects;

A Central Counter Party (Exchange) – CCP: CCPs are a developing issue in today's financial arena as their risk issues straddle the outsourcing agent and the assumption of risk by the CCP themselves. Pricing a product using GHOST for these entities moves away from the pure financial industry and assumes elements of operational governance in common with many other outsourcing businesses; and

An Infrastructure Project: Chosen because it removes major regulatory issues that surround the other examples this particular project highlights the interconnectedness of markets and yet highlights the similarity between pricing risk to the same objective outcomes: that of maintaining an on-going concern.

Operating at such a high level of abstraction individual performance outcomes cannot be offered however the strategic outcome of using Standby Capital as a defence against catastrophic failure is portrayed in each case along with the issues experience has to offer in the process of due-diligence.

Using the "Product Pricing Philosophy" for a financial institution as follows – figure 136:

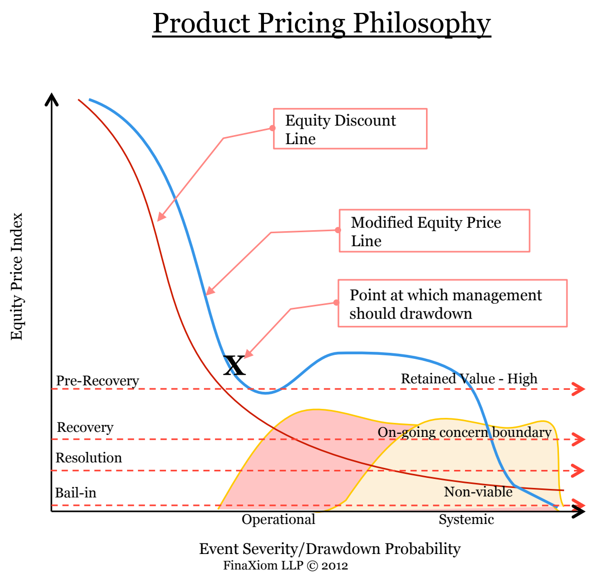


Figure 134: Product Pricing Philosphy

It is assumed that the managers of the business would rather not be faced with investor and equity volatility and their strategic aim is to capture possible events at the position X, in U.K. regulatory terms “pre-recovery”. At this stage only the senior managers and governance board would be assessing the situation.

It is assumed that a Standby Capital Product has be sourced and priced to meet the trigger requires of X and that investors in that product are happy with the risk-reward.

Chapter 5.1.2: One Heuristic – Different Lenses

The following table analyses the expected outcomes for each step of the due diligence and price negotiation processes as a guide to the potential future development of the component models. The general heuristics is explained in the first column “International Bank” and where modifications are required to adapt to the different type of business then those comments are entered but if not, and the heuristic is the same for all, then the cells are left blank and it should be assumed that the cell comments on the right are standard.

	Analysis Line	International Bank	International Insurance Company	Central Counterparty CCP	Infrastructure Project
Preliminary Research	• Organisation	Banks are dynamic organisations and regularly restructure their organisations however there are sufficient organisations that can supply an initial global organisation structure	Insurers differ little from banks in their behaviour and available data.	At a superficial level the CCP is an outsourcing agent for banks, traders, investment managers and insurers who want to manage their investment risk values. The organisation needs a high level of technical ability and is dependent upon a new type of regulatory requirement that is emerging now.	The ability of the managers reflects the competence by which the critical path will be managed. The levels of in-house expertise may only be necessary in the long term for the type of project at hand. The initial expertise to build and deliver may only be needed at the beginning of the project. However it is competence of each that will make the outcome assured.
	• Regulatory structure	Following the 2008 Credit Crisis the major regulatory authorities have developed a large supply of analyses along with the data providers and rating agencies. Regulations are changing quickly but the	The difference to regulatory constraints for insurers is the leverage exposure an insurance product imputes if a general insurance business. Elsewhere the money management, investment	The nature of regulation for CCPs is changing rapidly but until there is consensus on a resolution and recovery the focus should be on identifying the type of business risks and obligations the customers	Most infrastructure projects are regulatory light unless involving hazardous materials at which point environmental regulations are required and the expertise to administer them necessary on the

		economics of capital and debt are the same; the pricing of probable default on an integrated global bank therefore puts this project at the top of the complexity list. Be aware of changing accounting rules and legal structures.	profiles and offering of credit/derivative structures are the same and this should be the focus of attention: Ensure the pricing of products follows market-accepted practices.	transfer, the level and conditionality of the netting/asset matching required and the level/terms of the default fund. CCPs are extremely exposed to operational risk that means VSM type scrutiny.	team.
	• Markets	The complexity for a bank comes in knowing how the internal distribution of risk management reflects the external origins. It is good to develop an initial market network at a high level broken down into the components of the capital markets and estimate the dynamics first: it will save time later. A break down is usually available from the central bank.	In line with the above physical, social habits, legal and regulatory differences add an additional level of complexity to insurers. The social habits can be amplified by the legal environment or bias to moral hazard from social considerations of insurance.	Much is echoed from the comments above.	Compared to banks, insurers and CCPs infrastructure project are less complex in their markets structure but can be geographically complex in resource requirements. They are also dependent upon the economic environment in their resource and sales arenas that can affect temporal issues.
	• Performance	If this is a new bank then research the biographies of	There is little to add apart from the accent on	The trading margins and technology risks require	Great care should be taken in assessing the

		the proposed operative board, not the holding company. If you have a ”teaser presentation” then compare to existing market performance and highlight where common sense will tell you expectations are too high. If not then most central banks have performance data along with rating agencies and data stream providers. Be careful of consolidation of results within divisions and the changing accounting regulations over the years. Be aware of hypothecation and re-hypothecation as a form of funding, which includes residual liability from trades with counterparties. Strict care should be taken to determine the source of	leverage of general insurance business competition and the equivalent of re-hypothecation in insurance be “reinsurance protections” hiding bad performance, which includes residual liability from trades with counterparties. Strict care should be taken to determine the source of pricing of original products	CCPs to focus intently on turnover and operational viability. Performance should be drilled down to market and product type levels and the frequency of new product adoption.	components of performance and the reliance on accounting/regulatory arbitrage. It is the underlying performance of the business that needs to be unearthed along with any rapid changes in management and business acquisitions.

		pricing of original products			
	• Technology	Though an existing bank may seem complex it would be safe to assume it probably hasn't upgraded its communications technology to keep pace with changing markets and analysis requirements for consolidated ALM. Assume a highly level of competence but look for turnover of staff in the IT department and outsourcing of resource	The technological aspects of modern insurance pricing are important. Look for too much outsourcing as a developmental node on the network and the reliance on external consultants to price the products.	See above	The technology comprising the build, sales and forward performance should be tested for its sustainability. Markets change quickly and the lack of experience in employing complex building or technological products fraught with risk.
Network Maps	• Extract market share as separate nodes and grade size	Once the basic data is provided by the project managers an assessment of the network should start by grading the size of the market share and its geographical distribution adding parameters for delays in governance and information tenacity. This	Once the basic data is provided by the project managers an assessment of the network should start by grading the size of the market share and its geographical distribution adding parameters for delays in governance and information tenacity. This	Once the basic data is provided by the project managers an assessment of the network should start by grading the size of the market share and its geographical distribution adding parameters for delays in governance and information tenacity. This	Once the basic data is provided by the project managers an assessment of the network should start by grading the size of the market share and its geographical distribution adding parameters for delays in governance and information tenacity. This

		section is vital to assessing initial structural communications and performance.	section is vital to assessing initial structural communications and performance.	section is vital to assessing initial structural communications and performance.	section is vital to assessing initial structural communications and performance.
	• Apply customer turnover as a bonding parameter	Changes in customer turnover and market share at least give an indication of cohesion in the market but it also indicates the competitive nature of the business. The bonding value is modified by performance and consistency over time.	Changes in customer turnover and market share at least give an indication of cohesion in the market but it also indicates the competitive nature of the business. The bonding value is modified by performance and consistency over time.	It is a natural part of a CCP that tradiing occurs at a fast rate and turnover high. This section is effectively redundant here.	Changes in customer turnover and market share at least give an indication of cohesion in the market but it also indicates the competitive nature of the business. The bonding value is modified by performance and consistency over time.
	• Isolate Industry as sub graph	If a general Network map has been created then separate the project apart from the different market types and isolate its geographical structure.	If a general Network map has been created then separate the project apart from the different market types and isolate its geographical structure.	If a general Network map has been created then separate the project apart from the different market types and isolate its geographical structure.	If a general Network map has been created then separate the project apart from the different market types and isolate its geographical structure.
	• Test dynamics of the system	There are some standard test of the structure of networks that can provide insight into connectivity loops etc. Test these for	There are some standard test of the structure of networks that can provide insight into connectivity loops etc. Test these for	There are some standard test of the structure of networks that can provide insight into connectivity loops etc. Test these for	There are some standard test of the structure of networks that can provide insight into connectivity loops etc. Test these for

		more information needs	more information needs	more information needs	more information needs
	• Isolate areas needing additional input	If there are special areas of interest for the project such as a high concentration in complex products create a list of parameter requirements for the Vester Model stage.	If there are special areas of interest for the project such as a high concentration in complex products create a list of parameter requirements for the Vester Model stage.	The CCP is weighted toward an outsourcing agent for banks, investment managers, traders and insurers. The focus should be on what operational and residual business risks are transferred under the terms of doing the business.	If there are special areas of interest for the project such as a high concentration in complex products create a list of parameter requirements for the Vester Model stage.
Secondary Research & Modelling	• General business model	Ask for a general business model in order to contrast the opening ideas of structure to that of GHOST's eventual dynamics.	**ALL THE EMPTY CELLS SHOULD BE CONSIDERED FILLED WITH THE SAME ACTIONS TAKEN BY THE INTERNAITONAL BANK**		
	• Identify recursive structures	Begin to create an influence framework from the standard provided and then split it into markets so that the projects distribution of functional divisions is highlighted. Input the results into the			

		network map as parameters and/or additional nodes.			
	• Develop network model	If a standard network model is not already being compiled now should be the time to develop it. There should be enough data to create a basic network of the markets and their topographical characteristics. This should include basic macro-economic parameters and feedback structures. If desired a basic systems dynamics model can be created at this point.			
	• Identify agent parameters	Conversations with the project managers will provide their view of the agent parameters and the expected activity required to achieve the strategic plan. A basic agent model			

		should start to be created.			
	• Develop basic business model	Remember the objective is to triangulate models and at this stage the state-space model for Beer's VSM can be started. A simple spreadsheet can be created to model the Beer financial model and its extra parameters. This should be done by node within the network but linked recursively.			
	• Identify current & complementary capital markets for project	Depending on the type of original request for assets search for an alternative approach that could be considered. This will create a reflexive view within the analysis that may provide insight.			
	• Assess strategic cash flow issues	Cash flows are the main source of the liquidity of a business. Test the Jankensgard approach to			

		see if there is too much leverage and or insufficient resilience in the available liquidity under certain adverse events.			
Map organisation to VSM	• Functional structures for S1-5	There should be enough information to develop a VSM structure of functional components. Create the map.			
	• Test for Variety attenuators if available	Though an unusual request try to develop an idea of what bandwidth there is within the organisation to supply variety matching.			
	• Enquire after management movements in key positions over last 4-years	The market performance statistics should provide sufficient temporal insight to test whether governance is resilient. Test for major movements within management over the last 4-years.			
	• Test for audit plan and reports	Enquire what level or regular audits are taken in			

		person and remotely. The 3* aspect of the VSM is quite important.			
	• Sketch a Vester Sensitivity Model looking for:	The Vester Map can be taken as a start point or way-station but at this stage the data should be nearly available to create a Vester Sensitivity Diagram for each of the market and structures. Remember that Vester is a complex systems dynamics mapping process so the level of recursiveness needs to be explicitly imported from the network and VSM diagrams.			
	○ Product line performance dynamics	Models should be created for at least the major product lines at this stage to test the emergent performance of the business.			
	○ Resource discontinuities	Try to complete the			

		Sensitivity Model and identify any resources that may cause possible loss of functionality.			
	○ Emergent essential parameters	Run the model and repeat information requests until a stable set of issues and parameters emerge. These will be different at the different levels of recursion as each are added.			
Map Network again	• Map Network of Influence Framework (and customers if possible)	The best level of network resolution is the customer-by-customer connections with their own constraints added. This will not likely be available for a bank but an attempt should be made to approximate the breakdown and dynamics.			
	• Assume competitor influence by taking latest project data as a guide to their distribution and market capacity	Competitors should be considered across a range of differing differentiating parameters and then a network created for them.			

		The size and complexity will be derived from market available data and internal project assessments.			
	• Re-Run Hidalgo-type graph of market capacity by product and set agent models running to note competition results	The Hidalgo type map should now be complete for the type of project being considered, all remaining components of the market are assumptions but the critical breakdown will be how the project's map operates. The map should produce a layered effect that is recursive in outline.			
TEST ALM	• Run Asset/Liability Models based upon VSM, Network and derived Temporal Parameters	Existing ALM models can now be merged with the Beer model and existing value at risk models. All of the temporal and structural changes can now be input and the state-space created for scenario testing.			

CyberFilter	• Derive CyberFilter output	Separate to the standard ALM metrics is the CyberFilter output. The Beer model and the cash flow models will determine leverage constraints within the primary elements of production ability. The Market derived data and competitor analysis will start to determine the total available market.			
	• Test resilience of business governance	By making some assumptions on the governance structure from the network and VSM using the Saito/Tensegrity approach the stresses within the market/business will start to determine the viability of the business this will now feedback to the temporal parameters			
State - Spac e	• Finalise Cash Flow, Value Density and State-Space models	All of the above will provide insight into the			

		creation of the state-space model for budgeting future outcomes under different scenarios.			
	• Create Influence maps and	Finalise the Influence Maps and the Cash Flow/Value parameters…			
	• Re-run ALM model	Re-run the ALM model adjusted for these structures			
	• Derive first pricing range	The range of prices for the likely performance of the business will now be created along with scenarios of probable adverse events. The benchmark equity price should be set and then the discount curve can begin to be calculated.			
Deriving First Price	• Estimate industry market discount line	Assumptions with the project managers will likely only see a stadard discount line so create a simple curve for comparison			

		purposes.			
	• Develop Project-specific discount line	The project benchmark equity price and discount curve can now be added.			
	• Overlay governance and regulatory conditions	Weaknesses in local and global governance structures will be known and an allowance for that will be be input.			
	• Overlay systemic issues	Any systemic issue can now be added.			
	• Derive first Price	The first price depends upon what type of product is required. As mentioned above the conditionality of the assets transferred will determine the ultimate price. In this instance a Standby Capital Product is priced as to the risks that management can anticipate and react to adverse events and the business afford the price.			
Mon	• Alert Investment Team of pricing	This is essentially the same for all the projects and is market derived.			

	structure and/or possible need for more information	The internal models of the individual managers of the project will determine acceptance from which constant monitoring will determine the true outcomes and ability to manage.			
	• Start discussions with Project Managers and stakeholders				
	• Establish final price				
	• Mutual decision to invest:				
	○ Yes: Create legal structure and Transfer assets				
	○ No: Store data anonymously and update industry pricing structures				
	• Throughout the period of investment all of the due diligence work results are updated with as much information derived as possible to ensure changes in risk dynamics are captured				
	• Assess market capacity and appetite for sale of assets				
EXIT	• Does market purchase fit within ATPM overall portfolio existing strategy?				
	○ Yes: Sale				
	○ No: Retain				
	○ Concern: Consult Management	In the event that performance of any sort creates a major concern shareholder action is available depending upon the distribution of intentions of the other investors.			
General Issues		Banks are notorious for retaining data and opacity of models that makes structural analysis difficult. Changes in markets will determine the extent that	Competition, mature markets and a severe lack of innovation make insurers performance volatile. Bad pricing can be hidden behind reinsurance	Outsourcing agents are typically exposed to high turnover of staff and technology risks. The former dilute the necessary governance of the business	The level of experience and layout of the business plan with determine the ready understanding of the risks involved. Complex issue will mean complex

	this changes but it is still a matter of general belief that whilst banks are good at asset values insurance at liabilities neither manage both well.	programs that take time to mature. Regulatory capital requirements by the G20 are making the performance of the investment sides of insurers uncertain but it is still a matter of general belief that whilst banks are good at asset values insurance at liabilities neither manage both well.	and the latter operational risk that cannot be immediate responded to if a catastrophe risk program is not available or well thought through. Until regulators increase the transparency of business risks transferred to the CCP and the levels of technology assumed neither the CCP nor its member shareholders the desire to change stance.	investigations usually around technology. However it is the ability of the management and its governance that materially alters the success rate
Pragmatic Concerns	Unless the investment is of a substantial size the likelihood of all of the data being initially available is slim. Therefore general assumptions should be made, a model created and performance matched over time and discussions with the project management.	Unless the investment is of a substantial size the likelihood of all of the data being initially available is slim. Therefore general assumptions should be made, a model created and performance matched over time and discussions with the project management.	The size of the investment is material and the opportunities will weigh on the ATPM decision.	There is a significant difference between the internal models of project managers and investors that need to be carefully considered.

Chapter 5.1.3: Summary

The common objective of maximising net business "value" and not triggering a market "price" that would compromise this objective is achieved in all cases is X is a set of probabilistic performance outcomes using the particular firm's parameters and market environment.

Should any of the events materialise then the contract will be triggered (in part or whole) and an exchange of assets ensue. The additional liquidity should ideally facilitate a change in strategy to avoid the worst parts of the event and the investors will receive equity in the firm.

If adequate contingency plans have been enabled then management should be able to maintain their overall investor goal of providing "value" and liquid returns within a pre-set range.

Although the composition of final investors may not be the same as outset a successful placement would mean that the original conversation between the Standby Capital investors saw the business model effectively communicated between all parties through the due-diligence process and the price of the product mutually agreed. The final caveat being that the market is never totally predictable and in the case of the 2008 Crisis the strategy may eventually fail through no fault of management's efforts. However in the latter case to be operating after peers fall brings its own rewards in the eyes of long-term investors – validation of good management.

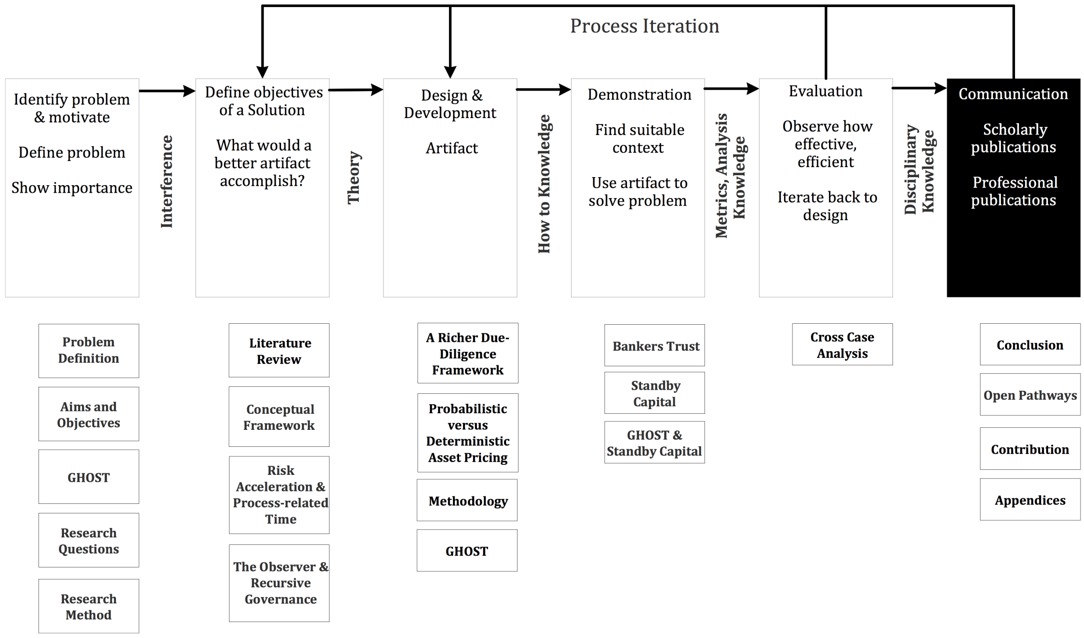


Figure 135: Chapter 6

Chapter 6 – Communication

Chapter 6.1: Conclusion

Chapter 6.1.1: The Research Propositions

This thesis aims to address Volcker's question about senior financial institutions managers' ability to govern in light of the 2008 Credit Crisis and whether Asset Transfer Pricing Models ("ATPMs") could be improved to ameliorate the forces that create extreme economic "bubbles" by anticipating emergent behaviour at each level of recursive organisation. The objective is to better understand the culprits of systemic failures in a commercial ecosystem and by treating them as complex eco-systems. By doing so what inspiration could we find in the Complexity Sciences to provide ATPMs to more effectively price risk and account for the dynamic changes in the structure and behaviour of markets? In particular it asks the following research propositions:

RQ1: If the assumptions of Value at Risk (VaR) do not represent a correct set of operational parameters for the valuation of assets, liabilities and risks then what insights can Management Cybernetics offer to improve this situation?

RQ2: If organisational structure affects the performance of systems in the anticipation process, and thereby the timeframes under which processes evolve, what role can the Viable Systems Model play in managing the investment strategies for ATPMs to supply investors with better outcomes?

RQ3: What roles can Agent-Based Models and Network Theory play in identifying emergent behaviour in these types of systems?

RQ4: Is there a framework that can communicate a richer understanding of the risks surrounding the outcomes of ATPMs to all parties using Complexity Sciences?

Chapter 6.1.1.1: Research proposition 1:

If organisational structure affects the performance of systems in the anticipation process, and thereby the timeframes under which processes evolve, what role can the Viable Systems Model play in managing the investment strategies for ATPMs to supply investors with a better outcomes?

Triana (Triana 2012), Tett (Tett 2015) and Savage (Savage 2009) highlighted the flaws lying at the heart of modern investment pricing models, Value at Risk. VaR, in its various forms, is the primary tool used to provide prices for assets, liabilities and risk that collectively inform investors of an investment proposal's value compared to their expectations.

Triana et al.'s (ibid.) central objection to using VaR is in its dependence upon the Central Limit Theorem with its assumption that, given well-defined criteria for independent random variables, the arithmetic mean of a large set of observations will be "normally distributed". In a practical sense this led investors to assume a sense of underlying determinism from which not only could they base current strategic outcomes but also develop others derived from conditions surrounding the terms of the financial instruments used. The flaw, they say, is that: the world is not "normally distributed", the methodology to calculate value loses vital information and ignores crucial criteria for ease of computation, and data is not available to justify the assumptions.

Experience of a team of financial professionals and a detailed conversation on the issues arising from the 2008 Credit Crisis found sympathy with this view. The application of RiskMetrics™ and CreditMetrics™ by JPMorgan, the Capital Asset Pricing Model and Arbitrage Pricing Theory within existing ATPMs illustrated the dependency upon a set of models that collectively turned probabilistic pricing into deterministic values and did not take into account all of the risks. The result, triggered by a gross miss pricing of the US sub-prime mortgage market, was a global loss of confidence in investment values irrespective of the underlying businesses. Some of the roots for this dependency on deterministic pricing can traced to the emergence of social reform post 1688's "Glorious Revolution" (Pincus 2009), the Industrial Revolution and Robert Ricardo's convincing (but faulty) arguments that grounded economics mathematically.

It was found that VaR did not include at least three crucial elements of pricing risk, the behaviour of agents within the strategy, the governance abilities of those entrusted to execute the proposed investment strategies and the internal/external organisational structure. Keynes mentioned the latter as a central determinant of his economic theory and all have a major influence on time as a component in financial formulae and, given the frequency of employment and importance of these calculations, changing such an important aspect leads to deeper concerns about VaR.

Given these findings the natural response was to search for a method incorporating the additional variables, reveal its own ontological/epistemological frameworks, and, if economic bubbles have become frequent, why had it not be implemented before? The answer was found in a practical investment project in 1995/6 for Bankers Trust ("BT"), USA to raise capital post the 1992/3-property bubble and concurrent with a rising Russian Bond crisis. This project had raised all of the issues above and BT had been at the forefront of developing VaR-based financial instruments and capital reserves with a product called Risk Adjust Return on Capital ("RaRoC").

BT's problem was the recognition of "tail-risks" derived from the very tool they used to price risk, VaR. They were struggling to find (and price) a Standby Capital product that would react to such events and supply much needed liquidity. Having already designed such a product elsewhere, using insurance and capital markets experience derived from previous market down-cycles, the author (herein) proposed a Contingent/Standby Capital that eschewed VaR, and insurance pricing methods, as they had been found inadequate for the same reasons above. Instead it relied upon a methodology from Management Cybernetics provided by Stafford Beer, the Viable System Model, who assisted in reviewing the project.

Management Cybernetics shares a common ontological platform with W. B. Arthur's Complexity Economics, a growing area of economic research to identify emergent market behaviour and pricing. Both move from a deterministic to probabilistic model, but more importantly Management Cybernetics allows the dynamic re-pricing for Standby Capital's own ATPM in concert with current events whilst accounting for both the endogenous/exogenous recursive organisational structures and real-time variety management, both missing from standard VaR and agent models.

Beer's VSM is preceded by two prior works being his report to United Steel Ltd and his book Cybernetics & Management. Both offered insights into how a move to probabilistic performance measurement would better manage the outcomes of forecasts, as Morlidge (Morlidge 2009, Morlidge 2010) reinforces, and each assess the practical application of Cybernetics in business. More importantly they are concerned with the parameters surrounding the risks and capital outcomes of the organisation essential to ATPMs. Having constructed a probabilistic business model dynamically accounting for these parameters Beer had to create a general framework from his experience in Chile for General Allende 1972/3 resulting in the VSM.

The VSM views the firm as a state-space of probable vector outcomes representing the current position and direction of the parameters and outcomes of a business that dynamically change in response to real-time inputs. By applying the VSM actions taken to maintain a target investment strategy (or capital level) change a "historic accounting practice" into a dynamic management programme whose current outcomes can be reported instantly. This assists in the pricing of “tail-risks”, and hence Standby Capital, because the firm constantly adjusts to inputs thereby avoiding the sudden conditions found in reacting to catastrophic events. In this respect Time becomes process dependent and constantly adjusts financial outcomes again assisting Standby Capital investors who can react to market changes in pricing and adapt their own portfolio outcomes.

The important aspects, and insights gained from his analysis in Beer’s paper on the impact of large catastrophic events on financial strategies (Beer and Casti 1975), correlate with those from a conversation with a market expert (see Appendix 1) on the current need for liquidity (2016) as ex-post 2008 market pressures that has reduced its current availability (also see Penner (Penner 2016)).

If Management Cybernetics could provide insights then why had it not been done before and what elements of the VSM (plus Beer’s prior works) were particularly strong?

VaR and insurance ATPMs are closely linked ontologically and because of the latter’s long history market inertia maintained its use regardless of recognising both of their shortfalls and lack of appropriate data. Any alternate method that required a change in mind-set would have been rigorously resisted (Kuhn (Kuhn 1962)/Bohm (Bohm and Peat 1987)) even though pricing benefits would occur because the capital markets had not previously seen the type of increased frequency, and global nature, that we now suffer ex-post 2008 Credit Crisis (Rogoff (Reinhart and Rogoff 2009) clearly shows otherwise).

However had Beer’s VSM been implemented, along with it flaws, individual events like LTCM may have taken a different course and likely not have been as large. However consideration should be made for regulatory, accounting and market structures that were completely different at the time, 1998. Indeed current global regulators have now begun to change how data is formed in order to remove unseen asymmetry and make accounts clearer. With respect to the cause of the latter: the explosion in the global economy; the rapid and reactionary response to historic regulatory failures and their unintended consequences; meant that over time the regular resources for ATPM analysis, the firm's annual/regulatory accounts, each year bore little comparison over its lifetime and seldom to its peers who may have used other accounting conventions. This compounded the problems of gathering homogeneous data not only vital for ATPMs but also Value at Risk models, Capital Adequacy Pricing Model and Arbitrage Pricing Theory.

The VSM uses a completely different approach to understanding current and future performance focusing on dynamic, non-linear feedback mechanisms rather than a typical historical accounting method upon which VaR models rely. It therefore presents investors with a better metric to reflect upon financial outcomes from events and their organisation's response.

Chapter 6.1.1.2: Research Proposition 2:

If organisational structure affects the performance of systems in the anticipation process, and thereby the timeframes under which processes evolve, what role can the Viable Systems Model play in managing the investment strategies for ATPMs to supply investors with better outcomes?

Cybernetics & Management and Brain of the Firm concentrate strongly on the business element of a firm and more particularly the latter as it introduces the VSM for the first time. However in later books the focus is more on the organisational elements especially as Beer develops the experience in Chile by implementing the principles of the VSM at the level of a wider economy not only in individual businesses. Nevertheless the business link between the VSM and investment strategies is made and he demonstrated that organisational structure is at the heart of the enterprise.

Keynes notes in his opus that one of the major variables in his economic theory is organisation, not only on the ability of the managers to exercise their strategies through the processes given but also the time scales, as Morlidge (Morlidge 2010) shows can directly affect the performance metrics used in business. Whereas Time is discussed in Question 1 the form of organisational structure also impacts outcomes.

Ex-anti the agreement to invest in the proposal the ATPM compares similar operational investment in the market and whether the execution risk by management is acceptable over a given timeframe. Any change to the underlying execution variables can therefore either improve returns by taking more risk in the processes or lower returns by having those risks materialise through bad management or inappropriate organisational structure.

The VSM, and by association the premise underpinning the IAD, provides a benchmark against which the functional elements of a viable enterprise can be compared and its outcomes measured. Dynamic changes in structure and processes that constantly occur in business can therefore be mapped onto a strategic state-space with varying outcomes and directions for the investment proposal. Investors using such an ATPM would initially be apprised of a fuller set of risk parameters and then made constantly aware of probable changes against which their own changing needs can be assessed. In short time has become process-dependent and a variable in current financial calculations with the consequences to market pricing. This approach also offers the possibility of maintaining certain reporting structures such as accounting and regulatory filing in the same format to reduce the cost of change.

Having established a direct causal link between organisation, process dependent time, investment strategies and the VSM an analysis of the VSM's own structure showed that, as a firm develops governance across different product lines the form of its functional components is self-similar but the parameters used to manage at each level change. The levels are not hierarchical but heterarchical as the latter allows the ad-hoc use of components across different levels to build functional components. This is a recursive structure, one that can extend beyond the boundaries of the firm and found throughout Nature. It is this ability to manage variety that makes the VSM attractive as Beer employs Ashby's Law of Requisite Variety and Ashby himself gives a good set of business examples in "An Introduction to Cybernetics" as to why it should be employed. Managing variety, the recursive structure of the VSM itself, and the dynamic management of events combine to provide a simple set of performance metrics Beer coined the Cyber-Filter.

The VSM also warns us that collapsing a recursive structure by assuming the functional parameters can be short cut drastically affects outcomes and the state of the firm is shown to be miss-leading due to the compounding of errors resulting in perverted strategies.

It was found that by implementing the VSM’s viability approach ATPMs might benefit from the knowledge that execution risks an efficient form of governance to give investors more comfort in outcomes. However whilst it took into account the differing parameters at each recursive level of operation it does not identify emergent behaviours of groups of businesses within the same market place, those that may influence them and vice versa, even though Beer offered a “Parasympathetic System” to take account of any such input.

Though Management Cybernetics holds various management models, as per Jackson (Jackson 2003), the VSM provides a benchmark framework for managing the faults of VaR. Technology change can however introduce rapid growth that spawns varying commercial outcomes but based upon organisational dependencies that need not be sustained over the same time horizons as existing investment strategies. The natural management response is to maximise profit at the cost of optimising resilience by reducing seemingly redundant costs in staff and processes. By comparison the cost base for implementing the VSM is slightly higher but its use as a benchmark to show where an investment proposal’s execution risks emerge should offset this.

To illustrate the latter a core element of the VSM is its use of Buckminster-Fullers dynamic geometry, Tensegrity, and illustrated by Snelson (Snelson 2016) in the form of an arch. Though the arch itself is internally resilient to internal/external forces and maintains its viability as an arch it is dependent upon two anchor points. As a metaphor the arch represents an internal organisational structure with two critical dependencies (the anchor points). Under Tensegrity rules an organisational structure this way would adapt to both internal and external commercial forces automatically whilst maintaining its functional operating strategy. Beer recognised the value of this process and embedded it within the VSM. However he also removed any dependencies thus making the VSM’s organisational structure more resilient (viable).

The VSM does not assume all business are or can be structured along VSM lines nor does it assume the market is made of symmetric data and skills, but it does provide criteria of effectiveness that not all business complies with a viable structure. However the perception of the VSM's form, as drawn, could be that of a rigid structure economically suited to a command economy. This was shown to be a dis-service to the VSM with its inclusion of a dynamic recursive framework and marking a distinct advantage over its peer Systems Dynamics. However it did leave the question of how the VSM could be shown to include open socio-economic systems. This was addressed by considering a business sector, modelled through recursive mapping, as a set of agents with embedded agents that form temporary networks. It is these networks that provide the dynamic inputs/outputs and to which the business or investment strategy will react whether they are customers, suppliers, regulators or other agents within the business itself. Using Capra's cell diagram (Capra and Luisi 2014), as a metaphor the bridge between the internal operations the VSM and its environment becomes the analysis of agents and the networks they create: The VSM becomes dynamically open, in model terms, to variety management.

By bringing confidence that the organisation can dynamically react to events the VSM also offers investors an increased level of surety that their financial outcomes are real.

Chapter 6.1.1.3: Research proposition 3:

What roles can Agent-Based Models and Network Theory play in identifying emergent behaviour in these types of systems?

The agents within, and without, a firm are constantly making connections from which networks begin to form as legal and other contractual forms define relationships for input, output and internal processing. Indeed the processes within the VSM itself were compared to Systems Dynamics that, notwithstanding its own advantages, was found to be limited as it excluded recursive structures and, like the VSM, did not anticipate new network structures created by its agents. However this does not rule out combining different types of systems models to achieve the required result.

Recapping therefore research found that the VSM had several advantages over existing forms of ATPMs but required a methodology to anticipate both the activities of agents and the networks they create. Although Beer may have been familiar with the Ising Model the real development of Agent-Based Models occurred after Beer's passing, as did that of Network Theory although he was well acquainted with Euler and Graph Theory.

From the perspective of Agents and Networks this thesis suggest that the VSM could be considered a recursive network built by its agents and monitored in real time as to performance. Extending this concept to recursive operational levels outside of the business processes introduces analysis by Agent-Based Models and Network Theory, models that Beer may have recognised as supplying the type of emergent parameters required for his "parasympathetic nervous system". In business terms this would equate to identifying market reactions and sentiment when assessing financial outputs of investment strategies. We have demonstrated here that to fit these models within the VSM would therefore bring a richer dimension to outcomes as well as inform strategy. This thesis therefore contributes to find a way to combine the strengths of two complexity management approaches, the ones from traditional Complexity Sciences, and from Organisational Cybernetics.

Chapter 6.1.1.4: Research proposition 4:

Is there a framework that can communicate a richer understanding of the risks surrounding the outcomes of ATPMs to all parties using Complexity Sciences?

The Complexity Sciences have developed in parallel to General System Theory, Information/Communication Theory and Management Cybernetics to name but a few but it is Information Theory that may assist is managing the conversation between buyers, sellers and agents of ATPMs such that all parties within which noise must not interrupt the transfer of data.

As ATPMs were defined as both a set of models and a due-diligence, or discovery, process the concept of a conversation was apt and research found that Klonowski's (Klonowski 2007) Emerging Market Investment heuristic supplied a framework to conduct that conversation. In addition Duarte's (Duarte 2010) interpretation of managing noise as a method to ensure information is properly created reinforced this approach as a good strategy to create GHOST, an artefact designed to reveal the full effect of the risks on the outcomes of a investment proposal by bringing new data into investors perception of organisation and emergent structures whilst also spurring the creation of new data for further research that over time may begin to form a wider understanding of an economic landscape. GHOST, as a broad definition, fits within that of ATPMs but does not focus on particular processes of one business: it is a meta-ATPM.

Using the Cellular Potts Model ("CPM") brings together the various models under a framework that is being used in the biological sciences to monitor structure and process in much the same manner that is proposed using the artefact GHOST: as a state-space machine for the underlying structure and processes that provide the outcomes sought by investors and/or stakeholders in an investment proposal. The CPM was chosen because its Hamiltonian can be structured as a multi-level topography and fits with the recursive nature of the VSM, agent activity and networks being analysed. GHOST offers this research a path to integrate state of the art knowledge from complexity and in particular, complexity economics, with an specific financial management process: the ATPMs use a benchmark of a multilayer recursive topology derived from the VSM modified by emergent behaviour of its agents and the networks they create.

Chapter 6.1.2: GHOST: A General Heuristic On Systems and Time

GHOST is designed to fit within the general definition of an Asset Transfer Pricing Model or ATPM being both:

- A set of models that assesses the values of assets, liabilities and risks within an investment proposal; and
- A "Due diligence" process conducted to verify the information supplied in the proposal and ensure that all parties within the conversation are aware of and concur with their respective expected outcomes.

As an ATPM GHOST is designed to overcome the limitations found within established pricing models such as VaR, CAPM and APT by including such variables as the organisational structures that exist within and without a financial proposal's execution processes, the identification of recursive governance variables that may impact extreme events and in doing so the effects on investment outcomes of these processes. The ontological framework of the artefact moves ATPMs away from their existing deterministic to a probabilistic pricing approach that responds dynamically to changes in strategy. A major consequence of which is that time, as used in corporate finance, be shown to be process dependent and variable.

GHOST is implemented in much the same manner as any other ATPM briefly described as follows:

- An investment proposal is presented with a set of financial outcomes;
- A set of processes are defined that produce a set of assets and liabilities with their attendant risks;
- In concert with the proposal a process of investigation is established to discern the veracity of the presented information;
- In conjunction with the above a process is established between the parties detailing what, when and how the data supporting the proposal will be derived;
- The models will derive values within the regulatory definitions, if any, and modified to account for "tail-risk"; and
- At the end of the investigation a summary of the proposal is created along with verification, or not, of the expected financial outcomes so that investors may conclude a transaction.

Apart from those areas of specialist knowledge such as the Complexity Sciences GHOST accesses the same expertise as relates to the proposal itself in order to verify data that could include forensic auditors, consultants specific to the underlying processes and investment professionals knowledgeable in the type of financial instrument being offered. With respect to the Complexity Sciences it would be expected that any firm regularly using GHOST would develop its own resources from a range of available software in the same manner investment professionals modify and retain spread sheets to access data provided for particular proposal. There are also ranges of dedicated professionals including Universities that can resource and analyse the data required.

To maintain the GHOST ethic it is envisaged the user should have a viable organisational/governance structure.

The following are the advantages and disadvantages of GHOST:

Advantages:

- GHOST aims to minimise the impact on current financial models by adjusting traditional performance metrics with organisational and market parameters;
- The due diligence process is extended to reveal additional market; characteristics that assist in the rigour of due diligence;
- Software is already available to create the mixed model structures such as AnyLogic 7/8;
- The Vester Sensitivity Model should augment result analysis by highlighting any emergent parameters that affect outcomes and
- The addition of changing temporal values should improve pricing by allowing the investors and markets to adapt to events in real time with better data.

Disadvantages:

- Research time is increased;
- The initial cost of due diligence will increase as new data is gathered;
- Current Network and Agent-Based Models are inadequate for the task leading to a trial period before sustainable results are available; and
- There will always be the unknown element of the observer input into model pricing, whether this is error or deliberate mistake.

Chapter 6.1.3: The Use of Design Science Research Methodology

This thesis applies the Design Science Research Methodology (“DSRM”) outline by Peffers for Information Systems. As the definition applied to ATPMs, being both a “set of models and a due-diligence” conversation, it draws upon a variety of information and theories from different disciplines aimed at clarifying the outcomes within investment proposals it was felt that this thesis resonates with Peffers own rationale.

DSRM usually aims to design and then create an artefact that can test existing information and then reveal new information useful in, or “improve the problem context” to, understanding the underlying function processes of a system. This is the case with GHOST – “a General Heuristic On Systems and Time”, an artefact designed as both a model and Thought Experiment to test the pricing model within ATPMs as well as augmenting the flow of information between the parties involved in an investment proposal.

Other research methods were considered but discarded because of their dependence upon either explicit data or access to qualitative models in financial institutions. The former being generally unavailable in most financial fields and the latter likewise being coveted by institutions under privacy laws.

Like Hill the thesis takes a Critical Realist, as well as a Performative, ontological position due in main to the intensely practical need to resolve the veracity of financial investment outcomes within a socio-economic context. However Peffer builds upon this approach that like Beer’s Yo-Yo Method, formalises a rigorous framework under which GHOST could be built, presented and tested.

In common with most researchers the act of acquiring data to inform the research problem “*reflects on the underlying values of the various participants and stakeholders*[xlviii]” which is very much the case herein given the opinions and insights from the investment professionals who contributed to the debate on ex-post 2008 economic conditions.

The rigour of DSRM became an obvious advantage during the research process for the rigour however DSRM mostly requires a feedback process from new field data that GHOST could not provide and hence why a Thought Experiment was considered. In the absence of hard data a Thought Experiment offered a way to articulate a logical framework that could lead to the production of new data and information. Though it allows the combination of various models to offset deficiencies perceived on some the exact methodology of arriving at these links and it is here that further research must be done.

As a practitioner in the financial markets back testing is always a consideration and whilst the above constraints still held it was believed the experience of developing the Standby Capital product offered an opportunity to show how GHOST operated across different project applications and why a Cross-Case Analysis was created. Each case was based upon a real proposal but had to remain anonymous for privacy reasons. However common solutions were found to address the problems faced by investors and managers alike: the use of Standby Capital to provide liquidity at vital stages of a business's critical development and that products dependence upon understanding the organisations structure that surrounded these events as well as how to price the risks involved. GHOST was therefore designed to address these criteria.

Chapter 6.1.4: The Ethics of the Research

Like Hill, and others, I uphold the need to be ethical in my dealings in accordance with those considerations outlined in Appendix VII.

Chapter 6.2: Open Research Pathways

The development of the Complexity Sciences is accelerating and researchers within the Bank of England show that economics is a target for the use of network theory in order to understand how economic policies and markets operate.

Given more time and resources discovering a link between the VSM and recursive network creation would have cemented a central pillar of GHOST as agents would then be able to dynamically create and populate a multi-dimensional topology within the CPM.

Should other researchers want to enter the scene, a fruitful and interesting direction would be to discover what other models could supply the function of the CPM and whether existing recursive networks provide verification of such.

In the longer term GHOST's individual application could be extended to a macro economic model by further analysis of the recursive structures involved and whether the networks created could become autopoeitic? This would offer a way of showing the cross dependency of a top-down vision being implemented through recursive governance with a bottom up execution framework.

In order to summarise the core theoretical and methodological contributions from GHOST, and to assess them Table 12 illustrates the advantages and disadvantages of the various systems and GHOST's application:

	Class	Advantages	Disadvantages	GHOST Applications
ORIGINAL SCHWANINGER COMPARISON (BOXED AREA)	Systems Dynamics	High order dynamic closed loops and an interest in nonlinearities High operational functionality, formal equations etc Insights and generality of application lead to robust models with a wide variety of variables Variety of modelling software available makes SD an effective learning tool for systems thinking	Not closed systems therefore only closed in an causal sense not materially Internal only focus Does not account for exogenous variety management No framework for organisational management whose definition of structure is different to SD's internal causality Limitation on managing variety (complexity) as per Ashby's Law	Application through the Vester Modelling tool and discrete process design to create the internal and intra-business communication processes. Can create dynamic financial models using linked network models and agent-based behaviour
	Organisational Cybernetics (VSM)	Focus on viability within complex environments High level of generality Strongest theory of organisational viability Allows identification of desired and current states	Makes no recommendations to particular structures leaving the observer to makes variety management decisions Does not stipulate how transition of states can occur Lacks definition of internal variable interaction Lack of comparable tools to apply the model makes its precepts difficult to understand	Provides the functional based recursive influence diagram derived from VSM methodology. Links to agent/Network models to test structural integrity of business.
	Network Theory	Formal:" Assumptions are clear Flexible: Structure can be rigid of flexible Generative: Emergent properties create greater awareness of processes Combinations: Can be used in combination with Complexity Methods, Engineering, Social, System Dynamics, Agents-based models Computationally efficient	Models can become hierarchical where heterarchical structures operate Choice of Model (Q-Theory, Rigidity, Constructal) all have drawbacks Methods used within must match objectives Functionality does not match operational process Unknown links change properties Care on weighting and direction	Used by GHOST to reconstruct the functional influence maps and then test for resilience. Also used to create the topography for the Agent-Based Models once functional mapping is occurs
	Agent-Based Models (Source:James Fowler University of California, San Diego)	Formal: Assumptions laid bare Flexible: Cognitively- agents can be "rational" or "adaptive" Tractable: Easier to cope with complexity (nonlinearities, discontinuities, heterogeneity) Generative: Helps create new hypotheses Social Science from the Bottom Up: "If you didn't grow it you didn't show it."	Models too simple Could be solved in closed-form (Axelrod 1984) Closed-form solution always preferable Models too complicated Not possible to assess causality (Cederman 1997) What use is an existence proof? Coding mistakes Many more lines of code than lines in typical formal proof Data analysis What part of the parameter space to search?	Allows a mix of models to indicate emergent behaviour and resolve marketing issues. See Figure below on System Change vs. System Dynamics

Table 12: Advantages & Disadvantages of Methods Used

Chapter 6.3: Contribution

The thesis aims to contribute to the development of theory, research and practise by proposing a methodology that can be tested and an artefact to which a practitioner might refer for best practise when assessing the outcomes of an investment.

In theory the thesis offers a multi-model approach that proposes moving away from a VaR deterministic approach to a probabilistic strategic state-space model thereby ameliorating deficiencies in current Asset Transfer Pricing Models. It further proposes that current ATPMs do not account for critical organisational and market regulatory structures thereby miss pricing the financial outcomes of investment proposals. To support this approach the thesis offers solutions from the Complexity and Viability Management Sciences to: identify the agents and networks they create such that emergent structures are discovered; a benchmark performance model tests the viability of the resulting organisational systems; and a communication model to ensure the data is understood by the stakeholders.

Individually the thesis is envisaged to contribute to the following areas:

- Complexity Economics: To provide a pathway to identify possible recursive economic structures and their dynamics;
- Management Cybernetics & Viable Systems: To identify how viable such economic systems are developed and sustained. However more specifically to use the VSM as a performance benchmarking tool along with extensions from Agent-Based Models and Networks Theory to identify emergent recursive structures.
- Agent-Based/Network Models: To use the derived recursive economic topologies as a base within the Viable System Model and Cellular Potts Model to show the emergence of such networks and dynamics to test the fragility of economic policies.
- Investment ATPMs: To provide both investors, and professionals within the investment community, with greater confidence that financial outcomes can be achieved using the tools available.

From a research perspective the proposals outline possible future paths that, along with the practical use of the artefact as a thought experiment or best practise reference, will generate more data thereby developing the use of the Complexity Sciences as tools in socio-economic systems.

In practise it is hoped that the artefact creates a richer due-diligence framework by the inclusion of recursive and compensating governance structures thus modifying existing pricing mechanisms for “tail-risk”, an essential determinant for investors looking for the possible failure rate of a financial proposal.

Realistically markets are comprised of asymmetric data and governance regimes subject to behavioural trends that can overturn logical processes. However is it felt that by offering a strong pathway moving away from deterministic pricing to a probabilistic strategy-based state-space new data might inform both investors and financial regulators alike. At a local level of economic organisation real-time changes in strategy might therefore inform regulators of the need to alter their own performance parameters and in doings so dissolve possible “bubbles” accordingly.

Chapter 6.4: Appendices

Chapter 6.4.1: Appendix 1

Chapter 6.4.1.1: The Conversation

The insights from a conversation between the author (Wasilewski 2014)and Angelo Sirignano ("AS"), Vice President & Senior Portfolio Manager for ManuLife (Canada), seeking to understand the underlying issues of market dynamics and regulatory pressure post-2008 Credit Crisis.

Chapter 6.4.1.2: Insights

No:	Headline Insight	Detail
1	"What is a systemic", Determinism & "Cycles", Local Markets	Hele comments on "systemic", Volcker et al on deterministic cycles and Armstrongs' comment on "Bull Markets local sectors"
2	Emerging Networks	When do "local transaction start to proliferate to become networks of a "bigger system" with its own parameters?
3	Probabilistic Value, Time and Network development	The Network and Agent activity is expressed Probabilistically and dependent upon the processes within Networks that might mean Time value of money scales according to process?
4	What is systemic?	Are systems "hard wired" networks, can they include others that "resonate" according to certain outcomes or is the latter the emergence of recursiveness?
5	"Risk free + Market Risk"	Many Corporate Finance pricing model assume a simple deterministic "Risk free + Market Risk" formulae that needs to be adapted to take into account 4 above
6	Others are searching for answers outside Classical Economic Theory	Hele, Armstrong, Keen and others are searching General Systems Theory and Complexity Theory for answers to how financial systems operate
7	Liquidity, Asset pricing and	Equity, Much of the current asset pricing in

	the "curve"	the debt and derivatives market is based upon discount pricing using time, interest rate and/or failure probability much of which is deterministically derived. Can the adaption of "Risk free + Market Risk" be incorporated into current Balance sheet/Product pricing methodologies and improve the liquidity of markets?
8	The use of "Standby Capital/Equity"	Offsetting stress (idiosyncratic) and other cyclical (systemic) situations
9	Definition of "liquidity"	Is it a "system" or an "outcome"? If the latter do derivatives actually offer true liquidity?
10	The role of exchanges in the financial system	Do exchanges provide liquidity through derivative trades backed by sufficient operational capital?
11	Scaling factors in recursive markets, Standby Capital pricing models	Does liquidity as an outcome follow the performance of recursive system parameters and if so what parameters do Standby Capital include – Tail and Gap risks?
12	Asset liquidity and investor variety	The concentration of assets into fewer hands effects market liquidity as a "switch price" is reached?
13	Managing variety on the market place	Variety is the real issue. Managing it within outcomes affects all of pricing model risks not only tail and gap risk. Examples of how variety can be managed: Ashby's Law and Beer's VSM
14	"Fire sales", Emotional Behaviour, and "Tipping Points [ ]"	Lowering the number of agents within a market also affects the application of the different parameters within recursive systems as they agents merge them or "cross Hedge" recursive levels to amplify "gap risks". Human behaviour within a sudden market sell-off of assets by one agent can trigger a market-wide response ("Fire sale") that directly impacts pricing
15	Bootstrapping market liquidity	"All the money is going to the same place…" "We used to have 23 types of investors now

		3…", intuitive increase the variety
16	Quantitative Easing ("QE")	The circular impact of inflation on asset price deflation
17	Finishing the "liquidity" issue, the role of the "observer" in systems	Experience has shown the material effect of agent emotions on the outcomes of ATPMs by their race to get liquidity at the best price and then restricting the market capacity when pricing as they do not observe the same markets continued value. This is addressed in "Second-Order Cybernetics" and much of David Bohm's writing.

Chapter 6.4.2: Appendix II – A Presentation on GHOST

GHOST – "A General Heuristic on Systems & Time" a new "Asset Transfer Pricing Model"

Introduction – Asset Transfer Pricing Models and their Value

1. Definition: Those models we use to price the value of other assets we may want to acquire: e.g. buying a loaf of bread.
2. How did they perform in the 2008 Credit Crisis?
    a. Overpriced mortgage funds started the crisis
    b. Market sentiment knew that other assets such as equity and debt were overpriced and a fire sale ensued.
3. In order to trade you need assets (Soft or Hard) but you also need:
    a. A sense of comparative value e.g. how much would you pay for your bread
    b. An understanding of the contextual risks e.g. what does the market value of flower bring to the price of bread
4. You also need to gather the data:
    a. A Due Diligence Process-a method to acquire contextual and project data
    b. Information transfer: did both parties understand the risks

Did managers of complex institutions understand in 2008 the variety of risks in order to create appropriate strategies in order to respond to events?

ATPMs: the Good, Bad And Ugly

The Good: Some current market models generally gather good data but the risks must be clear and simple. However no contextual data is retained.

The Bad: Complex financial products do not have general data gathering processes and assumed market methods are all true.

The Ugly: Most all these models are deterministic and where an element of probable outcomes is generated these are still fed into deterministic outcomes.

Synopsis: 2008 Environment

1. Variety of complex models
2. No general data gathering process
3. Parties are not consistently informed of data necessary to make appropriate opinions conforming to their strategy
4. No contextual structure model
5. Deterministic models and no real-time comparative for sustainable outcomes
6. The universe is probabilistic and dynamic

All of these conspired to bring about a fire sale in general credit markets and it would appear managers did not know how or could not respond dynamically to sustain outcomes that were overvalued.

Prudence and Liquidity Capital: what we lost since 1976

In the mid-1970s the Capital Adequacy Pricing Model began to take effect and its outcomes were not foreseen. The Capital Adequacy Pricing Model had a profound effect on all asset-pricing that were later found to be inaccurate or downright false. It brought about:

1. The belief that minimum capital could be maintained, as there would always be continuous access to the capital markets that would always be “liquid and deep”, in order to raise the Return on Equity for the project. This resulted in a severe lack of prudence in retained earnings and/or capital.
2. Leveraged finance

Constant margin and resource cuttingSo what did we lose?

1. Sight of underlying economic performance
2. The ability to adapt to changing circumstances

3. Access to liquidity that was loss absorbing (Equity) to pay for strategies when adverse events occur as markets suddenly changed strategies to protect their retained assets ex-post the 2008 Credit Crisis.

The combined effect of all of the above erodes the project's ability to adapt to severe adverse events and would be considered an imprudent strategy in most management approaches before the advent of the CAPM especially in the 1930's and the Great Depression when a prudent reserve for the unknown was standard practice

A Proposal: GHOST - a General Heuristic On Systems and Time

GHOST is an artefact comprising of a general model and a due diligence process.

The general model reviews how the agents create networks and sustain the business processes within an investment proposal.

What does it do?

1. It reviews the general processes through the investment and/or exchange of assets in order to arrive at a mutually beneficial financial outcome; and
2. It ensures that all parties understand the risks involved through the use of enhanced communication techniques.

What resources does it employ?

1. Existing market models and research (Klonowski's investment heuristic)
2. The use of complexity sciences to derive new data via
   a. Complexity economics: agent/network models in order to understand how the business operates and evolves
   b. Information theory: in order to ensure that the parties understand the processes and risks involved
   c. Management Cybernetics: to provide a benchmark model by which the evolving project maybe compared for its sustainable outcomes.

Application of Ghost

1. Klonowski's investment heuristic guides the investment process but is modified to identify:
   a. Management's ability to cope with variety
   b. A description of the economic contextual structure in a recursive form
2. An enhanced due diligence process uses:

   a. Information theory to highlight how effectively the parties communicate between each other and where failures occur
   b. Agent/network theory to show how the players (agents) create networks within the processes involved and the resilience thereof
3. The use of a generative and evolving model e.g. the Cellular Potts model to create probable outcomes from the processes and parameters used within the project, and against which a benchmark model can be utilised to show sustainable outcomes
4. Benchmarking performance through the use of management cybernetics is made available by:
   a. The application of the Viable System Model (VSM) created by Stafford Beer
   b. A simple performance model and functional structure embedded within the viable system model
   c. a recursive project and contextual structure to highlight the interaction of agents and their network structures
5. Drawbacks of the Viable System Model include:
   a. An inability to monitor evolving structures from new agent activity
   b. The ability to compare these new structures or networks and their outcomes over time
6. Putting It all together:
   a. The Cellular Potts Model offers the ability to model the use of recursive structures, read a market project and monitor their outcomes financially
   b. Project specific processes can be used to generate deterministic outcomes but the modified agent models are used to evolve probabilistic outcomes using different variables to the derived network systems
   c. The benchmarking process compares evolving performance against a proven viable system

Reintroducing prudence: testing the project's viability

GHOST in and of itself only tests the sustainability of existing capital. In order to ascertain whether the business/project is sustainable against catastrophic events an additional level of liquidity and capital is necessary to execute the chosen strategy going forward. A thought experiment is therefore constructed along with a cross case analysis using:

1. Standby Capital and an insurance like product that supplies needed liquidity/equity at the point of catastrophic events
2. GHOST as a pricing model of standby capital to determine the critical fracture points in the investment structure as it evolves

Conclusion and Issues

Conclusion

ATPMs are dynamic asset pricing models that derive financial outcomes sensitive to the processes and management of a variety of parameters within a recursive contextual environment.

Managers of projects need to cope with a variety of strategies that anticipate, then implement, changing circumstances in order to meet expected outcomes.

All parties must understand and communicate relevant data in order to price the exchange of assets. The process should not stop……..

Issues

There are a number of issues that need to be addressed:

1. The economy is a dynamic revolving environment within which some parameters may be hidden
2. Research is needed to develop recursive models within the CPM using new understanding of agent activity and network construction
3. Tetwork theory needs to develop a recursive, evolving structure in order to compare parameters and resilience
4. GHOST should be designed to be a simple heuristic in order that it becomes a default model and its wider benefits appreciated.

Chapter 6.4.3: Appendix III - Glossary of Terms

Agent-based Models: Asset Transfer Pricing Models are those models that appraise a business or undertaking whereby a prospective buyer assesses the risks involved to establish a commercial price such that the acquisition of either soft (services) or hard (money) assets meets a strategic financial goal. Such models can be simple, buying a loaf of bread, or complex e.g. the building of a nuclear power plant on behalf of a national government, purchase of Treasury stock based on economic data, and/or investment in complex banks or municipalities. All the latter complex items reflect different levels of risk dependent on multiple and different parameters.

Asset Transfer Pricing Model: Asset Transfer Pricing Models are those models that appraise a business or undertaking whereby a prospective buyer assesses the risks involved to establish a commercial price such that the acquisition of either soft (services) or hard (money) assets meets a strategic financial goal. Such models can be simple, buying a loaf of bread, or complex e.g. the building of a nuclear power plant on behalf of a national government, purchase of Treasury stock based on economic data, and/or investment in complex banks or municipalities. All the latter complex items reflect different levels of risk dependent on multiple and different parameters.

Autopoiesis: The circularly organized processes of “self-creation” that characterize living systems, and, by extension, processes whose products include the processes that produce them.

Black Box: A black box is a term used to identify a system where the individual component parts may not be known but the purpose or function becomes evident through the relationship of its input and output parameters. The insertion of a Black Box into the representation of a system/process allows for the assessment of observed interactions such that different outcomes for different strategies may be assessed. The black box is a fictional construct

Business (& Firm): A commercial house or firm

Causal Framework:

For the purposes of this thesis Causal Framework shall mean:

> *"The actions, or absence of, exogenous or endogenous agents that individually or collectively, directly or indirectly, cause an event or series of events that materially and adversely affect the performance of a persistent topographical structure. The agents may be connected or not within or without the topographical structure but it must be revealed that the interaction with the structure was necessary to alter the performance or outcomes. Performance refers to such temporally related expected outcomes that materially and adversely alter the potential viability of the topographical structure. The topographical structure shall mean an element, group of elements, and/or agent(s) made thereof that individually or collectively act in a cohesive and synergistic manner to maintain the functional existence of the whole "*

For a different view the following may be retrieved from Stanford University Website[xlix] on factual and counterfactual causality.

See also *clustering coefficient* in **Variety**

Cellular Potts Model: The Cellular Potts Model, or CPM, is a model that studies the long-term behaviour of complex systems such that its internal elements and how they react with each other under certain conditions and reveals parameters or characteristics that each element possesses. Elements can consist of individual agents, a collection of agents that operate under certain conditions and/or a nested variety of each. The central element of a Potts model is its Hamiltonian that represents the core set of assumptions the models' strategy aims to represent. The CPM, in common with agent-based models, can evolve macroscopic and microscopic changes of parameters. The CPM is programmed herein to compare a recursive market and investment project in the form of a set of agents derived from Due Diligence then generate a series of probable outcomes based on the agents activity. The outcomes are then compared to the benchmark Viable System Model ("VSM") of the same project and context to derive a set of comparative temporal and sustainable outcomes.

Circularity: The form of a process executed in an organization in which, after an indefinite (but usually small) number of steps the process ends up where it started (but often with a different value). Recursive systems are circularities, as is the understanding of control and of (conversational) communication explored in this article.

Collateralized debt obligations (CDOs): a type of structured asset-backed security whose value and payments are derived from a portfolio of fixed-income underlying assets. CDOs based on sub-prime mortgages have been at the heart of the global financial crisis. CDOs are assigned different risk classes or tranches, with "senior" tranches considered to be the safest. Since interest and principal payments are made in order of seniority, junior tranches offer higher coupon payments (and interest rates) or lower prices to compensate for additional default risk. Investors, pension funds, and insurance companies buy CDOs. (Nanto(Nanto 2009))

Communication: The act and means by which one system persuades another system to create an understanding (its own understanding).

Complexity Theory: Complexity Theory is the study of complex and chaotic systems to discern how order, pattern, and structure can be created to form coherent systems. It derives from the study of cybernetics, agent-based models and network theory.

Contingent Convertible Debt (Co-Co): A Contingent Convertible Debt product is a bond with terms that allow some, or all, of the outstanding principal to be forgiven or converted into shares of the issuer upon a pre-agreed formulae. As with any other bond liquidity is transferred at inception.

Control: The act by which one (controller) system shapes the behavior of another (controlled) system, so that its behavior is more to the liking of the controller. However, investigation shows that control is circular and that controller and controlled are roles determined by an observer.

Conversation: A circular form of communication in which each participant constructs his own understanding. Checks on understandings between participants occur through re- presentation of individual understandings in a feedback loop. Conversation occurs between participants and is essentially interactive.

Credit default swap (CDS): a credit derivative contract between two counterparties in which the buyer makes periodic payments to the seller and in return receives a sum of money if a certain credit event occurs (such as a default in an underlying financial instrument). Payoffs and collateral calls on CDSs issued on sub-prime mortgage CDOs have been a primary cause of the problems of AIG and other companies. (Nanto(Nanto 2009))

Critical Path:[l]

A project-management technique that lays out all the activities needed to complete a task, the time it will take to complete each activity and the relationships between the activities. Also called the "critical path method", critical path analysis can help predict whether a project can be completed on time and can be used to reorganize the project both before starting it, and as it progresses, to keep the project's completion on track and ensure that deliverables are ready on time.

Either manually or using computer software, the project manager first lists each activity, the order it must be completed in and how long it is expected to take, and then diagrams the process.

Investopedia explains 'Critical Path Analysis'

The critical path refers to the way the diagram shows those activities that must be completed, and complete in a specific order, so that the project can be completed successfully and on time. A series of lines and circles visually depict the critical path. Each circle represents an activity that needs to be completed and each line shows the relationship between two activities. The critical path will be the longest path through the diagram, and will show how long a project is expected to take if the scope does not change and everything goes according to plan.

Cybernetics: "The study of circular causal, and feedback mechanisms in biological and social science" (Macy Conferences); later, "Communication and control in the animal and the machine" (Wieners eponymous book).

Deleveraging: The unwinding of debt. Companies borrow to buy assets that increase their growth potential or increase returns on investments. Deleveraging lowers the risk of default on debt and mitigates losses, but if it is done by selling assets at a discount, it may depress security and asset prices and lead to large losses. Hedge funds tend to be highly leveraged. (Nanto(Nanto 2009))

Derivative – Financial Instruments: Derivatives

Derivative - System Dynamics: Derivatives define rates of change in state variables. For instance, if we had a state variable representing the size of a population, a derivative would specify how this population grows or shrinks over time. The population's derivative would aggregate all changes such as births, deaths and immigration or emigration to show the net change in the state variable over time.**(Foreman-Roe and G 2013)**

Derivative – Ontological Difference: Derivatives

System Dynamics Primitive	Differential Equation Equivalent
Stock	State Variable (X, Y, etc...)
Flow	Derivative (dX/dt, dY/dt, etc...)
Variable	Constants/Parameters (α, β, etc...)

Figure 136: BCTD - Ch.10 - Mathematics of Modeling

Since they do not differ significantly from a mathematical standpoint, what separates these two approaches to modelling? Where System Dynamics and differential equation modeling differ is in their focus and philosophy. The primary goal for differential equation modelers is analytic tractability (in other words, how easy is it to mathematically manipulate and understand the model's equations). This analytic tractability allows these modelers to derive definite results and conclusions from the model's equations. System Dynamics modelers generally are less concerned about analytic tractability and are more comfortable with simulating the model and drawing conclusions from observed trajectories and numerical results.(Foreman-Roe and G 2013)Ch.10p.3.

This application difference is amplified in ATPMs as inference in System Dynamics is replaced by exact values and boundary conditions that trigger events such as payments under or default of contracts. (Author)

Due Diligence:

Oxford English Dictionary

1. Reasonable steps taken by a person to avoid committing a tort or offence.

2. A comprehensive appraisal of a business undertaken by a prospective buyer, especially to establish its assets and liabilities and evaluate its commercial potential.

Investopedia.com

1. An investigation or audit of a potential investment. Due diligence serves to confirm all material facts in regards to a sale.

2. Generally, due diligence refers to the care a reasonable person should take before entering into an agreement or a transaction with another party.

   Offers to purchase an asset are usually dependent on the results of due diligence analysis. This includes reviewing all financial records plus anything else deemed material to the sale. Sellers could also perform a due diligence analysis on the buyer. Items that may be considered are the buyer's ability to purchase, as well as other items that would affect the purchased entity or the seller after the sale has been completed.

   Due diligence is a way of preventing unnecessary harm to either party involved in a transaction.

Economics: Ancient Greek οἰκονομία (*oikonomia*, "management of a household, administration") from οἶκος (*oikos*, "house") and νόμος (*nomos*, "custom" or "law") (Wikipedia)

Epistemology: What may be known, and how we can come to know this.

Firm: Derived from Investopedia.com (See Business)

Definition of 'Firm'

A business organization, such as a corporation, limited liability company or partnership. Firms are typically associated with business organizations that practice law, but the term can be used for a wide variety or business operation units.

'Firm' Description

While business activities are typically conducted under the firm's name, the legal protection to employees or owners depends on the type of organization it was created under. Some organizational types, such as corporations, provide more protection than others

First order Cybernetics: "The study of observed systems" (von Foerster).

Gross Domestic Product – GDP: The monetary value of all the finished goods and services produced within a country's borders in a specific time period, though GDP is usually calculated on an annual basis. It includes all of private and public consumption, government outlays, investments and exports less imports that occur within a defined territory.

GDP = C + G + I + NX

where:

"**C**" is equal to all private consumption, or consumer spending, in a nation's economy

"**G**" is the sum of government spending

"**I**" is the sum of all the country's businesses spending on capital

"**NX**" is the nation's total net exports, calculated as total exports minus total imports. (NX = Exports - Imports)

Hamiltonian: A is a dynamical system governed by Hamilton's equations. In physics, this dynamical system describes the evolution of a physical system such as a planetary system or an electron in an electromagnetic field. These systems can be studied in both Hamiltonian mechanics and dynamical systems theory **(Wikipedia)**

Heuristic: Enabling a person to discover or learn something for themselves (OED)

> *a 'hands-on' or interactive heuristic approach to learning*
>
> 1.1 *Computing* Proceeding to a solution by trial and error or by rules that are only loosely defined.

Hidden Variables: Non-given variables and unobservable relationships between variables are categorized as hidden variables. Identifying hidden variables is an important step in forming and testing a hypothesis.

In a scientific inquiry process with many variables, some variables are obvious, but others are either not given or cannot be determined directly. Some relationships between variables are easily observed, but other relationships don't show up during experimentation. Both non-given variables and unobservable relationships between variables are categorized as hidden variables. These hidden variables are related to other given variables and sometimes affect the dependent variable being tested. Thus, identifying hidden variables is an important step in forming and testing a hypothesis. (Filed in Dimensions of Scientific Reasoning on Apr.11, 2011)

Interaction: Mutual responsiveness that may lead to novelty, in which no participant has formal control over the proceedings. Interaction occurs between participants, not because of any one of them. Conversation epitomizes interaction in progress.

Law of Requisite Variety:

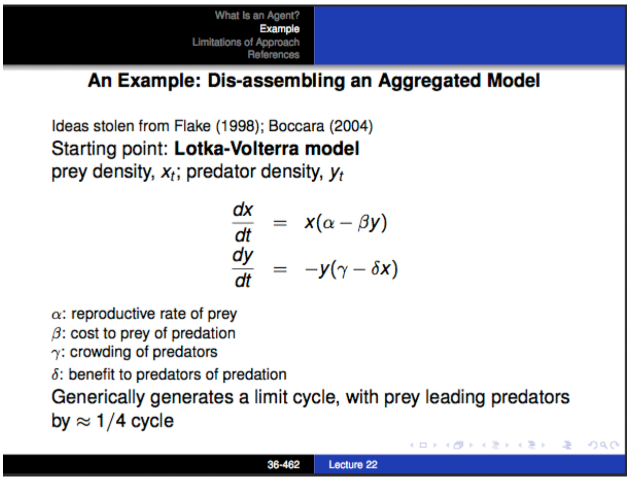
Law of Requisite Variety, An example *of one of the consequences of Bremerman's Limit:* "Achieving coordination in maneuver means that the total set of all possible combinations of movement (including those that lead at once to collision) are to be restricted to a special subset of the combinations (those combinations approved by naval strategy.)

Achieving the restriction demands the corresponding quantity of transmission (by Shannon's tenth theorem or by the Law of Requisite Variety.)

Thus, to be more definite, suppose that there are 100 ships, that the only requirement in manoeuvre is that all ships shall turn in the same direction, and that the signaller's total capacity as a channel provides 200 bits per course-setting. Such a fleet can coordinate its direction to the degree of choosing between port, starboard, and ahead (for 99[log2 3] is less than 200) but no distribution of signallers or arrangement of coding can refine the selection of direction to adding half-to-port and half-to-starboard (for these would require 99[log2 5] bits, which is greater than the 200 bits available).

Thus, the existence of a limit to the total quantity of information transmissible puts an absolute limit to the amount of regulation or control achievable.

Lotka-Voltera Model(Shalizi): Agent-Based Model Base



Measurement: A quantitatively expressed reduction of uncertainty based on one or more observations

- Concept of Measurement: The definition of measurement is widely misunderstood. If one understands what "measurement" actually means, a lot more things become measurable;
- Object of Measurement: The thing being measured is not well defined. Sloppy and ambiguous language gets in the way of measurement;
- Methods of Measurement: Many procedures of empirical observation are not well known. If people were familiar with some of these basic methods, it would become apparent that many things thought to be immeasurable are not only measurable but may already have been measured.

Hubbard((Hubbard 2010)

Models: Several definitions occur but No. 3 will be used herein

1. A three-dimensional representation of a person or thing or of a proposed structure, typically on a smaller scale than the original (OED)
2. A thing used as an example to follow or imitate
3. A simplified description, especially a mathematical one, of a system or process, to assist calculations and predictions

Mutualism: The reciprocal arrangement by which what may be of one may be of the other.

Observation: What the observer determines to be the case. Observation is not necessarily visual.

Observer: The system that determines what is the case.

OED: Oxford English Dictionary

Preferred equity: A cross between common stock and debt. It gives the holder a claim, prior to that of common stockholders, on earnings and on assets in the event of liquidation. Most preferred stock pays a fixed dividend. As a result of the stress tests in early 2009, some banks may increase their capital base by converting preferred equity to common stock. (Nanto(Nanto 2009))

Procyclicality: The tendency for market players to take actions over a business cycle that increases the boom-and-bust effects, e.g. borrowing extensively during upturns and deleveraging during downturns. Changing regulations to dampen procyclical effects would be extremely challenging. (Nanto(Nanto 2009))

Properties of Money: In conventional economic theory there are three well-known properties of money. They are:

1. A means of payment,
2. A store of value
3. A numeraire
4. There is a fourth property, which can be seen when exchange is modeled as a playable game. That is “Money as a way to distinguish agents. The nature of the strategic actions an agent can take with respect to money may

differentiate one agent from another. In particular government, private financial institutions such as banks and private natural persons have different actions they can take with respect to money. Agents are thus distinguished by the differences in their strategy sets with respect to their actions involving the creation and utilization of money" Structure, Clearinghouses and Symmetry: Martin Shubik and Eric Smith(Shubik and Smith 2007)

Process(es): A series of actions or steps taken in order to achieve a particular end

Recursion: Literally, backward movement, return: e.g. a process by which the response to a statement raises that statement again. Self-referential systems have this quality. An example of recursion is the round, "A dog came in the kitchen/ and stole a crust of bread/ then cook up with a ladle/ and beat him till he was dead// Then all the dogs came running/ and dug the dog a tomb/ and wrote upon the tomb stone/ for the eyes of dogs to come// "A dog came in" (from Samuel Becketts "Waiting for Godot"). All things that are applied to themselves, including the cybernetics of cybernetics , are recursive.

Risks: Parlour definition

- ***Market risk***. Counterparty risk represents a combination of credit risk (the deterioration of the credit quality of the counterparty) together with market risk (the potential value of the contract(s) with that counterparty at the point at which the credit quality deteriorates). This interaction of market and credit risk has been long associated with counterparty risk and will be a key feature of much of this book.
- ***Operational risk***. The management of counterparty risk relies on practices such as netting and collateralisation that themselves give rise to operational risks as will be discussed in more detail in Chapter 4.
- ***Liquidity risk.*** Collateralisation of counterparty risk may lead to liquidity risk if the collateral needs to be sold as some point due to a credit event. This may also be described as "gap risk". Such aspects also tackled in Chapters *5* and 8. Rehypothecation of collateral (Chapter 3) is also an important consideration here.
- ***Systemic risk.*** Central counterparties (CCPs) act as intermediaries to centralise counterparty risk between market participants. Whilst offering advantages such as risk reduction and operational efficiencies, they potentially allow dangers such as moral hazard and asymmetric information to develop and flourish. CCPs may ultimately create greater systemic risk in the market due to the possibility that they themselves might fail. This is discussed at length in Chapter 14."

Second order Cybernetics: "The study of observing systems" (von Foerster). Also, the study of cybernetics from a point of view informed by the understandings developed in cybernetics.

Soliton: In mathematics and physics, a soliton is a self-reinforcing solitary wave (a wave packet or pulse) that maintains its shape while it travels at constant speed. Solitons are caused by a cancellation of nonlinear and dispersive effects in the medium. (The term "dispersive effects" refers to a property of certain systems where the speed of the waves varies according to frequency.) Solitons arise as the solutions of a widespread class of weakly nonlinear dispersive partial differential equations describing physical systems. Source: Princeton.edu[li]

State Variable: A state variable is an object that represents part of the state of a system. For instance, in a population model you could have a state variable representing the current number of individuals in that population. In a model of a lake, you could have a state variable representing the current volume of water in the lake. In equations, state variables are often represented using Roman letters such as X, Y or Z (BCTD(Foreman-Roe and G 2013))

Standby Capital: An on demand financial contract that is asset-backed, pre-priced and placed with a simple trigger to convert from its “standby” mode into equity of the target Project. Upon conversion pre-allotted shares will be issued to the investors promising to supply liquidity at the time it is called, in proportion to the amount drawn and the formulae’s determined value and number of shares.

Systemic risk: The risk that the failure of one or a set of market participants, such as core banks, will reverberate through a financial system and cause severe problems for participants in other sectors. Because of systemic risk, the scope of regulatory agencies may have to be expanded to cover a wider range of institutions and markets. (Nanto(Nanto 2009))

Systems: A set of things working together as parts of a mechanism or an interconnecting network; a complex whole (OED)

United Steel: Was an amalgam of British steel and mining companies dating from 1918[lii] until their nationalisation in 1967 to become British Steel plc (now part of Tata Steel) and we must surmise that the objective of employing Beer, and his department, was to better define the operational requirements hence optimal profit of the organisation. The commercial process employed within the business, at the time, would first need to be identified and then set into an UK economic context which, being post-World War II, was in a parlous state and heavily indebted to the USA.

Variety: The quality or state of being different or diverse; the absence of uniformity or monotony (OED); the number of possible states of a system or of an element of the system (Ashby/Beer). Variety calculations:

> **States of a System:** e.g. the total variety of states in a system is $g = S^n$, where g is the variety of states, S is the number of states per element, and n = the number of elements;
>
> **Communications:** e.g. the total variety of states in a dualistic (two-way) communication is $r = n*(n-1)$
>
> **Clustering Coefficient:** is defined as
>
> $$C = 2n / m*(m-1)$$
>
> where:
>
> n is the number of links between
>
> m neighbors.
>
> A large clustering coefficient indicates that neighbours of a node are likely to interact to each other.

Chapter 6.4.4: Appendix IV – Organisational and Leadership Diagrams

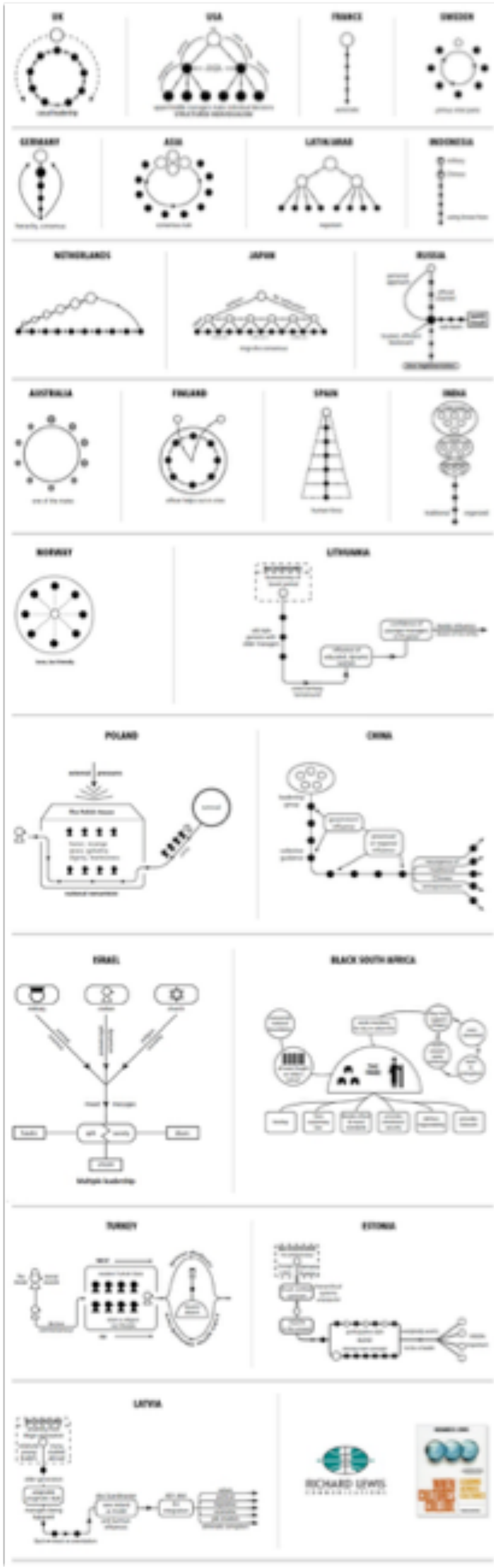


Figure 137: Business Insider (Australia)

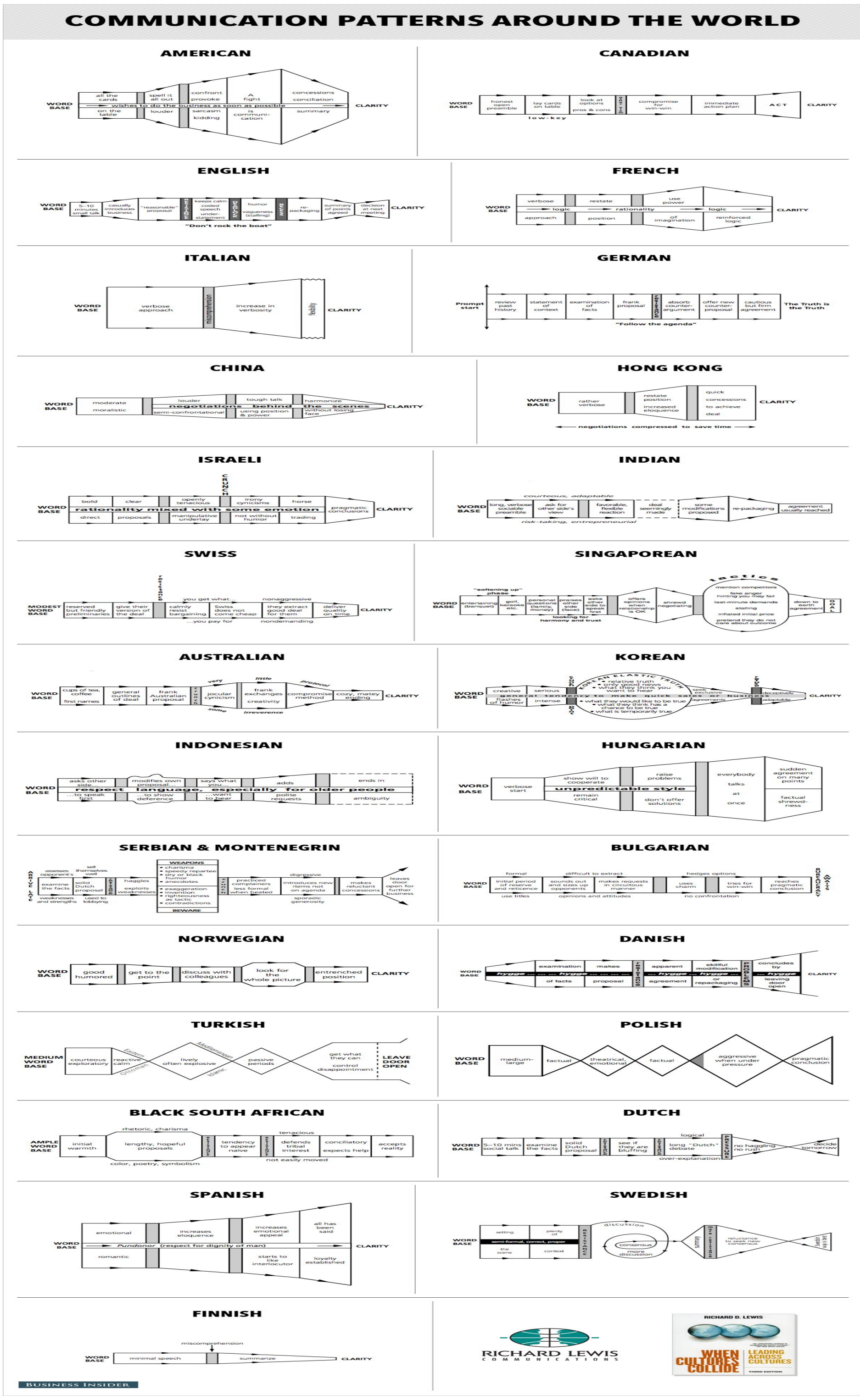


Figure 138: CrossCulture.com/BusinessInsider.com

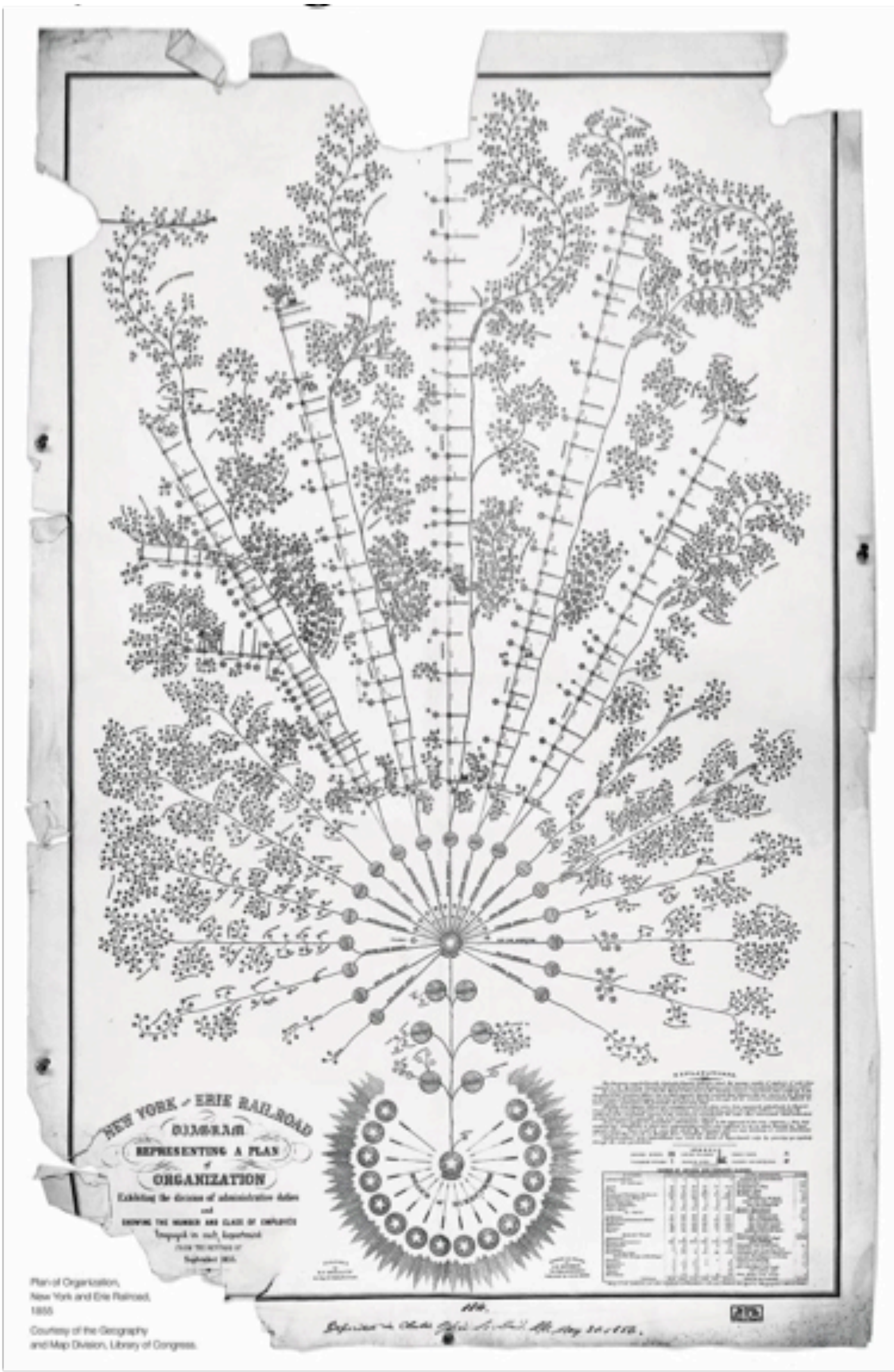


Figure 139: 1855 Organisation Chart - Eire Railroad USA

Chapter 6.4.5: Appendix V - Bankers Trust – Supporting Data

Bankers Trust Contingent Capital Data

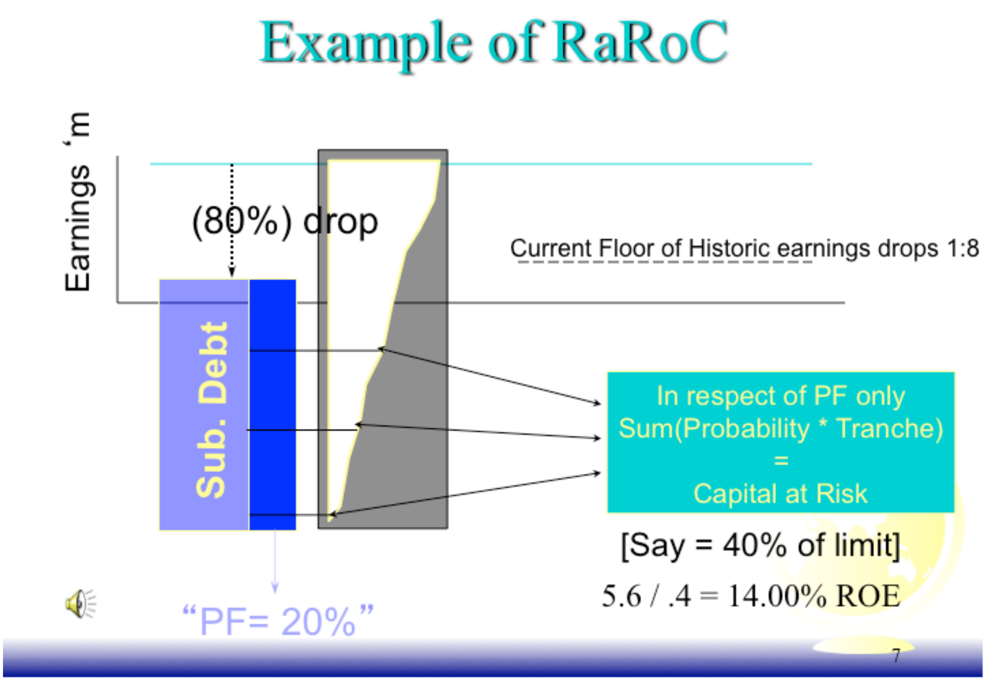


Figure 140- Example of BT Contract Structure – Drawdown

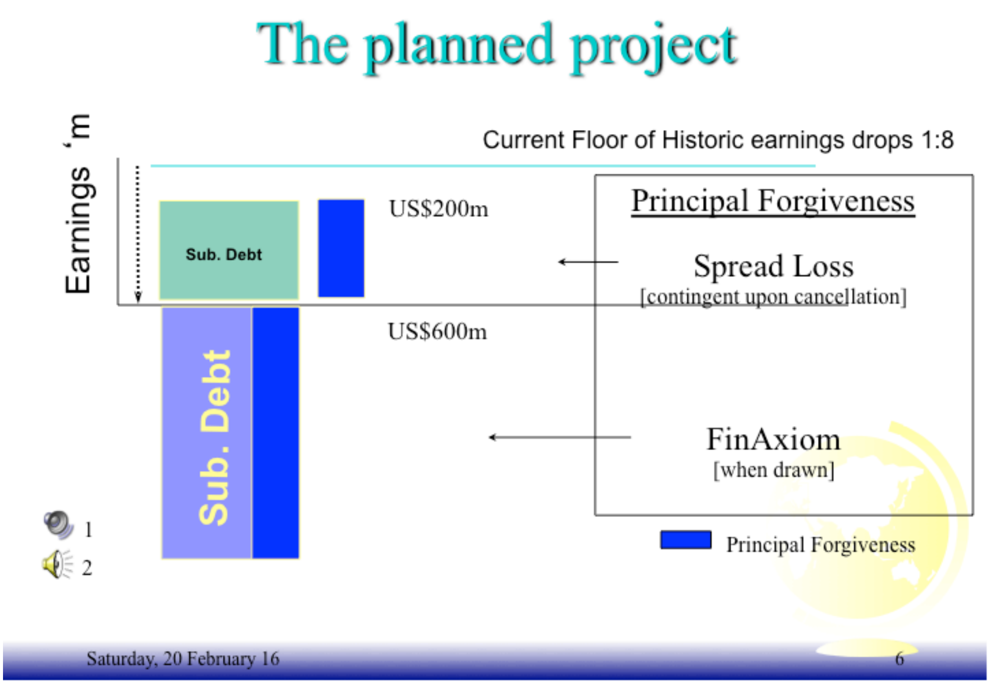
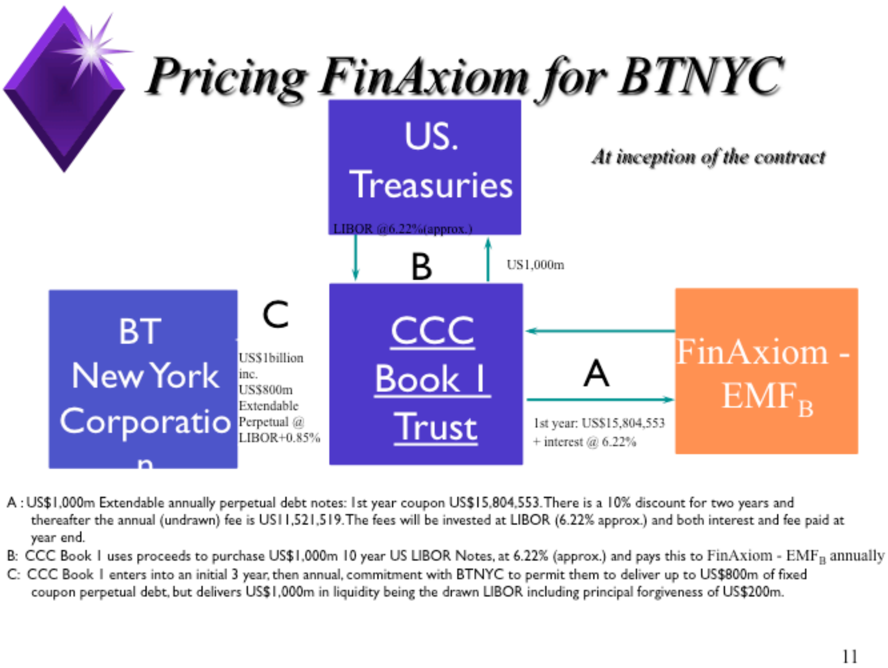
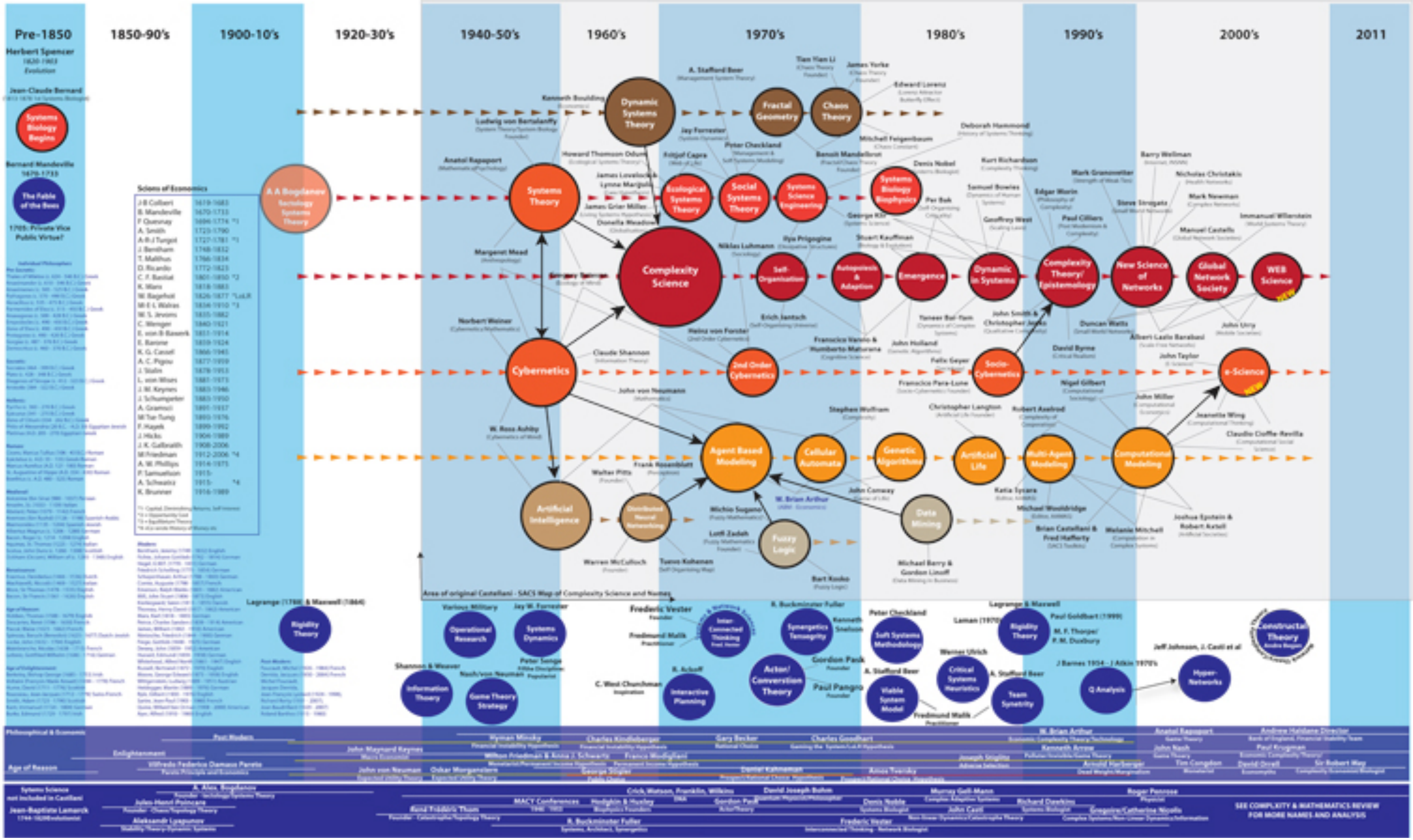


Figure 141: BT Planned Structure

Figure 142: BT block diagram of contract flow



Chapter 6.4.6: Appendix V! - Atlas of Economic and System Theory Players


Pre-1850
1850-90's
1900-10's
1920-30's
1940-50's
1960's
1970's
1980's
1990's
2000's
2011
Herbert Spencer
Jean-Claude Bernard
Systems Biology Begins
Bernard Mandeville
The Fable of the Bees
Scions of Economics
A A Bogdanov Tectology Systems Theory
Dynamic Systems Theory
Fractal Geometry
Chaos Theory
Systems Theory
Ecological Systems Theory
Social Systems Theory
Systems Science Engineering
Systems Biology Biophysics
Complexity Science
Self-Organisation
Autopoiesis & Adaptation
Emergence
Dynamic in Systems
Complexity Theory/ Epistemology
New Science of Networks
Global Network Society
WEB Science
Cybernetics
2nd Order Cybernetics
Socio-Cybernetics
e-Science
Agent Based Modeling
Cellular Automata
Genetic Algorithms
Artificial Life
Multi-Agent Modeling
Computational Modeling
Artificial Intelligence
Distributed Neural Networking
Fuzzy Logic
Data Mining
Area of original Castellani - SACS Map of Complexity Science and Names
Rigidity Theory
Operational Research
Systems Dynamics
Information Theory
Game Theory Strategy
Inter Connected Thinking
Synergetics Tensegrity
Soft Systems Methodology
Actor/ Conversation Theory
Interactive Planning
Viable System Model
Critical Systems Heuristics
Team Syntegrity
Q Analysis
Hyper-Networks
Constructal Theory
SEE COMPLEXITY & MATHEMATICS REVIEW FOR MORE NAMES AND ANALYSIS

Chapter 6.4.7: Appendix VII – Ethical Statement

Within this thesis there are multiple ethical considerations and areas where intellectual property will be concerned. The thesis is not only an assessment of some of the areas but also the approach intended to mitigate the issues. I have used an iterative approach as this dentifies the boundaries as well as the issues.

Whilst the thesis in based upon my own experiences and documented events any interviewees requiring anonymity were given unless they specifically gave permission to be quoted and any intellectual property that is transferred was quoted as such. Over-riding this was the need for confidentiality and all reports were given to interviewees prior to inclusion in the papers and their agreement to published signed-off by them.

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EndNotes

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[i] http://www.iso.org/iso/home/standards/iso31000.htm
[ii] http://www.journalofaccountancy.com/issues/1998/jul/carter.html
[iii] See history at http://www.balticexchange.com/default.asp?action=article&ID=19
[iv] http://www.londonstockexchange.com/about-the-exchange/company-overview/our-history/our-history.htm
[v] What was to become the Industrial Revolution between 1760 and 1840
[vi] See the development of continuous production of paper (Fourdrinier machine) that influences rolled steel production
[vii] A full debate on the Commerce Clause can be found at http://www.bu.edu/rbarnett/Original.htm
[viii] The name used for the core founding fathers of the Constitution
[ix] http://en.wikipedia.org/wiki/Gibbons_v._Ogden - ***Gibbons v. Ogden***, 22 U.S. 1 (1824)
[x] Henry Oldenburg was the first Secretary of *The Royal Society*
[xi] http://mises.org/daily/3689/
[xii] http://www.unifr.ch/econophysics
[xiii] http://www.nature.com/nature/journal/v238/n5364/abs/238413a0.html
[xiv] See Glossary of terms
[xv] This also lies at the heart of hypothecation as the seller may gain financial but retain unknown risks: "gap risk"
[xvi] http://en.wikipedia.org/wiki/Leverage_(finance)
[xvii] http://uk.businessinsider.com/leadership-styles-around-the-world-2013-12?r=US&IR=T#ixzz2wxsJZTd3

[xviii] A conversation with Allenna Leonard, Beer's partner for 25-years until his death.
[xix] http://www.youtube.com/watch?v=q3yNJPkdtYo
[xx] Though in a meeting with Stafford in 1998 the author received the distinct impression he recognised but was concerned about its military application
[xxi] http://www.iep.utm.edu/hume-cau/
[xxii] http://www.unice.fr/DeptPhys/sem6/2011-2012/PagesWeb/PT/Pendule/En/study.html and http://www.phy.davidson.edu/stuhome/phstewart/IL/final/data%20and%20results/choasintp.htm
[xxiii] http://kennethsnelson.net/
[xxiv] Discussion with Barry Clemson, Viable System Model LinkedIn, "Can anyone recommend some simple resources on Bayesian statistics"
[xxv] http://www.math.uni-hamburg.de/home/gunesch/Entropy/dynsys.html
[xxvi] http://www.thefreedictionary.com/entropy
[xxvii] See Glossary of Terms
[xxviii] See Ecosystem, Economics & Recursion in Glossary of Terms
[xxix] Oxford Dictionary: a substance, organ, or other agent that participates in an effect of synergy
[xxx] See previous definition of autopoeisis
[xxxi] A private placement for a Pyrolysis reactor in the UK by FinaXiom LLP
[xxxii] A Standby Capital product by FinaXiom LLP
[xxxiii] See Vogal & HayesVogel, F. E. and S. L. Hayes (1998). Islamic law and finance : religion, risk, and return. Boston, Mass., Kluwer Law International. and Natalie SchoonSchoon, N. (2005). "Residual Income Models and the Valuation of Conventional and Islamic Banks."
[xxxiv] FTPress: By Yaakov Weber, Christina Oberg, Shlomo TarbaWeber, Y., S. Tarba and C. Oberg (2013). Comprehensive Guide to Mergers & Acquisitions, A: Managing the Critical Success Factors Across Every Stage of the M&A Process London, Pearson FTPress.
[xxxv] http://www.anylogic.com/blog?page=post&blog=blog_EN&id=133
[xxxvi] Part of a classification of financial language devised by the author and Barry L Zins at Merrill Lynch in 1993
[xxxvii] http://www.investopedia.com/terms/d/debt.asp#axzz2Mlf5zTBh

[xxxviii] Part of a classification of financial language devised by the author and Barry L Zins at Merrill Lynch in 1993
[xxxix] http://www.investopedia.com/terms/d/debt.asp#axzz2Mlf5zTBh

[xl] Online Oxford English Dictionary - paraphrased
[xli] That part of a recursive level that organises one or more underlying components/enterprises/agents
[xlii] www.thefreedictionary.com/allometric Allometry is the study of change in an organisation as a consequence of growth

[xliii] http://www.wsj.com/articles/SB904691855730967500
[xliv] A full term sheet was never completed with legal approval as LTCM defaulted on the same day as board approval was to be given.
[xlv] See *www.imc-seminars.com/uploads/papers/Alan%20Punter.ppt*
[xlvi] This does not mean investors or outside parties know about impending issues just that it is not confirmed public knowledge or crystallised losses.
[xlvii] http://www.fsb.org/2015/11/tlac-press-release/
[xlviii] Gregory Hill, PhD - http://ghill.customer.netspace.net.au/docs/ch2_method_design.html

[xlix] http://plato.stanford.edu/entries/causation-counterfactual/

[l] http://www.investopedia.com/terms/c/critical-path-analysis.asp
[li] https://www.princeton.edu/~achaney/tmve/wiki100k/docs/Soliton.html
[lii] http://en.wikipedia.org/wiki/United_Steel_Companies