ENTREPRENEURIAL KNOWLEDGE TRANSFER

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Declaration

The work in this thesis is my own except where otherwise stated.

Benjamin John Heslop
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I’d like to first like to express my gratitude to my original supervisors, Dr Gerard Borg and Dr Jeffrey Harris, who were consistently patient and encouraging. Thanks also go to Dr Margaret Rossiter and Dr Romeo Turcan for introducing me to System Dynamics and Grounded Theory respectively.

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Thank you all; this work would have been impossible without you.
ABSTRACT

This work first creates its own definition of knowledge transfer; one that renders a symmetric economic exchange unnecessary. Set Theory is then utilised to categorise those activities that fall into what is nominated as Entrepreneurial Knowledge Transfer (EKT). A methodology informed by Grounded Theory is proposed, in which interview data is incorporated from practitioners is collected from four British universities with an innovative approach to EKT.

The results are then expressed in the form of a System Dynamics control theory model which contends that EKT is carried out from within a cooperative yet diverse network of people. Such a network was found to have four fundamental independent dimensions with accumulating stocks identified as Activity, Capacity, Spectrum and Engagement. In addition to these, Coordination emerges as an instantaneous variable (and 5th construct) approximating to management or leadership. The five constructs interact via cause-effect linkages, of which there is complete saturation of the model, with each linkage finding resonance in a broad cross-section of literature.

Notwithstanding a lack of explicit knowledge of mathematical dependencies, the polarity of the linkages gives rise to analysis of behaviour based upon feedback coupled with qualitative consideration of a number of exogenous forces, including market access and leadership strength. Phases of growth are introduced with the suggestion that as the network matures, emphasis is gradually shifted from Engagement and Activity (uncomplicated but invigorating and dynamic) to Capacity and Spectrum (resource depth and diversity allowing market penetration).

This analysis leads on to the specific recommendation that the role of grant officer and facilitator be merged, essentially allowing the formation of small networks based upon informal interaction rather than written application. Transparent availability of information to participants as well as public funding agencies regarding the performance of individual facilitators/networks was postulated as a critical aspect of any systemic solution. When considered in the context of numerous networks operating in conjunction, such information feedback effectively allows a virtual ‘oversight’ network to be created that represents smaller networks cooperating to take advantage of the critical mass thus created.
INDEX OF TERMS

The follow terms have a particular meaning in this thesis in relation to the paradigm model developed; all occurrences of ‘linkages’ within the model are underlined.

A

abuse position: impact on Coordination, 119; independence to premise. See premise, betrayal of; linkage justification, 73; personal preference, 106; premise betrayal. See premise accept responsibility: freedom to exercise creativity, 82; impact on Activity, 101; linkage justification, 76 Activity: construct definition, 57 allocate roles, 92; impact on Capacity, 105; interaction with gain recognition. See; linkage justification, 90

B

barrier: first usage, 3 benefit: first usage, 3 broaden membership: impact on Spectrum, 117; linkage justification, 88 build proficiency: comparison with. See share experience: impact on Capacity, 108; linkage justification, 69 buy loyalty: conjunction with establish reputation, 114; impact on Spectrum, 115; linkage justification, 71; similarity to marketing, 115

C

Capacity: construct definition, 58 capture information: coalface feedback. See share experience: impact on Coordination, 122; linkage justification, 68 confidence: first usage. See interpersonal trust confirm assumptions: impact on Engagement, 111; linkage justification, 90; S-shaped relationship, 111 constructive interaction: impact on Engagement, 109; linkage justification, 67 Coordination: construct definition, 61; emergent on basis of mutual consent. See

D

demonstrate inclusivity: impact on Spectrum, 117; linkage justification, 86; S-shaped relationship, 229 diminishing returns: impact on Activity, 99; linkage justification, 69; S-shaped relationship, 229

E

Engagement: construct definition, 59 entrepreneurial knowledge transfer: first usage, 10; value of literature comparison, 123 establish reputation: impact on Spectrum, 113; linkage justification, 66 exclude difference: company recruitment. See broaden membership; conjunction with group think. See confirm assumptions: impact on Spectrum, 116; linkage justification, 79 external obligations: impact on Coordination, 121; linkage justification, 85

F

foster coherency: funding policy, 114; impact on Engagement, 112; linkage justification, 89

G

gain recognition: impact on Engagement, 111; linkage justification, 72 generate novelty: impact on Activity, 103; linkage justification, 82; social norms, 97 goal: first usage, 3; merging entrepreneurship, 11; motivation, 11

I

interpersonal conflict: counteraction of foster coherency, 113; impact on Engagement, 110; linkage justification, 84

K

knowledge transfer: considerations from donor perspective, 11; Stages, dictionary definition, 2; Working hypothesis, 5, 160

M

medium: first usage, 2

N

network: conceptual definition, 56; conservative (non-innovative). See premise, betrayal of; institutions, 97; negative Coordination, 229

P

paradigm model: evolution of proforma, 35; first mention, 34; introduction of constructs, 57; optimisation. See Analysis peer induction: comparison to broaden membership, 88; comparison to buy loyalty, 72, See; conjunction with establish reputation, 114; impact on Capacity, 105; linkage justification, 77 premise: always take opportunities to assist network, 224; betrayal of, 62; betrayal of, within the literature, 98; conceptual definition, 56; current and future needs of the network. See allocate roles; fragmented. See premise, betrayal; group behaviour, 96
preparation: first usage, 3

recipient: first usage, 3
recognise authority: as opposed to beneficial search position. See generate novelty: impact on Coordination, 118; linkage justification, 78

share experience: impact on Capacity, 108; linkage justification, 74; S-shaped. See Spectrum: construct definition, 60
structure activities: impact on Activity, 102; linkage justification, 92; similarity to. See allocate roles suitable expertise: impact on Capacity, 107; linkage justification, 83
supply resources: impact on Activity, 100; linkage justification, 71; premise betrayal. See premise

S

set theory, 9

ACRONYMS

<table>
<thead>
<tr>
<th>AIC</th>
<th>Algorithmic Information Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANU</td>
<td>Australian National University</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
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<tr>
<td>EKT</td>
<td>Entrepreneurial Knowledge Transfer</td>
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<td>Go8</td>
<td>Group of Eight (Australia)</td>
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<td>IP</td>
<td>Intellectual Property</td>
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<td>KT</td>
<td>Knowledge Transfer</td>
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<tr>
<td>LAN</td>
<td>Local Area Network</td>
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<tr>
<td>MD</td>
<td>Managing Director</td>
</tr>
<tr>
<td>NCRIS</td>
<td>National Collaborative Research Infrastructure Strategy (Australia)</td>
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<tr>
<td>NRP</td>
<td>National Research Priority (Australia)</td>
</tr>
<tr>
<td>NSF</td>
<td>National Science Foundation (United States)</td>
</tr>
<tr>
<td>PC</td>
<td>Productivity Commission (Australia)</td>
</tr>
<tr>
<td>TT</td>
<td>Technology Transfer</td>
</tr>
<tr>
<td>TTO</td>
<td>Technology Transfer Office</td>
</tr>
</tbody>
</table>
4.2 LINKAGE JUSTIFICATION ........................................................................................................65
  4.2.1 IMPACT OF NETWORK ACTIVITY ..............................................................................65
  4.2.2 IMPACT OF NETWORK CAPACITY .............................................................................70
  4.2.3 IMPACT OF NETWORK ENGAGEMENT ......................................................................75
  4.2.4 IMPACT OF NETWORK SPECTRUM ..........................................................................81
  4.2.5 IMPACT OF COORDINATION ....................................................................................87

5 LITERATURE .........................................................................................................................95
  5.1 PRELIMINARY CONSIDERATIONS ..................................................................................95
    5.1.1 EXPLANATION OF THE APPROACH .......................................................................95
    5.1.2 PREMISES WITHIN COOPERATIVE GROUPS ............................................................96
  5.2 COMPARISON TO LINKAGES ..........................................................................................99
    5.2.1 IMPACT ON ACTIVITY ..........................................................................................99
    5.2.2 IMPACT ON CAPACITY .........................................................................................104
    5.2.3 IMPACT ON ENGAGEMENT ..................................................................................109
    5.2.4 IMPACT ON SPECTRUM .......................................................................................113
    5.2.5 IMPACT ON COORDINATION ..............................................................................118
  5.3 CONCLUDING REMARKS ...............................................................................................123

6 ANALYSIS ............................................................................................................................125
  6.1 STATIC ANALYSIS OF BEHAVIOUR ...........................................................................125
    6.1.1 LINKAGE MEDIATION .........................................................................................125
    6.1.2 MEDIATION BY OPERATIONAL ENVIRONMENT ....................................................127
  6.2 DYNAMIC ANALYSIS OF BEHAVIOUR .....................................................................132
    6.2.1 SHORT TERM MEDIATION OF LINKAGES ............................................................132
    6.2.2 FEEDBACK LOOPS ...............................................................................................134
    6.2.3 PHASES OF GROWTH ..........................................................................................136

7 RECOMMENDATIONS .............................................................................................................143
  7.1 EXAMINATION OF EXTANT NETWORKS .....................................................................143
    7.1.1 PUBLIC GRANT ALLOCATION NETWORKS ...........................................................144
    7.1.2 MULTIPLE LAYER CONGLOMERATE NETWORKS .............................................147
  7.2 GRANT OFFICERS AS FACILITATORS .........................................................................149
    7.2.1 FACILITATOR REGULATION ...............................................................................149
    7.2.2 PERFORMANCE METRICS ..................................................................................150
    7.2.3 SYSTEM REFINEMENT .......................................................................................152
PREAMBLE

For the author, postgraduate study began as a radio frequency engineer working as part of a small project team designing innovative long distance telecommunications equipment under the leadership of a theoretical physicist, Dr Gerard Borg. However, during the first year, the author became increasingly dissatisfied with the technical work while at the same time developing a fascination for commercialisation under the guise of attempts by the project to find a market niche. The decision to change topics was taken in the context of this discontent, which considering the intriguing nature of the subject matter, was one easily made.

Exploration in the direction of commercialisation of the project unfortunately proved futile. While in no way could the university be held responsible, it nevertheless was apparent that it might have become so. Policies were unclear and/or perverse, advice and resources negligible and official approval mechanisms arbitrary and bureaucratic. In attempting to understand why the situation persisted, not only at the author’s university by more generally, especially in light of the lost potential the failure of our project represented, the author consulted the literature and found it entirely confounding. An apparent dichotomy between the economic importance of commercialisation and ambiguous literature led to the hypothesis that inherent complexity was at its root. After comprehending that extant research was not a source of enlightenment, it was with some enthusiasm that the author turned his hand to engineering in pursuit of a solution: and thankfully it proved more satisfying than circuit design.

Employing the tools of engineering was prompted partly by their availability, but also by recognition of an opportunity. With the ‘soft sciences’ saturating the field, there was left open a gap able to be filled by an investigation based upon an approach supplied by engineering. Typically rigorous mathematical modelling is utilised to characterise a problem in anticipation of solving it, but since this depends upon numbers that are both easily defined and measured, their significant lack in the realm of knowledge transfer created an interesting dilemma. In sum therefore, an engineer was confronted with a problem he couldn’t understand, and utilised tools familiar to him in taking remedial action. This thesis constitutes a description of those actions, and the results they produced.
1 INTRODUCTION

Readers of this work will be those with an interest in the medium of funding delivery for the purpose of commercial activity relating to research institutions; specifically that involving proof-of-concept research and early stage spin-outs. This introduction is intended to provide the groundwork for the absorption and therefore appreciation of the thesis more generally. The purpose of the research is discussed, followed by a definition for knowledge transfer derived from the constituent words, and this then serves to highlight logical weaknesses in conceptions of the term in official use. On that point, it is worth noting that this research does not take any orthodoxy at face value, and will to a certain extent require the reader to suspend disbelief.

Purpose of Research

In layman’s terms, the purpose of this research is to advance understanding of commercial activity in which academics participate. There already exists a large body of theory either directly or indirectly relating to this, but as asserted by the latest report by the Parliamentary Standing Committee on Innovation, resolving it into definitive policy has proven problematic;

There are diverse understandings of innovation and commercialisation, resulting in a range of ambiguities¹

The value of theory bridging these ‘ambiguities’ is in enabling a coherent understanding of the task amongst all stakeholders, whether university, government or corporation, that can then inform harmonious action. In other words, it would be desirable to have better coordination of opportunities for commercialisation arising as a consequence of engagement between otherwise disparate parties. This is not only true for those directly involved, but also the economy as a whole, as a notable submission to the aforementioned committee contends.

Innovation policy is central to innovation performance, and hence to wider economic performance. All major theories and all empirical analyses of economic development treat innovation as the key explanatory factor in growth²

¹ Foreword, Report of the Parliamentary Standing Committee on Science and Innovation, Pathways to Technological Innovation, House of Representatives, Commonwealth of Australia, 2006
² Profs K Smith and J West, Submission No. 18, Standing Committee on Science and Innovation p. 3.
Entrepreneurial Knowledge Transfer

However, rather than couch this research in terms of commercialisation and/or innovation, it is regarded as preferable to focus on the concept of knowledge transfer. Focussing on the movement of knowledge is more subtle than either its creation or utilisation. It allows a nuanced scope, not strictly limited to transactions in the economic sense. However, as will be now explained, there exists a deficit in the veracity of available definitions that must be remedied if this thesis is to have robust theoretical foundations.

Knowledge Transfer from First Principles

Nevertheless, it is useful to place knowledge transfer on a more substantial foundation, starting with the contemporary meaning of knowledge and transfer. Merriam-Webster (online) define knowledge as a noun with two relevant interpretations.

- the fact or condition of knowing something with familiarity gained through experience or association
- acquaintance with or understanding of a science, art, or technique

Transfer is a transitive verb having three meanings considered germane.

- to convey from one person, place, or situation to another
- to cause to pass from one to another (transmit)
- to make over the possession or control of (convey)

The most important point to note regarding the definition of both words is that, with some notable exceptions, they mandate the involvement of people. Only a person can know something; a company or book cannot gain familiarity through experience, and neither can they have an understanding, in the functional sense, of a technique. However the third definition of transfer, reminiscent of conveyance of property title, has its basis in the law, from whose perspective a company is a legal entity that can indeed possess ‘knowledge’, as in the case of patents. Yet this would appear to contradict the fundamental criteria that knowledge may only be held by a person, and while a company has legal status, a book is only a medium of information storage, but regardless neither is a person. That being the case, knowledge transfer becomes a conceptually straightforward process, illustrated by Fig. 1.

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3 http://www.m-w.com/dictionary/knowledge
4 http://www.m-w.com/dictionary/transfer
Chapter 1: Introduction

Two people, the donor and recipient, are intrinsic to the transfer of any piece of knowledge; however each of the three facets of knowledge transfer has its attendant considerations, born of the reality that knowledge is a form of power, and there are implications of its bestowal by one upon another. Foremost, the donor will have a goal that they believe a successful transfer will somehow help achieve. Next, the donor will need to undertake actions to prepare for the transfer, including consideration of the medium to be employed and any barriers to successful transfer likely to be confronted. Finally, the recipient will themselves anticipate some benefit in absorbing the knowledge that has been made available to them, depending upon the confidence they have in its veracity.

The most common perception of a goal is as financial reward, such as when knowledge is embodied within a product that is then sold for profit or in the form of wages where knowledge is transferred via direct application of skills. In this case, while the customer is still the recipient, it would appear the owner/s of the company are on-selling their employee’s knowledge, but in actual fact are merely including their own entrepreneurial/managerial skills: a form of knowledge that, due its intrinsic ability to overcome particular kinds of (market) barriers, may be highly lucrative. It may seem strange that a customer would buy a product without being fully aware of its providence, but nevertheless it is a common enough occurrence completely in keeping with the principles of both knowledge and transfer. Yet this potential for knowledge to remain hidden from the recipient is not evident in other interpretations of knowledge transfer, which for the purpose of illustration will now be examined.

Interpretations of Knowledge Transfer

Amongst the considerable diversity of conceptions of knowledge transfer, by expressing it in terms of dissemination of knowledge from a smaller to a larger group, Microsoft
Entrepreneurial Knowledge Transfer

Encarta is closest to the commonly held perception of promulgation of academic research to the wider society.

... communication of specialized knowledge developed in part of an organization to a wider group such as another part of the organization or business customers.  

Within Australian officialdom, the Department of Education, Science and Technology (DEST) provide two definitions of knowledge transfer; the first is non-specific with the second identical except that it demands commercial benefit.

Knowledge transfer for commercial benefit is the process of engaging, for mutual benefit, with business or government to generate, acquire, apply and make accessible the knowledge needed to enhance the success of commercial enterprises.

From the author’s point of view, and although plausible at first glance, both interpretations presented by DEST fail to clearly annunciate the core difference between an economic barter and knowledge transfer. Engaging for ‘mutual benefit’ has connotations of symmetric payoff between the donor and recipient, while conversely ‘make accessible’ implies a one-way flow of information without a mandate as to awareness whether such a payoff ever occurred. Furthermore, the inclusion of both the generation and application of knowledge ignores the true meaning of transfer, being to pass along rather than create or utilise. Finally, specifying that one party in the transfer must be ‘business or government’ forgets that knowledge transfer, with or without commercial benefit, can occur (for instance) completely within academia.

Nonetheless, a commercially beneficial transfer does not necessarily imply the donating party knew this would be the outcome; only that that steps were taken to enable reception of the piece of knowledge (that the recipient can then treat as they wish). However, while deliberate action from the donor is necessary, it would appear this presumption does not extend to the recipient. For instance, given that the value (or even existence) of knowledge may not become apparent until utilisation has begun, it becomes possible to receive something commercially advantageous entirely by

5[www.encarta.msn.com : search[encarta knowledge transfer]]
6[www.dest.gov.au : search[dest knowledge transfer]]
7This situation is reminiscent of the statement made by Donald Rumsfeld concerning ‘known unknowns’ and ‘unknown unknowns’ in the context of uncertainties surrounding the justification for the 2003 invasion of Iraq, the latter being a reference to useful knowledge that one is not aware exists.
accident. In fact, gaining benefit can even precede\(^8\) awareness of possession of the knowledge, yet it is not clear that such a transaction falls inside the criteria applied by DEST. It remains therefore that the only constant is a donating party who places the knowledge within reach of the recipient/s, which would seem to cut to the conceptual heart of the phenomenon.

This however raises the question of what impediments had otherwise prevented the transfer already occurring so as to render deliberate intervention on the part of the donor unnecessary. While the idea of deliberate action is supported the Encarta’s dissemination principle, from some perspectives this would appear to contradict the mutual benefit stipulation given by DEST. Overcoming a barrier implies a cost is incurred, yet ‘mutual benefit’ would seem to presume that the recipient is expected to provide immediate compensation. Thus, while mutuality of benefit carries tones of economic exchange in the sense of a ‘bartered price’, in situations where the recipient is unaware of the knowledge, no barter can take place. Nevertheless, no one is completely altruistic, and the donor must anticipate deriving some benefit from their action. This separation of the impacts of the transfer, combined with the assumption of a barrier, leads to a new hypothesis for a definition of knowledge transfer.

**Hypothesis:** Knowledge transfer occurs when, in furtherance of personal goal/s, a donor takes deliberate action to make knowledge available to a recipient/s who only accepts if he/they anticipate benefits arising.

Thus, the anticipated benefit may be commercial in nature, or it may not, but the donor of the knowledge need not to be aware of these details, or even whether the recipient ever achieves the benefit he anticipates. Rather, since there is no implication of information flow between the recipient and donor (only the other way around) the transfer is entirely done on the basis of prediction rather than surety of outcome. Therefore, from the perspective of the donor, the act of making the knowledge available is expected to attract its own reward, with its eventual utility to the recipient predicted but conceivably never known, and therefore possibly independent of the goal. Regardless, the esoteric nature of knowledge transfer makes explanation difficult, and it is therefore preferable to instead attempt a more concrete designation for the purpose of this research.

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\(^8\) An example being a writer who, without conscious awareness of doing so, reuses a plotline read elsewhere.
2 SCOPE

This chapter introduces the logical structure and ensuing rationale underlying the strategy\(^9\) adopted for this research. It begins with a discussion of formats available for defining the scope, ranging from descriptive to analytical, with the latter being selected. The definition of knowledge transfer already advanced is utilised as a basis for an analytical scope and it is examined from the perspective of both consideration (from the perspective of a donor) and properties (of entrepreneurship). The resulting criteria are then used to categorise activities satisfying the definition of knowledge transfer, a number of which are sourced explicitly from a publication concerned with university-based knowledge transfer. Finally, with the intent of placing in context the strategy employed by the methodology, inferences are drawn regarding that subset of knowledge transfer consistent with entrepreneurship.

2.1 Format of the Scope

The vague universality of the definition of knowledge transfer proposed in the introduction makes devising a logically defensible approach to research problematic. In order to render the task of investigation both tractable and rigorous, the scope must be narrowed, and a description of how that might be achieved constitutes this section.

2.1.1 Descriptive Approach

A potential problem with the depiction of knowledge transfer adopted by this thesis is a lack of scientific precision. Nevertheless this is not an uncommon problem when taking the descriptive approach to categorising (typically abstract) phenomena, where a robust, logical foundation to theory is sacrificed for the sake of (apparent) accessibility, completeness and/or brevity. In a similar way, the longevity and prevalence of a pithy urban myth is no guarantee of accuracy. Even if a truism is valid for a majority of circumstances, intermittent contravention still renders it a fallacious basis for scientific research. Notwithstanding, many theoreticians employ a descriptive approach, usually for good reason, which includes the one now discussed.

\(^9\) Considering, as intimated by the introduction, there was difficulty experienced giving the original motivation of the research precise expression, this chapter is work accomplished largely in hindsight, nevertheless the author is confident it faithfully reflects that original intent.
Howard and Partners

John Howard is a consultant researcher with expertise within the same topic as this thesis; commercial innovation involving universities. In a recent report\textsuperscript{10} to the Australian government there was presented a list of ‘knowledge products and services’, demonstrating that, even limited in context to universities, knowledge transfer can take many forms. Howard apparently uses the medium of delivery\textsuperscript{11} (as mentioned in the introduction and discussed further in §2.2.1) as a basis for differentiating between types of knowledge transfer in the following list; an approach that gives one of the most comprehensive ‘definitions’ available, implied though it is.

\textit{Creation of intellectual property rights:} knowledge property in the form of patents, copyrighted material, designs, plant variety rights and other codified and/or documented representations of knowledge

\textit{Academic publishing:} production, marketing, distribution and sale of books, papers, electronic material through academic presses established for this purpose

\textit{Knowledgeable graduates:} people possessing knowledge and skills capable of development application in a business and commercial context

\textit{Industry-targeted teaching:} accredited courses, qualifications and certifications involving the preparation, marketing and sale of courses and programs that meet a specific user need for professional recognition and career advancement

\textit{Contract research and consultancy:} project-based research, advisory and consultancy services involving the sale of explicit and tacit professional knowledge as a service

\textit{Staff interchange and faculty appointments in industry:} members of staff available to assist businesses in the development of strategies, particularly in complex science and engineering areas

\textit{Research publication:} publication of the results of research in peer-reviewed academic journals


\textsuperscript{11} An obvious instance of mode of transfer within academia is the written word within peer-reviewed publication, or alternatively embodied within personnel moving between institutions. Knowledge is also transferred via research consultancy and spin-out companies, and it is this final mode that most closely reflects the thrust of this research. Yet it was found necessary to broaden the scope to encompass more than straightforward commercialisation in order to capture emerging commonalities between otherwise-heterogenous activities.
Chapter 2: Scope

Formation of spin-out companies: knowledge-based start-up companies, created to own and market a discovery or technology and (possibly) a product or service based on them. (Howard and Partners 2005, p. xi)

Howard provides a useful indication of the span of types of knowledge transfer originating from within universities, a number of which are directly relevant to the intended (commercial) scope. However, with no similarly satisfactory analytical definition found (see Appendix D for a critique of further instances of descriptive theory) supplying such will require its creation from the ‘first principles’ established in the introduction.

2.1.2 Analytical Approach

In developing an analytical definition, techniques such as induction (philosophy) or set theory (mathematics) can provide logical rigour. Because of its suitability to the task of conceptual grouping, and the author’s familiarity, set theory is selected. On the basis of earlier rationale, it will be contended that from the donor’s perspective, knowledge transfer is a three stage process that can be applied for the purpose of entrepreneurship. However, before this is explored, set theory itself must first be introduced.

Introduction to Set Theory

The founding premise of set theory is that to be a set, or group of like items, will have a property (or combination of properties) in common. The strength of set theory is in expressing that combination of properties in a rigorous fashion. If each item within a set possesses at least one of a list of properties, it is termed a union (U) of the sets represented by the respective properties. Alternatively, when all items have two or more properties in common, the result is known as the intersection (∩) of the respective sets. As Fig. 2 shows, the possible combinations (two in this case) can be represented diagrammatically using overlapping 2-dimensional spaces. Any item may then be located in the appropriate region, and it is immediately obvious with which other items it shares an intersection or union.
If it is found that all knowledge transfer activities can be categorised via a small number of distinct properties, then set theory can be employed as the basis for an analytical definition. Given the abstract nature of the phenomenon, and the lack of quantitative data, the best indication of the validity of any criteria established by set theory is the ability to categorise, without undue ambiguity or contradiction, an exhaustive list of items. The creation of the list, and subsequent categorisation, is undertaken after the properties of the constituent sets have been identified.

### 2.2 Properties of the Scope

To utilise set theory it is necessary to develop properties upon which activities may be delineated. In doing so, the process of knowledge transfer is first divided into considerations, and entrepreneurship into properties. The considerations and properties are then correlated to deliver three criteria (properties) that a knowledge transfer activity must satisfy to fall within the scope, hence known collectively as entrepreneurial knowledge transfer (EKT).

#### 2.2.1 Merging Knowledge Transfer and Entrepreneurship

In order to arrive at a definition from first principles it was decided to pull the considerations shown by the donor before attempting knowledge transfer, and then merge it with entrepreneurship. Entrepreneurship is inherently concerned with taking advantage of unique knowledge to gain a competitive edge in the market. This resonates with commercialisation from universities, and is therefore regarded as the
logical knife that can demarcate in accordance with the intended scope. First however knowledge transfer is recast as a process from the perspective of the donating party.

**Donor Considerations in Knowledge Transfer**

Based upon the hypothesis proposed in the introduction, the salient aspects of a knowledge transfer are: deliberately making available knowledge to those who would otherwise not have had access *while* anticipating achieving a goal by doing so. This tension begs the question why the knowledge had not previously been accessible, suggesting the existence of some kind of barrier needing to be overcome. If it is presumed that the act of overcoming this barrier and reaching the recipient entails engaging in a deliberate process then it becomes possible to posit what the constituent considerations might be. Since initiation of the transfer depends entirely upon the donor, it is their perspective that takes precedence, and classification can therefore conveniently ignore the intended recipient/s for the time being (Fig. 3).

The first step taken by the donor is establishing what his motivation or goal in attempting the transfer actually is. However, as mentioned, knowledge transfer is not a symmetric transaction in the traditional economic sense, and a single transfer may involve multiple recipients whose identity may not be known to the originator, or indeed even whether the anticipated benefit was ever realised. Indeed, the rate at which the recipient/s successfully accrues benefit may in fact be independent of the achievement of the goals of the donor\(^\text{12}\). This offers the distinct possibility that neither the anticipated goal of the donor, nor the benefit of the recipient, will be achieved even if knowledge is successfully transferred between the two. Unlike barter between objects of known value, the eventual utility of a piece of knowledge is entirely unique to the individual recipient; and uncertain even then.

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\(\text{12}\) As in the case of the ‘snake oil salesmen’ where the sale of a potion or salve is not expected to deliver the consumers’ anticipated benefit, yet certainly does achieve the purveyor’s goal of monetary reward.
Entrepreneurial Knowledge Transfer

Following establishment of a goal are actions taken in preparation of the eventual transfer. After preparations are concluded, the knowledge is then made available to potential recipient/s via the delivery stage. Choice of mechanism of delivery is dependent upon available communication mediums, which (as indicated by Howard) includes embodiment within an employee or other contracted staff, and the nature of the barrier, which may for instance be cultural as opposed to physical. Conceptually each delivery requires its own process, and therefore its own preparation and goal/s, with at least one goal of entrepreneurship always being profit. However, before being capable of categorising knowledge transfer (see Appendix B for all instances, but three examples are shown immediately after the following section), the considerations need a basis upon which to distinguish between them, and will hopefully be provided by a more thorough understanding of entrepreneurship.

Properties of Entrepreneurship

From its French root, entrepreneur means “one who undertakes”, with the term now used to refer to anyone who undertakes the organization and management of an enterprise involving independence and risk as well as the opportunity for profit. Bob Reiss, entrepreneur and author, defines entrepreneurship as:

...the recognition and pursuit of opportunity without regard to the resources you currently control, with confidence that you can succeed, with the flexibility to change course as necessary, and with the will to rebound from setbacks. 13

From the perspective of the economy, wealth creation occurs when innovation results in a new demand, or an unchanged demand is met with fewer resources. From this viewpoint, one can define the function of the entrepreneur as one of combining various input factors in an innovative manner to generate value to the customer with the hope that this value will ultimately exceed the cost of the input factors, thus generating superior returns that result in the creation of wealth.

Considering these conceptions of entrepreneurship, a number of underlying properties become apparent. First, the eventual goal of entrepreneurship is profit through taking a risk in the market. In achieving this, the entrepreneur will have the independence to act flexibly and innovatively. Finally, pursuing an opportunity without initially having

access to all necessary inputs presumes they will be acquired at a later stage. In turn, this implies the existence of negotiation with those who currently hold those resources, the establishment of trust that it will be put to the use as promised, and therefore deliver the projected returns.

**Examples of Categorisation from Appendix B**

The rationale behind the categorisation of two instances from Howard’s list and one supplementary are repeated here for the purpose of illustration. After reading the text, examine Table 1 and then Fig. 7.

**Knowledgeable Graduates**

...people possessing knowledge and skills capable of development application in a business and commercial context

![Figure 4: Donor considerations when a knowledgeable graduate](image)

The transfer of knowledge incorporated in graduates is two-fold; the first stage being to impart knowledge to the student, which is then followed by their finding a position within a firm, yet from Howard’s wording it would appear the latter aspect is emphasised. That being so, the activity essentially becomes one of knowledge embodied in a person who, once given a role, can utilise their learnt skills to benefit the business. This situation, in terms of being employed within a pre-existing team, is dependant upon trust within the workplace and (by-and-large\textsuperscript{14}) undertaken for a commercial purpose.

Nevertheless, the act of hiring staff is not itself entrepreneurial since a procedure is usually followed, and once hired, the new staff member is well advised to conform to their situation rather than find a novel way of participating. This does not mean that innovative outcomes will not result from a new graduate, but that there will be a process

\textsuperscript{14} The logic here is rather weak however since markets are imperfect and many companies actually innovate very little, instead surviving through stasis of market share, or growing via anti-competitive practices such as a favourable regulatory environment.
Entrepreneurial Knowledge Transfer

to be followed to allow that input to be made. For instance, the employee who ‘goes over his bosses’ head’ is generally not welcome for long.

Contract Research and Consultancy

*project-based research, advisory and consultancy services involving the sale of explicit and tacit professional knowledge as a service*

**Figure 5: Donor considerations when a consultant**

Consultancy and contract research occur when researchers collaborate with firms to investigate an issue of commercial interest. This raises the likelihood of eventual market engagement else (similar to the logic used previously) why else would the firm bother with the expense and inconvenience?

There is also a novel aspect since each arrangement is unique and must be individually negotiated (putting aside minor levels of ritualisation introduced for instance by standardised contracts and non-disclosure agreements). Finally, since the activity requires close cooperation between the parties involving substantial outlay of time and resources without (as demonstrated by the Du Pont anecdote) the easy availability of legal or institutional protection, trust is a prerequisite.

Advertising

**Figure 6: Donor considerations when advertising**

Advertising aims to convince people to consume a good or service with a positive message transmitted via mass media such as television, radio or even non-technological methods such as billboards and moving signs. Those expert at advertising are valued for their ability to introduce novelty since consumers quickly learn to ignore established techniques. However, with the process of advertising generally being a straightforward fee for service, the development of trust is not critical.
2.2.2 Criteria for Entrepreneurial Knowledge Transfer

Taken together, this gives entrepreneurship the properties of market orientation, novelty of approach and trust-based relationships. These will now be merged with the donor’s considerations to deliver the criteria for EKT.

**Market Orientation**

The first query is whether the transfer is being undertaken with the intent of having a commercial impact? In the context of a good or service made available to the market, such activity is known as *innovation*. Innovation\(^{15}\) is the act of introducing something new or different into what may be broadly characterised as ‘the market’, meaning it is available to those who would wish to benefit from its use. It is regularly observed that the biggest impediment to innovation is the unwillingness of the consumer to adopt change, implying that changing their position via education is critical. This then means that knowledge *is* in fact being transferred whenever a new product or service finds acceptance within the market.

In terms of knowledge transfer, the customer is intended to be the ultimate ‘beneficiary’ of the knowledge embodied in the new product, but engagement in a market economy also allows for dispersal - even to those not actually purchasing the item. Thus, the intent of giving the market access to new products and services can be seen as a deliberate act that enables knowledge to be transferred to those who otherwise would not have access to it. In other words, market orientation (a goal) carries an assumption of knowledge transfer via education of the market\(^{16}\) (a delivery mechanism), although this need not be the only mechanism involved, and may otherwise be safely presumed but otherwise ignored.

**Criterion #1**: In undertaking the transfer, is the goal of the donor to reach the market?

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\(^{15}\) The Macquarie Dictionary defines innovation as; 1. something new or different introduced. 2. the act of innovating; introducing of new things or methods.

\(^{16}\) On the other hand, simply being a member of the private sector does not always entail innovation. A company can become dominant outside the channels of fair competition when they transgress into the realms of protected markets, price fixing and favour-buying. When this happens, collusion stifles innovation in favour of more direct avenues to profitability, and in so doing suppresses knowledge transfer via market competition.
Entrepreneurial Knowledge Transfer

**Novel Preparation**

The second attribute is novelty of *approach*, rather than the knowledge itself, or of the delivery mechanism, which therefore is a consideration of the donor’s preparation. This has some resonance with the impediment that knowledge transfer inherently overcomes, such as institutional or cultural boundaries, many of which require a novel approach to overcome. In some senses, otherwise there would not be boundaries (or at least, they would be less imposing) since there would already exist an ‘approved’ process to transcend\(^\text{17}\) them.

A novel approach means the activity is not part of a formulaic, repeated ritual and is rather a one-off event, implying there are no prior examples to copy from blindly (though they may be adapted). Therefore those involved in the activity must use their own judgement in deciding how to proceed and consequently are at greater risk. At the same time, there is likely to be a higher reward since the knowledge being transferred will not have been previously available. In fact, and this returns to the question of a barrier, it may be that a novel method is entirely critical since the barrier will never be overcome (regardless of the resources expended) with a conventional approach.

**Criterion #2**: Is a novel approach to preparation important to a successful transfer?

**Interpersonal Trust**

The final attribute is the degree to which trust is a success factor in the transfer process. For some, it will be nonessential or even ancillary, but for others it will be critical. Concerning this point, the chief technology transfer manager for DuPont Corporation gave a presentation in March 2007 at the ANU. Du Pont has a long history of collaborating with university researchers, and he strongly emphasised the importance of trust in overcoming corporate-academic barriers. At the same time, he downplayed the use of measures such as protecting intellectual property. His numerous anecdotes\(^\text{18}\) of

\[\text{Take diplomatic convention between nations for instance, the rituals of which are designed to overcome cultural and political ‘barriers’ that would otherwise threaten the relationship between nations.}\]

\[\text{In one example, DuPont sponsored a researcher for 4 days a week, but when a ‘great invention’ arose he claimed to have discovered it during work undertaken only on the 5th day, meaning DuPont had no claim. Rather than seeking legal redress, DuPont simply broke ties to the researcher in question. In another case a single studio among many within a department refused DuPont’s offer of funding, but they declined to exert revenge by using their funding as leverage. In general, the permissive attitude indicated that DuPont had decided to accept the risk of reneging/insult in preference to weighing down its projects with legal bureaucracy, and that in the majority of cases trust proved a sufficient guarantee. As an indication of the effectiveness of their approach, July of last year (2007) Du Pont announced they had built the world’s most efficient solar cell (42.8%) in partnership with the University of Delaware.}\]
Chapter 2: Scope

repeated partnerships showed that stakeholder attitude rather than the nature of the project itself was what determined whether future collaborations would be engaged in. While the original idea might fail, the relationship that had developed would allow others to take their place, but once trust was lost, there was no possibility of ongoing or future collaboration.

Criterion #3: Is interpersonal trust in preparation important to a successful transfer?

**Set Theory Representation**

It is intended that, taken together, these three questions allow any the interrogation of any transfer activity. This can be demonstrated graphically through the set theory diagram (Fig. 4) where any knowledge transfer can be positioned somewhere on the diagram (including, if no criteria are satisfied, completely outside it), and if located in the central region (I+N+M) our criteria for EKT are satisfied.

![Set Theory Representation of EKT criteria](image)

**Figure 7: Set theory representation of EKT criteria**

It is important to note that, unlike Howard, in this analysis the mechanism of delivery is not regarded as a useful basis upon which to distinguish between types of knowledge transfer. This is because entrepreneurship does not itself care if a profit is made, and does not specify (or exclude) in what industry, region or indeed medium it will achieve it. This is no criticism of Howard, merely a product of his choice of logical knife. The result of application of these criteria is the subject of the next section, with Table 1 showing the results of categorisation of Howard’s list, the full details of which are found in Appendix B.
Entrepreneurial Knowledge Transfer

<table>
<thead>
<tr>
<th>Instances of Knowledge Transfer</th>
<th>Preparation Novelty?</th>
<th>Interpersonal Trust?</th>
<th>Market Orientation?</th>
<th>EKT?</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP Protection</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
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<td>Academic Publishing</td>
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<td>No</td>
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<td>Graduate Employment</td>
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<td>No</td>
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<td>Yes</td>
<td>Yes</td>
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</tr>
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<td>Research Publication</td>
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<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Spin-out Company</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 1: Activities listed by Howard

Another clarification is in regard to spin-outs (also see Appendix B for full description) which are perhaps the stereotypical instance of entrepreneurship within universities. Nonetheless before actually leaving the grounds of the institution, or legal creation of a corporation, the ‘yet to emerge’ project with a commercial focus (such as the author’s mentioned in the preamble) is effectively identical as far as this study of knowledge transfer is concerned.

Figure 8: Exploded view of set theory categorisation of knowledge transfer
Chapter 2: Scope

In concluding this section a number of activities are categorised and mapped onto the set theory diagram (Fig. 8), with those satisfying the criteria for EKT found within the centre region. It means therefore that this research is limited to research consultancy, faculty secondment and spin-out companies – a list that accords well with the intent to investigate commercialisation involving knowledge transfer from universities.

Upon examination of Fig. 8 it becomes evident that seemingly dissimilar activities are grouped together. The reader is encouraged to judge the efficacy of the method of categorisation by considering what these might hold in common, and how this matches the properties used to distinguish them. If, upon closer inspection the approach seems logical, the reader is invited to extend this logic further into specific characteristics of the scope.

2.3 Characterising the Scope

Now that EKT has been defined analytically, a more extensive characterisation becomes useful in aiding its investigation. A better understanding of the phenomenon, even if only on an exploratory (provisional) basis, will provide context for the strategy that is subsequently employed. On the basis of the criteria already established, logical deduction will inform an ‘internal’ characterisation, which will then be joined by an ‘external’ version of the same with the incorporation of information from official sources. These two ‘pictures’ will then be compared, with any contradictions identified serving to provide perspective for the research that is to follow.

2.3.1 Internal Characterisation

In examining the criteria already established, there will be comparisons drawn between the central (EKT compliant) and surrounding regions of Fig. 8. This is accomplished through the two lenses of risk and reward, which cut to the heart of entrepreneurship, and therefore EKT.

Greater Probability of Failure

Upon individual examination of the properties, it becomes apparent that EKT is more likely to fail than other variations of knowledge transfer. This based upon the assumption that the probability of independent events occurring at the same time is given by multiplying those individual probabilities together. Considered on this basis,
Entrepreneurial Knowledge Transfer

the requirement of each property presents a greater risk than its absence. Succeeding in a competitive marketplace is likely to be more challenging than not having to, as is dealing with the vagaries of human nature when the activity depends upon trust, or inventing a new process as opposed to following one already established. Thus, each of the properties is considered to be a potential mode of failure: failure to meet a market demand, failure of a novel process and failure to maintain relationships between stakeholders. These qualitative probabilities multiply to give EKT, as a subclass of knowledge transfer, the highest likelihood of failure.

Rewards for Success

All of these factors increase the risk of failure, but as tends to be the way of things, a reward of increased magnitude is usually anticipated. Obviously the potential for profit is a powerful incentive, but entrepreneurs are renowned for also seeking the excitement of a new challenge. Aside from the satisfaction of following a new path, for others it is the pleasure of working in the cooperative environment of a team. Aside from personal gain, the human tendency for empathy gives pleasure from helping others, whether on an individual or generic basis.

2.3.2 External Characterisation

Providing a contrast with characteristics of EKT generated from the criteria themselves, there is now an examination from perspectives derived from alternative, external perspectives such as societal impact, extant theory and investment rates.

Societal Impact

It is worthwhile to consider EKT as a mechanism for societal change, since access to knowledge brings not only economic but cultural and personal advantages. Speaking pragmatically however, allowing knowledge to combine in new ways fosters creativity and innovation, and so economic dynamism, which provides the wealth from which other advantages may be realised. So while the risk inherent in EKT is great, so are the rewards, both for the participants and wider society. Nevertheless, and perhaps surprisingly, Australia is one of a majority of nations with a poor record of investment that is sympathetic with EKT.
Chapter 2: Scope

Reticence to Invest

In general, it appears there is some reluctance by Australia to invest in research and development, whether from public or private sources;

_Australian expenditure on innovation and science is dwarfed in absolute terms by the expenditure in many other OECD countries, but even single multinational companies spend about the same on R&D as the whole of Australia. For instance, three US corporations, Microsoft, The Ford Motor Company and Pfizer each spent about the equivalent of around A$10 billion on research and development in 2003, which was [individually] just a little less than Australian GERD (Gross Expenditure on Research and Development) and roughly double the Australian Government budget for public support of science and innovation (National Science Board 2006, p. 420). In fact, all of the top 20 global R&D spending corporations spend about the same as, or more than, the Australian Government on R&D_.

From the Australian perspective, a 150% tax rebate on investment in R&D was removed ten years ago: a decision that has only recently been reconsidered. However, recent reports concerned with university commercialisation reveal that, alongside poor private investment, considerable reticence to risk public monies also persists. The claimed reason is a lack of viable metrics (_§3.1.1 System Design_), but it would seem that uncertainty is also a persistent factor, which given the state of theory, is not surprising.

Theoretical Ambiguity

The inadequacy of the descriptive approach to defining knowledge transfer has been asserted in principle (_§2.1.1_) as well as in specific instances of both theory and policy (Appendix D). The resulting lack of definitive understanding becomes problematic when governments are unable to implement coherent policy.

_There are diverse understandings of innovation and commercialisation, resulting in a range of ambiguities...innovation means different things to different people – this is reflective of the fact that the nature of innovation is different across sectors and industries. Various understandings result in divergences about the spectrum of activities that are considered innovative, the expected and preferred outcomes of innovation, and the range of factors that are seen to drive the innovation process; and_

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19 Public Support for Science and Innovation, Productivity Commission, 2007, p. 602
20 See Appendix D for an overview of various reports from Australia and elsewhere
Entrepreneurial Knowledge Transfer

the meaning of commercialisation varies across sectors as does its significance as an outcome of innovation. (Report of Standing Committee on Science and Innovation p. 6)

An instance of changeability of policy driven by evolution in theory has been the shift in dominance from the theme of technology push to market pull.

Early models of innovation describe a linear process with research as the prime driver of innovation. In this model, innovation is considered to be driven by ‘technology push’. An alternative early model of innovation attributed the major driver of the innovation process to ‘market pull’, with research and development being tailored to meet market demand. (Standing Committee on Science and Innovation p. 2)

It is reasonable to posit that such changes in government policy are connected with trends in academia. In Australia, a more recent (and regrettable) shift has been towards an emphasis on short term commercial outcomes, notably in research institutions such as the CSIRO\(^2\), with impacts such as disillusionment (and loss) of senior researchers and the axing of projects undertaking valuable basic research. Such outcomes would be less likely if a more comprehensive understanding of the link between knowledge creation and innovation occurred at the political level.

2.3.3 Implications for Strategy

Apparent dichotomies between the possibilities inherent in EKT and an almost-universal failure to realise them naturally prompts attempts at explanation. With an eye to framing the methodology adopted by this research, two are now proposed. The first is in regard to systemisation, and forms the basis of the research questions in the following chapter, while the second is complexity, the discussion of which Appendix C provides a context for the remainder of this research.

Resistance to Systemisation

The first contradiction lies between the rewards offered by individual participation in EKT, and its low levels of occurrence in universities, where the richest ‘deposits’ of knowledge lie. Part of the reason for this may lie in the tension between traditional university culture and the properties of EKT, especially its commercial focus. While

\(^{21}\) The CSIRO has become increasingly ‘market focussed’ and in so doing lost much of its research capacity that had historically proved invaluable to domestic, and especially agricultural, industries. Another is the CRC program, which after ten years of developing similarly impressive scientific, has this past year been threatened with severe funding cuts due to a lack of commercial success.
research is rewarded for peer-reviewed publication, EKT has no such established system of recognition.

In general, the prevailing culture within universities can be so inward-looking that any activity crossing boundaries, whether between disciplines or (even more so) industry, meets substantial resistance. Yet since EKT constitutes an inherently novel process, it is difficult to systematise, whether from the perspective of an institution designed for teaching and research, or a government that must consider accountability when spending public monies. This being the case, this research should endeavour to understand how to better systematise EKT.

**Inherent Complexity**

The second apparent contradiction is that between the economic (and wider social) value of EKT and the lack of definitive theory to explain it. With grant money and employment prospects not unrelated to political concerns\(^\text{22}\), there has existed substantial incentive for practicable theory. Furthermore, kudos follows a substantial contribution to society, and examination of extant theory certainly indicates that extensive effort across a broad spectrum of fields has been directed in the direction of EKT. That success has thus far proven elusive suggests the task proved more difficult than was anticipated.

One possible reason is that the underlying factors resist measurement, rendering statistical techniques, upon which fields such as econometrics depend, less useful. However, as indicated by the scrutiny of descriptive definitions, conceptual theorists have also made substantial efforts. That being the case, it seems reasonable to posit that the problem is inherently one born of complexity, and exacerbated by operational variables that are inherently qualitative. These are not in available data sets, but in addition do not resemble that which had been regarded as important. Evidence of this can perhaps be seen in the progression of theory where we see old characterisations evolving increasing subtlety.

> More sophisticated models of innovation have now superseded both the technology push and market pull linear models. The newer models of innovation have attempted to capture the non-linearity and complexity of the innovation process, placing a strong

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\(^{22}\) As evidenced by the extensive financial support and employment prospects available for practitioners of newly emerged disciplines such as econometrics and econophysics.
Entrepreneurial Knowledge Transfer

emphasis on supporting sectoral interactions and feedback loops, through developing human capital and promoting linkages or networks to enhance knowledge flows and transfer. (Report of Standing Committee on Science and Innovation, p. 48)

If the proposition of complexity is accepted, the process followed by this research must be designed to overcome it. The methodology as described in the following chapter indeed assumes that complexity is a problem, and for that reason, insights into its nature are sought. For it to be dealt with professionally, complexity needs to be more than a vague notion, and as such is treated in detail in Appendix C.
3 METHODOLOGY

As contended by the Scope, subject matter not amenable to measurement while at the same time being inherently complex will pose significant hurdles to its investigation. When the attempt is made to convert subsequent theory into real-world solutions, a resistance to systemisation will give rise to further difficulty. Nevertheless, regardless of these confounding challenges, this thesis has set itself to task of creating theory that handles the intended scope. Achieving this requires a structure appropriate for a milieu likely both qualitative and highly intricate, and for this reason grounded theory is selected, most clearly enunciated by the following ‘rules of thumb’ from Strauss’s seminal work on the subject.

1. Steer your thinking out of the confines of both technical literature and personal experience
2. Help you avoid standard ways of thinking about the phenomenon
3. Stimulate the inductive process
4. Focus on what is before you so the data can’t be taken for granted
5. Allow for clarification or debunking of assumptions made by people who appear in the data
6. Help you to listen to what people are saying and what they can possibly mean
7. Stop you from rushing past ‘diamonds’ in the rough’ when examining the data
8. Force the asking of questions and the giving of provisional answers
9. Allow fruitful labelling, although provisionally
10. Allow exploration or clarification of the possible meanings of concepts
11. Discover properties and dimensions in the data (Strauss 1990 p. 76)

The final ‘rule’ insinuates the importance of robustly defining arising theory, and suggests the need for the second technique adopted by this research, one that brings discipline and formality to a methodology that is otherwise entirely quantitative. By allowing “dimensions in the data” to become active variables founded in engineering control theory, system dynamics forces vague concepts into a representation governed by mathematical laws. In addition, system dynamics provides for the diagrammatic and conceptual expression of results, as well as their testing. However, the overall structure of the methodology remains guided by grounded theory, the first stage of which is theoretical sampling.

23 Appendix A provides an outline of Grounded Theory and System Dynamics.
3.1 **Theoretical Sampling**

The aim of theoretical sampling is to focus effort, constrain irrelevant variation and sharpen external validity. In so doing, the problem is first articulated via a set of research questions, and these then are then extrapolated to explain and justify the overall design of the research.

3.1.1 **Problem Articulation (Research Questions)**

Problem articulation sets out what direction the research will take through the questions it will attempt to answer, reflecting the 8th rule of thumb: “Force the asking of questions and the giving of provisional answers”. The questions arose through a combination of direct experience24 and extant literature, and on both fronts, initial investigations were attempted in the early stages of the research, and led to the following questions:

1. **Question 1**: What university policies will promote EKT?
2. **Question 2**: What role might facilitators play?
3. **Question 3**: How might greater investment be attracted?

Each of these research questions are now expanded upon.

**Optimum University Policy**

This research will endeavour to identify policies that are likely to foster successful EKT by removing some of the mystique surrounding it. In so doing, it is hoped that universities will identify for themselves strategies that allow a range of objectives25 to be pursued and not exclusively EKT by any means. Generally, it is thought more effective to identify and explain the phenomenon in a systemic way as opposed to making blunt assertions regarding its ‘obvious’ desirability. Rather than taking recommendations on trust, exposure of underlying logic will encourage university administrators to draw their own conclusions, and hopefully render them more inclined to adopt its principles.

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24 Experience was acquired by the author working within a wireless communications project as well as employment within the commercialisation arm of the ANU.

25 Within the authors’ own university there is understandable pride in its international standing as a ‘research intensive’ institution. However, at least to some extent, this would appear to have come at the expense of commercialisation, and just in general academia’s external interactions. Over a number of administrations, there have been successive failures to implement a successful TTO, ending with almost complete abandonment of the pursuit of these objectives in any institutionalised fashion.
Chapter 3: Methodology

Role of Facilitators

It would seem reasonable to assume that the barrier implicitly suggested by the hypothesis is unlikely to be reduced, and perhaps even worsened, when knowledge is transferred between those with divergent perspectives or motivations. This is especially likely in the context of EKT where the danger to a novel, trust-dependent process is magnified by complications induced by diversity. Yet it is often the case that the greatest value is realised when diversity is bridged, which then begs the question of whether proactive intervention of some kind would prove constructive. As such this research proposes to investigate the role that might be played by independent third parties, otherwise known as mediators or facilitators.

From the author’s observations, the natural role of facilitator is one of mediator\(^\text{26}\), such as within projects spanning academia and business, while also providing advice on the basis of their extensive experience. While this may be entirely accurate, it nonetheless seems imperative to develop a rigorous understanding of the role that facilitators should indeed play. Hopefully this would enable greater clarity from the perspective of the administration in dealing constructively with those within their jurisdiction, and lead to a more conducive environment that can take advantage of people’s abilities. Further to this, there would appear to be inconsistent\(^\text{27}\) awareness of character traits desirable for facilitators, suggesting that normalisation of recruiting criteria would also be beneficial.

Attracting Investment

Carrying on from both the previous is the appeal of designing a system that can attract investment. EKT, especially when in the guise of early-stage spin-offs or proof of concept research, is so risky that the government is often the only investor able to justify involvement. Yet universities (quite reasonably) pursue outcomes likely to attract the greatest funding, in turn implying that attention should be paid to which outcomes are actually being rewarded.

\(^{26}\) While the role would ostensibly seem best performed from a position of autonomy, university bureaucrats nevertheless felt obliged to intervene, either indirectly through obstructive policy legislation or personally, the latter sometimes in the midst of delicate negotiations. Considering an ongoing concern to maintain the perceived integrity of the ‘research intensive’ label, such actions are perfectly understandable, yet the eventual outcomes could be unsatisfactory for all concerned.

\(^{27}\) While the role of facilitator would appear to be primarily one of communication and mediation, in the author’s university as well as others studied, academic qualifications and/or industry networks/contacts were commonly sought after.
Entrepreneurial Knowledge Transfer

However, for government agencies to hold themselves accountable, funding must be allocated on the basis of objective measures. Yet the costs of data collection can sometimes become disproportionate or, if metrics are too inadequate to provide an accurate picture, completely pointless.

... it should be kept in mind that an increase in any one of the various indicators may not necessarily be a better outcome for the economy. This is true especially for input type indicators such as those in the knowledge creation and human resources categories, as it is difficult to prove a direct relationship between increased expenditure and subsequent increases in innovation output.

Examination of documentation from DEST indicates they are aware of these concerns, yet it seems the solution space should not be limited to crafting clever metrics.

- maintain the existing time series data for the core indicators developed through the National Survey of Research Commercialisation;
- address any deficiencies in data quality so as to improve data timeliness, availability and/or reliability; and
- whenever possible, draw upon existing and reliable third-party data to reduce the burden on respondents and to ensure consistency.

Rather than accepting the immutability of the status quo, consideration might be given to designing a system from scratch such that its constituent activity is made easier to measure. This option is given impetus in light of the historic difficulties experienced both funding and measuring innovation and commercialisation, as the Standing Committee concur in their second ‘consensus issue’.

Measurement and assessment of innovation performance is important to formulating, implementing and evaluating effective innovation policy. There are, however, limitations to innovation and commercialisation metrics frameworks and there is scope for different assessments of the metrics meaning. (Standing Committee on Science and Innovation, p. 8)

In summary, this research will strive to identify designs for systems that are both amenable to EKT and will attracting investment to it. In the context of public funding

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metrics are important, but it may also be found that similar considerations will have bearing on private investors\textsuperscript{30}.

3.1.2 Research Plan

After defining the research questions, the next task is to construct\textsuperscript{31} a research plan that will address them. Awareness of the need for a research plan was prompted by a situation in the author’s university regarded as less than satisfactory, while available literature served more to confuse than enlighten. This gave rise to the necessity of going elsewhere in search of understanding, whether Australia or further afield.

**British Research Destination**

Unfortunately investigation into Australian universities revealed, if not performance as poor as the author’s own, then certainly significant system immaturity. There were isolated cases of promising beginnings, but considering the time spans involved in commercialisation projects, not to mention accumulating corporate knowledge and changing cultures, a system with less than a decade of consistent operation is little more than an interesting idea. It was therefore deemed necessary to travel abroad, but with the communication advantages of remaining within the English-speaking world, two possibilities arose – the United States of America and the United Kingdom.

A survey of both nations indicated that universities within the UK had had the benefit of extensive government support for more than a decade. Furthermore, the funding was targeted at a diverse range of systems within individual universities, essentially giving rise to a series of controlled experiments. Even aside from direct applicability to the research questions, the UK was ripe for research into commercialisation of any kind.

By contrast, the USA had taken a legislative approach to the issue, and while the performance of their universities were statistically impressive, it was difficult to separate that from other factors, such as entrepreneurial culture. While individual institutions such as Rensselaer, Babson and MIT had impressive reputations, there were anecdotal reports that systems were neither well informed nor organised.

\textsuperscript{30} Not least of which being the need to spread risk through financial instruments that require dependable access to quality information.

\textsuperscript{31} This was not something the author was formally conscious of at the time, meaning that, along with much of the methodology, this section is largely a justification in hindsight. Nevertheless, the approach of Grounded Theory was found to be fundamentally consistent with that of author, and thus provides a valid framework through which to explain the steps carried out in accomplishing this research.
Entrepreneurial Knowledge Transfer

In interviews conducted during the past 15 years the answer to the question ‘what motivates your technology transfer activity’ quite often was ‘we were told to’. That same response often explained much about the increase in CRADA (industry-research collaborations) signings. In short, much public sector technology transfer activity...was a direct result of formal mandate, not bottom-up in the way of doing business. (Bozeman 2000 p. 644)

Taking this into consideration (as well as shorter travel distances) it was decided the UK provided the best opportunity for insight and illumination.

Four Universities Selected

As such, a six-month trip\(^2\) to the UK was planned, with a month long stay at each of four universities\(^3\). Each was selected on the basis of the unique nature of its EKT system. Oxford University possessed both an impressive research record as well as the most successful TTO in the UK, and would hopefully provide evidence that the two could happily coexist. Surrey was proximate with the largest technology park in Europe, and it would be interesting to how closely linked they actually were. Strathclyde had, among a highly successful incubator and TTO, as well a centre dedicated to research and teaching of entrepreneurship, raising the question of wider integration into the university culture (and also whether it could be taught). Bath had an impressive record of student internships and spin-outs (as well as a single spin-out by students), with the author keen to understand how students might be incorporated into EKT more generally. Taken together, these institutions had a good likelihood of providing useful data, details of whose collection are now provided.

3.2 Data Collection

The next stage of grounded theory research is data collection, which has the intention of finding data that is likely to generate better theory than that already in existence. One philosophy for achieving this is ‘triangulation of evidence’, where data from a diverse range of manifestations allows provisional theory to be cross-checked by relatively independent perspectives. This becomes more important when quantitative information

\(^2\) Thanks to ANUTECH for funding the field research.

\(^3\) It was originally five but unforeseen circumstances mid-travel forced the cancellation of Teesside.
Chapter 3: Methodology

is unavailable for validation, and places emphasis on acquiring rich data in order that refined correlation of between data sources becomes possible.

3.2.1 Unstructured Interviews

The best interview data is experiential rather than conjectural. In order that these might be easily identifiable, an effort was made to draw out as much detail as possible during the interview.

Relaxed Environment

Generally it was found that once the right environment was created, people would divulge significant amounts of data, typically over a 30 to 45 minute period. Any attempt to prolong the interview beyond this point was usually not appreciated by the subject. In general, allowing the conversation to ‘flow’ naturally and without pressure created a desirable state whereby anecdotal information could be cleanly extracted. Stories were best delivered when the subject was relaxed and did not feel expectations were being placed upon them or their answers. As such, during the course of the interviews, if the disclosure was flowing well, little attempt was made to guide the interview beyond that required to prompt for extra information, or to move to a new topic once the current one was exhausted.

Gaining Access

To gain access, a relationship was first established with the relevant authorities, assisted by the offer of a full briefing at the conclusion of proceedings. Since they were usually grappling with the difficult task of managing the system, the opportunity for an external perspective was appreciated. This meant being given status approaching that of consultant, which implied full access to the employees. Once this was established within one office, if necessary, access could be extended to other parts of the university.

After gaining formal status as a visiting researcher at each university, the strategy was simply to interview whoever had substantial relevant experience, including those not currently working in the field. While the field itself might not be amenable to exact definition, it was not difficult to distinguish potential subjects. Familiarity with projects having only a slightly commercial facet to them prompted a request for interview.
Audio Recording

In order to more-fully engage with the subject, and avoid the distraction (to both parties) of note-taking, the interviews were recorded rather than transcribed. In seeking permission to record from the subjects, most expressed no reservations, and in fact many commented positively on the accuracy of the approach. It was intended that the question reflect, and certainly the author’s tone was couched as, an appreciation of the value of the forthcoming information.

Fostering Disclosure

During the interviews themselves, the major danger was in not reaching beyond formulaic responses. With knowledge transfer being a ‘hot’ research topic, the subjects often had substantial prior experience of being interviewed and surveyed. These tended to conform to extant theoretical paradigms, and these answers would be reproduced unless sufficient attention was paid to extracting full and frank disclosure.

To create a state whereby information was openly divulged, it was sometimes necessary to ‘play mental games’. For instance, offering competing solutions to answers given by the subject created a sense of competition that would prompt further disclosure. Alternatively, one might inject ‘childish enthusiasm’ into the interview by expressing a sense of (usually sincere) wonder at (for instance) the wider implications of the subject’s work. In general, the aim was to bring the subject out of his ‘professional detachment’ and enable a state where he enthuses about experiences and opinions (occasionally relating to fellow members of staff).

It is worth noting that people prefer to speak in terms of what has rather than what hasn’t worked. The desire to avoid embarrassment, whether to themselves or their colleagues, is understandable but failures can make invaluable data. While factors behind success can remain opaque, those behind failure are usually painfully obvious, and provide definitive indication of a link between cause and effect. Therefore, in so far as it was tolerated by the subject, any hint of past failure attracted immediate attention.

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34 Afterwards however some did express disquiet at the extent to which they had revealed highly-personal and sometimes confidential information. While the subject was always immediately (and successfully) reassured, an unintended effect was to give the author added confidence in the veracity of the data.

35 It was often valuable to exaggerate the Australian stereotype of a relaxed and laid-back attitude, especially in England as opposed to Scotland.
Chapter 3: Methodology

3.2.2 Cognitive Mapping

The next stage of data collection is transcription of the interviews via a technique known as cognitive mapping. In forming a bridge between unstructured interview data and further conceptual abstraction, the technique supported maximum preservation of data integrity and richness.

![Figure 9: Screen shot of concept mapping](image)

**Transcribing to Textboxes**

While listening to recordings of interviews, statements made by the subject are recorded within individual text boxes as shown in Fig. 9, numbered to allow for cross-referencing and reproduction. These are then joined by ‘causal’ arrows to show the logical flow of cause and effect, which may be different to the order it is enunciated. This is not preferred since deviating from the original recording impedes recall, but multiple strands of rationale will often connect in numerous places, and these must be captured in a coherent fashion.

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36 Cognitive mapping used Decision Explorer software published by Banxia (student license limits the number of statements to approximately 300 per subject) as shown in Figure 10 below

37 When making particularly important observations, interviewees would sometimes make little effort to order their statements logically. Speculation on the part of the author is that in such cases he was being made to ‘work’ for the data since the behaviour was suspect given the respondents were highly intelligent, and the data was in the form of a linear narrative that should have been familiar to them.
If there is a similarity or reference between two statements at different points in the interview, it is indicated by a ‘connotative’ (dashed) link. Linking such disparate conversational threads can leave the map criss-crossed with dashed lines, but it provides clarification of the logical foundation of the subject’s rationale. Conflict links (red) serve to highlight a point of tension in reality, or within the subject’s perception of reality. They are also included as a way of highlighting either ambiguity between the subject’s assertions, or else a problem intentionally raised by the subject.

**Visual Aid to Memory**

In serving the first aim of preservation of richness, it is deemed useful to maintain the appearance of the individual conversation threads in the form they are first laid out. This allows better synchronisation of the aural and visual memory to be maintained. Later, when examining the maps, the visual image helps to trigger the recall of details such as tone of voice and inflection, which allows more efficient utilisation of the full spectrum of data.

As the map is built, the mind uses the patterns to navigate the interview in its entirety. Given the complexity, subtlety and extent (with interviews sometimes approaching one hour duration) of the data, this ‘signposting’ becomes valuable as the data accumulates over many interviews. Rather than needing to return to the recording, it was found that with the assistance of visual cues, memory alone can be sufficient to resolve ambiguity. This saves time while also providing the benefit of reinforcing the actual memory rather than revisiting the recording, a valuable side effect considering that the point was important enough to return to in the first place.

### 3.3 Data Analysis

The next phase of the research is data analysis, where the properties of constructs are developed and integrated with the rest of newly-formed theory. The purpose of this research is to arrive at a single, comprehensive level of abstraction that is represented by what grounded theory refers to as the paradigm model. In the meantime, the theoretical framework is progressively confirmed, extended and sharpened; and ends

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38 The software enabled the map to be entered into up to 4 ‘submaps’ on separate screens. Although this feature was utilised initially, it later was found to prevent disparate linking statements and prevented this mechanism of maintaining internal coherency.
the process when marginal improvement becomes small enough to suggest that accuracy is adequate\textsuperscript{39}.

The process starts with the creation of the \textit{initial proforma} based on data held within memory (which is itself a specialised process). Once this is achieved, the initial proforma is compared directly to interview maps, and if substantial conflicts arise, it is evolved (improved) to accommodate the new data. Once the model fits \textit{all} the data thus far – meaning the current map as well as earlier data (requiring a degree of back-tracking over previous maps), \textit{validation} has been achieved, and the next interview map is selected. The process concludes when all interview maps deemed viable have been validated against, whereupon the paradigm model is ready for testing. For the purposes of illustration, work accomplished before adopting the grounded theory approach is also included.

3.3.1 Early Work

Shown are two of the early models, in the form of a system dynamics model and concept map respectively. In the early stages of the research, as well as during, it is useful to develop dynamic hypotheses. They are called dynamic because they are expected to change as new information comes to light, but at the time they serve the purpose of crystallizing thoughts, and generating new directions. It is this work that formed the basis of the research questions presented earlier in the chapter. They also provide comparison of results generated by a naïve as opposed to structured process, and indicate the advantage to be gained by employing concept mapping and system dynamics in concert as opposed to isolation.

\textit{Early System Dynamics Model}

Before undertaking the research trip, an attempt was made to build a system dynamics model of commercialisation processes with a university. This was aided by direct observations and experiences, as well as readings from the literature. The one shown (Fig. 10) is one of five parallel models, which together attempt to represent the full working of a university from perspectives such as staffing and political support; both forerunners to later work.

\textsuperscript{39} The reader is reminded that models will only ever be imperfect simplifications reality, and expressions such as ‘adequate’ and ‘small enough’ are used in place of more absolute terminology
Entrepreneurial Knowledge Transfer

Figure 10: Early System Dynamics model of university spin-outs

Early Concept Map

Once the interviews had commenced, information gathered gave rise to a model based around the physical processes inherent in knowledge transfer (Fig. 11) as it was then conceived. While eventually disregarded in preference to more systematic approaches\(^\text{40}\), just like the system dynamics model, this work helped guide thinking. During the research trip, the process of model building assisted in thinking clearly about the situation, while also providing a useful shorthand reference to prompt questions during interviews. In general, identification of key variables, causal processes and the separation of endogenous from exogenous formed the mental framework that informed construction of the initial proforma.

\(^{40}\) Some variables were eventually disregarded, such as those involving the KTF (Knowledge Transfer Facilitator), which eventually lost its explicit designation (also discussed in §3.3.5: Limit of Evolution)
3.3.2 Initial Proforma

The initial proforma constitutes the first logical representation of a substantive proportion of the interview data, and is regarded as an important milestone. The aim is to use the mind to build a foundation upon which to process data. The human mind possesses the capacity for subtle correlations to be made, often between variables that the conscious mind is not fully aware of; and it is this capacity that is sought. However, due to limitations of cognition and memory, this process must make pragmatic compromises against the impossibility of absorbing and scrutinising all the data at any one time.

While incorporating the entirety of the data is the norm for a computational technique such as regression, it has the advantage of data storage capacity unavailable to the human mind. To overcome this, the process must therefore be designed around the limitations of memory through iteration, where valid improvements in theory are secured at each step. Thus, even if change is marginal and incremental, the limited amount of available data must be efficiently employed to build theory in a constructive fashion.
Entrepreneurial Knowledge Transfer

...while coding we are constantly moving between inductive and deductive thinking. 
That is, we deductively propose statements of relationships or suggest possible 
properties and their dimensions when working with data, then actually attempt to verify 
what we have deduced against data as we compare incident with incident. There is a 
constant interplay between proposing and checking. This back and forth movement is 
what makes our theory grounded (Strauss 1990 p. 111)

As the process iterates between construct and linkage identification (see Fig. 12), the 
intention is to reduce the number of constructs, and thus lessen the load on cognition. 
Due to early unfamiliarity with the data, there will be an early tendency towards an 
excessive number of constructs. This is because the mind lacks sufficient insight to 
perceive commonalities, giving rise to multiple constructs that are similar yet different. 
Over a number of iterations, an improved capacity to discriminate allows peripheral 
concepts to be discarded.

![Figure 12: Convergent process to reach paradigm model](image)

Eventually, constructs become fewer in number and more exact by definition. In this 
way, a convergence occurs, perhaps not representative of the entirety of the data, but 
certainly of that fraction defined by the data met thus far. To maximise the fraction of 
data considered in the first attempt at model building, a technique developed explicitly 
for this research is employed.

**Aural Immersion**

The intent of *aural immersion* is to build up an initial store of data within the memory 
to then inform an accurate version of model as is possible. Early accuracy is critical 
as it lessens the extent of alterations required later, reducing the difficulty of the process 
overall.
Chapter 3: Methodology

The concept is saturation of the memory by interview data in readiness for a first attempt at building a model. Thus, analysis of information is suspended in favour of straightforward absorption, and is designed to provide a large quantity of fresh, rich data for the mind to work with. In conjunction with these newly imbibed perceptions are pre-existing impressions such as those reflected by the early models (Figs. 10 and 11), and are collectively intended to fuel a first attempt at theory.

Those first pages of field notes are puzzling, you don’t know where to start, or even what exactly you’re looking for, or whether you’ll recognise it if you see it. It’s all an undifferentiated mass – all of this [will be] reflected in your early memos. Here is the place to put down, without concern for what others will think or for what is ‘correct’ or true, your first impressions, thoughts and directions to yourself. You can be as insecure as you want in these early stages. Just remind yourself, that if you or even others knew all the answers, there would be no reason to do this particular research. (Strauss 1990 p. 204)

Following completion of transcription via cognitive mapping, aural immersion was found to be a highly valuable precursor to model building. When the interviews were originally undertaken, only a portion of the information was absorbed, and while transcription added to this, the resulting body of memorised data was in no way coherent or efficiently accessible. If the interviews had been more structured, or the subject matter less intricate, the immersion process may not have been necessary. However, with an average of three quarters of an hour of densely-packed, highly contextual information, the information load is simply too great.

In the time taken to visually examining and searching cognitive maps, the modeller can lose track, especially if a number of provisional assumptions are being held. When building theory, even if a relevant piece of data is found, without a means of calibrating it to the memorised body, it cannot be contextualised. On the other hand, theory is much easier to destroy, and a single contradictory piece of data can invalidate all work to date. With the interview data consisting of thousands of pieces of data, this can be difficult to protect against, which is essentially why immersion is undertaken. Absorbing the data through listening again to the subjects speak allows it to resonate in a manner nearly as good to first hand experience. This then allows the brain can sift and locate data effectively while at the same time retaining a sense of the larger context through use of aural memory.
Identifying Constructs

The process of defining constructs is largely intuitive as the brain subconsciously sifts and correlates memorized data. The conscious mind has a cognitive limit that disallows a holistic examination that would give rise to a coherent and mutually-exclusive array of constructs. Given sufficient time after aural immersion, patterns emerge from the data, from which a set of constructs is created, one example from the final results being (Network) Capacity, shown in Fig. 13 below and defined as;

Capacity expresses the resources available at any one time that are suitable for contribution to network activities – including those currently being utilised. (§4.1.2)

Figure 13: Cutaway section of final paradigm model included for illustration

After the constructs have been identified, they are examined for linkages, discussed in the next section. If the set of constructs prove inadequate, such that all linkages cannot be included without conflict, the set is rejected and reassessed in light of the conflicts discovered. Linkages are expected to undergo numerous permutations before the stocks are reconsidered. Nevertheless, if the patterns suggest otherwise, there will be no hesitation revising them.

Justifying Linkages

Linkages are a directional cause-effect relationship between two constructs, and may take any one of three forms; positive, negative and absent. As shown in Fig. 13, the polarity indicates whether the linked constructs will rise and fall in tandem or in opposition, with the colour also used in presenting the rationale behind the linkage, as the example of abuse position above shows, which like all linkages is always written in small caps and underlined. The constructs involved in abuse position shown to the left
and right of the title bar, with the originating construct to the left. Below the title bar is, on the left, a summary and to the right, the justification in point form: which in the case of this, fairly abstract, linkage is relatively extensive.

<table>
<thead>
<tr>
<th>Network Capacity</th>
<th>abuse position</th>
</tr>
</thead>
<tbody>
<tr>
<td>As a network grows in strength, the members who hold that strength will inevitably see opportunities for abuse.</td>
<td></td>
</tr>
<tr>
<td>Another perspective is as a disconnect between power and responsibility – whereby a member is exercising power under cover of the network, yet betraying its’ central tenant.</td>
<td></td>
</tr>
<tr>
<td>Agendas may be on an individual or group basis, but the difference with external obligations is they are not intrinsic, formally recognised nor unavoidable. In other words, corruption is a choice.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 14: Linkage justification of abuse position (§4.2.2) included for illustration

An absent link implies the two behave independently from each other. Absent linkages are a novel addition to both system dynamics and grounded theory, but have been deemed necessary for the purpose of this research. They record that data has indicated the absence of a relationship, and given the intricacy of the model, this can constitute an important insight:

*The purpose of axial coding is to suggest and verify relationships between a category and its subcategories in terms of the paradigm, and to continue to look for variation in properties through dimensions. Therefore, memos will reflect your successful and sometimes unsuccessful attempts to link pieces together, your hunting for just the right connection. They will address questions like: What are the conditions bearing upon this phenomenon (causal, contextual and intervening)? What are the strategic or routine actions/interactions taking place? With what consequences? What happens when conditions change? (Strauss 1990 p. 211)*

After receiving the set of constructs, memorized data identifies the existence of relationships. As stronger linkages are become highlighted, those remaining appear progressively less certain. At the same time, conflicts also arise, often as a result of the definition of a construct ‘deformed’ by competing rationalisations of linkages. The fault may lie with the construct definition being perhaps too broad or having the wrong focus. If too broad, intersection with another construct may arise when examined in a particular context. If badly cast, different contexts will give rise to inconsistency within the construct itself, akin to ‘being all things to all people’. Alternatively, a construct
Entrepreneurial Knowledge Transfer

may be too tightly defined to accommodate the full range of instances that it might be expected to.

When these conflicts arise, the instinctive response is to remedy the problem directly – tightening up a loose definition, broadening a tight one or redesignating multiple constructs to achieve separation. However, without having the ability the consciously track the full repercussions of the change, this is merely ‘fishing in the dark’. Since it was high complexity that necessitated this methodology in the first place, the full ramifications of a change may be unpredictable. What is more, the change may violate an important underlying condition made by the subconscious when the set of constructs were initially created, but which the modeller has not yet become aware of. Unless a conflict can be tackled with a change in definition that is, as far as can be ascertained, largely cosmetic (although some flexibility is required), it is preferable to remove all linkages and return to the construct phase.

Gradually, over much iteration a satisfactory level of confidence is reached, and an accompanying reduction in the number of constructs, with accompanying improvement in their accuracy and relevance. Fewer constructs also means fewer potential linkages, adding to the overall reduction in information represented by the model, bringing it closer to the cognitive limit and rendering the process more manageable. Furthermore, constructs that better reflect the fundamental nature of the system reduce the potential for inconsistencies to arise. In this way, there is a convergence towards a simpler yet more accurate representation of the system. At the same time, the modeller becomes more familiar with his memorized data. Familiarity means the subconscious has itself begun grouping its data in a coherent way, meaning the patterns it forms have better ability to categorise memorised data.

Keeping Descriptive Notes

Unfortunately the mind has a tendency for ‘fractured’ thought, similar to George Orwell’s ‘double think’, where perceptions shift depending upon the context. This means that one can happily assume something in one circumstance, but believe something entirely contradictory\textsuperscript{41} in another; and appears to be exacerbated the subject

\textsuperscript{41} This seems to occur because the human mind has evolved to deal with only single directly experienced reality. There was only ever one context, and no need to rigorously examine underlying assumptions for inconsistencies, such as those that generate ‘culture shock’ when a new reality strikes discord with those previously experienced.
matter is complex and there is insufficient personal experience with which to ground it. To counteract inadequate detection of conflicting assumptions, it is necessary to explicitly detail the rationale behind all constructs and linkages by keeping written notes.

*Validating one’s theory against the data completes its grounding. One does this by laying out the theory in memos either diagrammatically or narratively. Then statements regarding the category relationships under varying contextual conditions are developed and finally validated against the data.* (Strauss 1990 p. 133)

A written record allows the mind to reliably compare and contrast the assumptions behind conclusions it has drawn, thus revealing inconsistencies. It also helps the unconscious mind to organize its data as it receives negative feedback when an inconsistency is detected. The subconscious is powerful, but not necessarily well-ordered.

**Circular Logic**

As a final digression before moving onto the next section, it is thought the following observations will provide some amusement for the reader.

In general, maximising efficiency of development of the initial proforma means minimising future need for extensive modifications. Model flexibility was achieved through keeping constructs broad and abstract while allowing linkages greater detail. Aside from avoiding the need to completely rejuvenate the model, it is also inherently sensible because constructs are originally created by the subconscious, which does not tend to be logically definitive. Also, the kind of subject matter that requires a methodology of this kind is likely to have constructs that are, for reason of their inherent nature and/or the mind’s capacity to grasp it, resistant to explicit identification. Circularity of logic aside, evidence of this would seem to lie in the necessity of the research at all, for if the constructs were straightforward and concrete, they would already be known.

While constructs must be inferred from the data, linkages should be referenced to it overtly. There is to some extent based on a presumption that if the constructs cannot be

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42 By way of illustration, science concerns itself with the physical world, where constructs are usually well-defined, quantitative and recognisable. It is perhaps for this reason that science has built an extensive theoretical edifice while the social sciences remain mired in fundamental controversies.
Entrepreneurial Knowledge Transfer

measured with units already in common usage (such as energy or money), then this will require previously unknown units. This implies therefore that constructs will only be revealed by their interaction with other constructs\textsuperscript{43} revealed by the model since these are also likely to have been ignored by present theory.

So, constructs can be left vague in the (perhaps unduly optimistic) expectation they will reveal themselves in time. However for this to occur, in accordance with the principles of triangulation of evidence, there must be dedication and discipline shown in the rigorous authentication of linkages against an extensive range of data. Once the modeller is satisfied that the model as a whole adequately represents internalised data, the proforma is ready to be evolved.

3.3.3 Examine Maps

The evolution phase of the data analysis stage is designed to build towards a final model by progressively testing the proforma model against individual interviews\textsuperscript{44}. Through forcing the proforma model to explicitly reflect a larger and larger proportion of the interview data, understanding of the system is progressed. The following description builds on many of the themes introduced in the previous section, but as suggested by the need for two distinct processes as shown by Fig. 8, extensive differences remain.

\textit{In developing a grounded theory we are trying to capture as much as the complexity and movement in the real world as possible, while knowing we are never able to grasp all of it. Recall, that we are not counting numbers, though we are looking for evidence to support and qualify our statement of relationships regarding the data. The discovery and specification of differences among and within categories, as well as similarities, is crucially important and at the heart of grounded theory. (Strauss 1990 p. 110)}

Mapping interview maps requires a completely different perspective to formulating the initial proforma. Whereas previously, the idea was to generate a model using data internalised via aural immersion, the aim now is to completely clear the mind of

\textsuperscript{43} To carry on the scientific analogy, the discovery of gravity is a case in point. Gravity (a construct) was discovered through careful observation of the movement of celestial bodies in relation to one another. It was noted that relative distance and mass seemed to interact and produce an inverse square attractive force (the linkage) that gave planets elliptical orbits. The existence of gravity was postulated from the behaviour of the planets, but had not itself yet been discovered even though everyone was permanently under its effects.

\textsuperscript{44} Some interviews did not meet the minimum requirements for experience and/or consistency, and are excluded from the research. See Appendix H for detail of correlations within the interview data.
anything bar the formal definitions for the constructs. To map an interview precisely, there should be no preconceptions that will interfere with the modeller’s ability to understand what the subject has experienced. In general, the mind has a tendency to ignore information it does not understand; that which does not ‘resonate’. Unless there is a palpable reason to give new information priority, such as danger or curiosity, the default response is to avoid expending the mental resources required to understand it.

**Handling Conflict**

In the early stages of mapping interviews to the proforma, conflicts are almost guaranteed to arise. The proforma was created with an amalgam of interview data and personal experience, but now it must accommodate every detail of another’s perception. However, there is no point returning to create a new proforma without enough new information to make it worthwhile. Yet, it is also unsatisfactory to force the interview data to fit a set of constructs in an unrealistic way.

The options remaining are to make a note of those statements that could not be accommodated, and move on to the next interview, or alternatively to make ‘running’ repairs on the proforma. If the latter, assuming the data deemed significant, the proforma is altered as much as is necessary to accommodate dichotomies. This is a judgement call on the basis of bearing and veracity, meaning the data is perceived as relevant to the conflict at hand, and emblematic rather than aberrant.

**Seeking Resonance**

In making the comparison to the proforma, the modeller is hoping for ‘resonance’ (or to be more prosaic, recognition), meaning the piece of data has some similarity to an aspect of the model. A spark of recognition invites further investigation, whereupon the modeller changes from ‘search’ to ‘evaluation’ mode. Here the modeller examines the data in depth in order to uncover exactly how it will map onto the proforma. As you might imagine, the process can be mentally draining. As such, it is important that the modeller remains aware of their effectiveness and not fall into the trap of ‘brushing over’ data, and in so doing miss a resonance, whether in the form of.

When the mind has conceived an internal ‘structure’ that is somehow ‘representative’ of the information, a resonance occurs. The mind responds to the resonance by accepting the sensory input, partly because it knows that fewer resources will be required to absorb it, but also because a pre-existing structure indicates the similar information has
Entrepreneurial Knowledge Transfer

been important in the past. Therefore, an assessment is made – largely subconsciously - on the basis of familiarity and resource expenditure. Translated to the context of analysing an interview map, it becomes apparent that poorly-understood data is more likely to be ignored. If the data is important, missing it of course is a cause for concern, but it may be poorly understood because it is irrelevant and safely forgone therefore. However, when resonance occurs, a new process in entered into, as will now be explained.

3.3.4 Displace Memory

While listening to interviews is certainly useful, it does not compare to the efficacy of the evolution process in terms of its capacity to infuse improved understandings. Since the data is entering the memory is forcibly contrasted against prior assumptions, the mind evolves its insight quickly. While exhausting, actively manipulating data against a framework produced by the subconscious is very effective at categorizing and absorbing quite detailed information.

That being the case, an interview used to inform development of the initial proforma may give very different results when employed within the subsequent evolution stage. While on paper the proforma improves, a greater change is taking place in the mind of the modeller. He has developed a subtle awareness of the system backed up with a large amount of internalised interview data contained within a robust mental framework. When an interview is examined in this context, a far greater proportion of the data finds resonance. In this way, the methodology allows earlier ‘misses’ to be recovered.

Shock Therapy

The underlying strength of proforma evolution comes from forcing the mind to prioritise new data over the old in attempting to accommodate it. This prompts a re-examination at the level of the subconscious, taking advantage of the mind’s ability to integrate multiple bodies of data – at least when it is pressed to do so. Furthermore, doing this while the information is still fresh maximises its chances of uprooting the assumptions the mind has already embedded. A delay of even a few hours will dramatically reduce the impact of the new data. With it existing as a short-term memory rather than a deep structure, especially as it contradicts the pre-existing structure, the mind will soon begin to dismantle it.
Chapter 3: Methodology

In essence, to evolve understanding, the mind needs to be given ‘shock therapy’ by forcing it to confront contradictory data. The modeller, knowing the interview data is an exact representation of the experiences of a practitioner in the field, has to order his mind to give it priority. Once this order is firmly put in train, the mind will temporarily de-prioritise the old data and begin to produce suggestions for new constructs to resolve conflict. In other words, by forcing the mind to work with the new data, in the context of the old, the result will be integration of the two. This may take some time, perhaps a day or more\(^{45}\), but the outcome is highly desirable. Nevertheless, the resulting proforma will typically remain imperfect with a small number of (hopefully minor) conflicting interpretations of construct definition (demanded by different pieces of data absorbed thus far) but these will be identified by other aspects of the methodology (see §3.3.5: Repeating the Process).

**Voiding Personal Experience**

Another consideration when memory is displacing unwelcome data such as that formed by personal experience or deeply-held conviction, and as per the first rule of thumb. Yet the process must begin with *something*, whether research questions or preconceptions, while as discussed earlier, creation of the initial proforma draws considerably on personal experience.

Internalised perceptions are required to provide the framework with which to absorb large amounts of foreign information, but nevertheless have to be upgraded to accommodate new realisations produced by the *actual* data. To do so, preconceptions must be degraded through a combination of continuous absorption of new data and reconfiguration via models. Similar to before, any cessation is to be avoided as it will allow the older, deeper memories to re-establish themselves.

**Model as Memory Guide**

Utilisation of the model as a guide to mental categorisation raises another aspect of it functionality to the research process. Identifying relevance to the proforma model requires the modeller to comprehend interview data and then compare it with the internal framework. While recent and regular use mean the full proforma model

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\(^{45}\) Since working from short-term memory is more difficult, the mind will tire relatively quickly, and as it tires, it loses the capacity to manipulate its new data. At this point, the modeller is advised to stop, accept the current set of constructs, tidy up the model and then acquire sufficient rest to enable a resumption.
Entrepreneurial Knowledge Transfer

(including linkages) is fresh in the modellers mind, he must nevertheless attempt to think only in terms of constructs rather than linkages (which are more ‘descriptive’ than logically definitive, even if abstract). From experience, this takes a little practice, but occurs surprisingly quickly – not least because reducing the proforma information to a minimum makes the process less onerous.

In that it exists relative to its relationship to other memories, memory is relational. By forcing your mind to enhance one set of relationships over another, new connections replace the old and the memorised data will adopt the new structure. Of course, considering it is essentially a rewiring of the brain, it is a costly process. Very similar to heuristics, changing memory structure will exhaust the brain while also incurring a delay until the new memories structure is strong enough to be useful. Just as discussed in relation to the subconscious, improving mental fitness over the course of this process will increasingly allow the brain to recover from exhaustion more quickly and embed new pathways faster.\footnote{By the final stages of research, the author was able to force a major change in memory configuration a maximum of 2-3 times a day, also bearing in mind that the amount of data stored was by then quite substantial.}

Even when a large amount of data is already stored via an old model, by forcing your mind to correlate its memories against a new structure, your memories will begin to change to reflect it. This may be a result of altering patterns of neuronal connections rather than physically adding new cells, but the effect is the same.

3.3.5 Validate Model

As already described, proforma evolution is an iterative process of absorbing data and comparing it against the proforma model in the search of gradual convergence towards a sufficiently accurate representation of the data. The validation process for a particular interview occurs by removing all the linkages from the current, leaving only the constructs. The task is then to translate the concept map (as per Fig. 9) in its entirety onto the blank proforma by associating pieces of the conversational logic with cause effect between constructs (linkages), or the constructs themselves.

Principles of Convergence

While the process of proforma evolution is designed to represent the distillation of accumulated, internalised data, there is a risk that new changes will begin to contradict earlier data (see 3.3.2: Fractured Thought). Even though the process is akin to solving a
puzzle (and not a little enjoyable therefore), validating an interview without regard for earlier conclusions risks missing a breakthrough that would otherwise have united them. In this way, the modeller can effectively go around in circles, adjusting and readjusting variables around a critical flaw without ever understanding, or even noticing, it.

Selective coding denotes the final step in our analysis: The integration of concepts around a core category and filling in of categories that need further development and refinement. At this time, memos and diagrams show depth and complexity of thought that serve to mirror the evolving theory (Strauss 1990 p. 217)

However, when due regard for the process was taken (once it had been sufficiently developed to be followed) the proforma was found to converge such that it eventually satisfied all data, whether recently examined or not. Strauss calls this point theoretical saturation, but the ability of the modeller to detect saturation is limited by his ability to recall a significant proportion of the data. Even before saturation is remotely anticipated however, recalling more data makes convergence towards saturation more efficient as it reduces likelihood of conflicts, whether between data directly or indirectly through a proforma (explained later in the section).

Another technique to improve convergence and minimising the need to remember and navigating between large blocks of data is (similar to the rationale behind aural immersion) to develop a high-quality proforma as early as possible. This not only reduces the number of evolutionary steps, but also means that new data is categorised within memory in a fashion that will not require upheaval to redress a fundamental misconception, otherwise known as mutation. To a large extent this depends upon the quality of the initial proforma, but also in faithfully following the dual processes of induction and deduction.

Induction and Deduction

One of the primary tasks of evolution is to adjudicate conflicts arising in the data, typically between new and old. Accomplishing this requires a weight or credibility to be assigned to each on the basis of a ‘neutral’ framework provided by the current proforma. However, with numerous ‘shadows’ of old proformas remaining in the subconscious, it can be difficult to ensure that only the latest version is utilised. As mentioned in the previous section, embodying the current framework in a proforma gives it added presence, encouraging the mind to prioritise it.
Entrepreneurial Knowledge Transfer

Also, by acting as the distillation of all data examined thus far, the proforma acts as the long term memory of the process. However, to maintain equivalence between the written and subconscious proformas, the most recent theoretical developments must be forced into the mind. This is assisted by actively referencing the latest proforma, where the most recent changes were fashioned on the basis the interview directly preceding the one under consideration, encouraging the mind to call upon that data when parsing new information with the proforma. This is desirable since earlier interpretations of data were formed on the basis of more primitive assumptions, and are likely to be less accurate therefore.

In summary then, conflicts between early and recent data must be adjudicated from the most recent proforma, but pre-existing associations between the old data and the older proforma it informed must be actively broken for this to occur. Strauss chooses to express the interplay of relational memory in the subconscious with analytical rationale in the conscious as inductive and deductive thinking respectively.

As you have probably noticed, while coding we are constantly moving between inductive and deductive thinking. That is, we deductively propose statements of relationships or suggest possible properties and their dimensions when working with data, then actually attempt to verify what we have deduced against data as we compare incident with incident. There is a constant interplay between proposing and checking. This back and forth movement is what makes our theory grounded! (Strauss1990 p. 111)

Inherently, the goal of model validation is to supersede earlier, flawed perceptions, but given their stubbornness, mapping of a single interview (with inherent linkage creation and construct redefinition) may need to be repeated up to 3 or 4 times. In the process, constant reinforcement of the new data allows the proforma evolve into something that may be entirely different from the state it began mapping of the interview with.

**Mutation of the Proforma**

In an ideal world, extensive modification of a proforma would simply indicate that the interviewee in question possesses insights unique to himself, or at least missed by those already mapped. Problematically however, it may also indicate the presence of a newly-arisen mutation, or alternatively that the earlier version of the proforma had hitherto unknown flaws, and itself constitutes a mutation that had thus far remained undetected. If the latter, this indicates that earlier data had either significant faults or was incorrectly
interpreted, or alternatively (and commonly) the modeller’s grasp was insufficiently
developed to make sense of aspects of the data, and it was effectively ignored. The
question then becomes one of establishing if there is in fact a mutation (as opposed to
insightful interview subject), and if so, whether the current or previous versions of the
proforma are at fault.

Since it is usually impossible to know these have occurred, the modeller has no choice
but to provisionally reject the most recent version, or risk laying incorrect neural
pathways that will present considerable difficulty to remove. Instead, the previous
proforma is readopted and the mapping process continued, starting with the next
interview in line. By successively confronting the earlier proforma with new data,
points of mutation (whether founded on misinterpretation of, or flaws in, the data)
should reveal themselves and lead to a correct convergence. This will perhaps be similar
to the provisionally rejected proforma or perhaps not (but if so, might indicate that the
subject was indeed extraordinarily insightful). However, if no convergence occurs, it
may be that resonance from earlier data (as per §3.3.3: Seeking Resonance) was missed.
This then necessitates a return to earlier interviews for the purpose of complete
reinterpretation, a process that continues until the modeller is confident that
convergence has recommenced.

**Referencing Data to Proforma Models**

Improving veracity by compensating for imperfect memory and increasing speed of
referencing is a technique that grounded theory refers to as memoing, shown by Fig. 15.

> Short quotes or phrases can be included in the memos. They are handy reminders of
> the data that gave rise to a particular concept or idea. Later, when writing, these can
> be used as illustrations. (Strauss 1990 p. 115)

> Each analyst must develop his or her own style for memoing and diagramming. Some
> may choose to use computer programs, others coded cards, while still others prefer
> putting typewritten pages into binders. The method is not important, so long as it works
> for you. What is salient, however, is that your memos and diagrams remain orderly,
> progressive and easily retrievable for sorting and cross-referencing. (Strauss 1990 p.
> 114)

In order to keep a record of what data supports what aspect of the model, small coloured
boxes are placed on the newly-created linkages, or if a construct, overlapping its edge.
Included here for the purpose of demonstration is a cutaway section from the data.
Figure 15: Cutaway section of data showing use of markers to reference data on a proforma model

The markers are also numbered, which reference the concept map. Since the data presents as conversational threads, one number is selected as representative of the entire thread, which may include many individual statements from the concept map. At the same time, a single thread can give rise to numerous linkages, which typically indicates it is particularly interesting or demonstrative. This is on a subjective basis of awareness at that time, and would not necessarily be duplicated given a more advanced or retarded awareness, but nevertheless indicates the importance of remaining responsive to the conditions.

*Be flexible and stay relaxed when memoing and diagramming. Rigid fixation on form or correctness stifles creativity and freezes thought. (Strauss 1990 p. 115)*

On the margins of the proforma itself the thread is then displayed verbatim for easy referencing, assisted by coloured highlighting of sections of text in concordance with their respective linkage markers. All colours are free to be used for referencing except for three given special meaning: red, blue and grey. As with the concept map, red indicates a negative effect while blue is the absence of such, which as discussed previously (§3.3.2: Nominating Linkages), means the subject has stated there is no...
causal link between two constructs. Taken together, these non-positive linkages provide a counterpoint to the remaining majority of the data that create simple positive linkages, shown in black\textsuperscript{47}. On the other hand, text with grey highlighting (and any associated boxes) are thoughts of the modeller rather than verbatim data, but nevertheless provide valuable interpretations of statements that might otherwise be confusing when taken out of the context of the interview.

**Illustrative Example of Mutation**

Examination of Appendix H demonstrates how significantly different the early and later proformas are from each other\textsuperscript{48} A specific instance of mutation was the early dedication of a range of constructs to facilitators (see U1\textsubscript{2}) that were eventually abandoned completely. This approach was prompted early assumptions carried through from the initial proforma (and reflected by the research question) that was later to introduce irreconcilable conflict, leading to unmanageable complexity, in the model. A distinction made between facilitators, administrators and other participants created additional constructs, which were required to operate independently, and gave rise to a large number of new potential linkages. The existence of each linkage (or lack thereof) had to be confirmed by the data consistently, which due to both deficiencies in the logic they embodied and the author’s capacity to adjudicate it, proved impossible to achieve. This lead to the replacement of a division of labour based upon the labels of ‘facilitator’ and ‘administrator’ with one based upon a single unified concept with aspects of information and power (and titled Coordination) allowing facilitators and administrators to coexist.

### 3.4 Theory Development

The final stage of research suggested by grounded theory is *theory development*, and its aim is to improve theory both specifically, in terms of detail such as labels and definitions, and more generally, with regard to the overall structure of the model.

\textsuperscript{47} Although in some of the proformas in Appendix H, positive linkages are coloured as well, but this was only a brief experiment that was rejected as it was needless colour clutter.

\textsuperscript{48} In many diagrams within Appendix H, construct labels are obscured by text but generally this was only allowed in the later stages when the set of constructs had stabilised such that their identity could be inferred from elsewhere.
Entrepreneurial Knowledge Transfer

This occurs via three processes; comparison with literature, model analysis and creation of recommendations. Literature provides useful insights by manipulating data-generated theory against frameworks that have been created by others, whether individually, as an entire field or statistically. After incorporating these insights, the author then attempted to logically analyse the paradigm model, instigating further revelations that were assisted by tests suggested by system dynamics (detailed in first part of Appendix E). Following this were recommendations, of necessity both sensible and applicable, adding another dimension of challenge to the paradigm model as it now stood. This prompted, for instance, inclusion of peer induction; one among the many linkages that constitutes the paradigm model presented in the next chapter.
4 RESULTS

This chapter portrays the crux of this research: a system dynamics model produced by a methodology founded on grounded theory that uses operational constructs (and their intervening linkages) to characterise the behaviour of a group of people engaged in knowledge transfer to entrepreneurial purpose. This intent is to now enable insight into all aspects of the paradigm model’s operation and its relevance to the real world.

The model is presented in two stages, starting with the constructs and exogenous variables, and followed by linkages, at all stages accompanied with supporting quotes from the data. However, as mentioned at the conclusion of the previous chapter, the model incorporates not only interview data but also subsequent investigation of literature and logical. Please note that after discussion of the final linkage, the chapter concludes without further remark, reflecting the intention of saving secondary analysis for subsequent chapters.

4.1 Paradigm Model Introduction

The intent here is to introduce the reader to the basics of the model; its fundamental concepts and operational constructs, as well as exogenous variables, reflecting the preference for a model boundary by systems dynamics (see Appendix A) to explicitly designate what is included, and what is not.

4.1.1 Foundation Concepts

This section is intended to provide the first layer of understanding upon which the remainder of the chapter is built. The two fundamental concepts of premise and network are presented, followed by a narrative explanation of system dynamics and finally the stock and flow diagram of the paradigm model is displayed.

49 To preserve anonymity of the interview subjects, none of the quotes are attributed, however they may all be found within Appendix H and are referenced by proforma and quote number. The proforma number registers the particular university and interviewee, and provides an idea of the spread of quotes. Furthermore, every quote taken from the proformas is underlined in Appendix H, and inspection of this indicates for each proforma the proportion of quotes used in the thesis proper.
Entrepreneurial Knowledge Transfer

**Network**

A network is assumed to be a group of intelligent agents collaborating in a consistent fashion. Consistency implies there is a way of distinguishing appropriate from inappropriate activities, and the members of the network join in the expectation that others will comply with that distinction.

**Premise**

A premise encapsulates why the network exists, and by extension, why its members joined in the first place. The premise also serves to encourage consistency by guiding the actions of individual members within collaborations. In so doing, the premise must be universal in the sense of being known and comprehensible to all members.

**Stocks and Flows**

The model is composed of three components; stocks, flows and variables; the foundation of system dynamics. When used in concert they constitute the mathematical elements of algebra; integration, differentiation and operation respectively. Conceptually, a stock is reminiscent of a bathtub filling with water, where the volume of water at any one time is the level of the stock, while the rate that water is pouring out of the tap is the flow. Variables are simply an instantaneous calculation based upon the inputs at the particular point in time. Collectively, the stocks and variables affect the flows within the model via linkages, and can be represented visually as shown in the paradigm model below.

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50 Collaboration occurs because it delivers an advantage over lack of collaboration since if individual action was sufficient, there would be no requirement for a network. See Proposition 1, Appendix G

51 See Appendix A: Modelling Techniques
Chapter 4: Results

4.1.2 Construct Definition

Paradigm model constructs are introduced accompanied by verbatim statements from the interview data.

**Network Activity**

Activity represents the sum of actions being undertaken at a point in time that fall within the aegis of the premise, in this case being EKT.

*Do the technology transfer by creating the platform, and then you build a business. Start out, prove the principle, do the market evaluation, protect the intellectual capacity. You have to have quality in terms of management and you drive the technology up the value chain. You have to have availability of money. (U1_3:107)*

*It could be [to] educate through informal networking, it could be workshops, multi-media modules. It could be educate through professional development through our own commercialisation people. (U2_7b:49)*

However, some activities fall outside of the scope, such as keeping in touch with alumni. Unless done with commercial intent, this cannot be classified as EKT.
entrepreneurial knowledge transfer

The information derived from alumnus should be fed back into the universities' activities. Effort should be made to find out what they're doing and how they're doing (U2_5:195)

The level of Activity appreciates when a preparation for transfer commences, and diminishes when it ceases. Conceptually a unit of measure might be man-hours/day, of which each activity contributes a standard amount based upon a nominal amount (the ‘size’ of which not being critical to the model itself since the flow is effectively a contiguous fluid).

Network Capacity

Capacity expresses the resources available at any one time that are suitable for contribution to network activities – including those currently being utilised. Their expression may vary considerably, between intangibles like know-how, ideas and communication skills, and tangibles such as equipment, buildings or money. Nevertheless, all resources are presumed to ‘belong’ to an individual, which becomes important elsewhere in the model.

Enterprise hubs have been created to have three important components. One is flexible workspace where you're trying to encourage the companies to be close to each other. You can more-easily deliver services to them. You get peer group networking the second part has be connection to either a research establishment or a university and the third bit is the business advice you can get from other local support providers (U1_5b:55)

[A]mateur angel investors] don't have the kind of networks and experience within a start-up framework to be of huge value to the businesses [and] because the business doesn't go completely 'vertical' after a year, they go away but they've still got a share in the company so what you're left with is an extremely messy balance sheet then it's very hard to get further investment into the business (U2_6b:64)

Normally the idea tends to be [the entrepreneurs’] own idea - he tends to be the visionary guy - very much the technologist who wants this thing to happen they tend to be the driving force behind the technology (U1_1:42)

In understanding the behaviour of Capacity, the closest approximation in physics is a combination of potential energy and exergy. Exergy is the total amount of useful work done by a system, while potential energy is the energy remaining to be used. In this context, useful is a term that depends upon what the system is designed to achieve, and
Chapter 4: Results

the more potential energy that becomes exergy, the greater the efficiency of the system. Capacity is akin to potential energy feeding a system with 100% conversion efficiency, meaning we have been careful to evaluate the energy entering the system for its future value.

The importance of ‘purity’ is demonstrated by the second quote, where the ‘wrong kind’ of Capacity has a number of negative effects that overall lead to the conclusion that the premise operated upon by the ‘amateur angels’ is not genuinely EKT. For instance, ‘not going completely vertical’ implies expectation of a specific growth path rather than acceptance of a novel (and therefore unpredictable) process.

Network Engagement

Engagement is the extent to which people are willing to commit themselves to a network, and therefore its premise. However, this is not necessarily a completely rational choice\(^{52}\) since perception is malleable and objectivity neither absolute nor constant. Rather, people respond at an instinctive level, where an instinctive desire to conform and belong, as well as enjoyment interacting with others, can become dominant.

While belonging to a network occurs on the basis of a premise, whether implicit or explicit, Engagement remains more an indicator of the strength of connections between members than the premise itself. Engagement is reminiscent of social capital, but with the focus placed upon EKT as the objective rather than social welfare. However, any relationship only exists within the network, and outside that setting it disappears.

\(\text{The difficulty is you've got to find an individual within a department within the university who is capable and willing to help you. Again it's one of the problems of us not being a university department, [and] therefore we sit on the fringe of the campus. I would like to see a quicker route in to the university to resolving problems for them to engage a little bit more with SME's - particularly when we've got, sort of, technical gaps for some of our companies. (U2_6a:240)}\)

\(\text{...if he's not enthusiastic with you [as a facilitator, then] he's not going to be too enthusiastic with an MBA [student being imposed upon him and his research]}\)

\(\text{(U1_4:126)}\)

\(^{52}\) As demonstrated by people during war, willing to overlook and undertake acts extreme brutality and cruelty, even without any coercion to do either.
Entrepreneurial Knowledge Transfer

There is so much engagement [that will occur] and people will want to engage because we add value (even if there are no longer funds available to give them) and so we'll now become a membership organisation where we'll have 20 institutions as members and then locally they'll all continue the delivery that we (originally) pump-primed not now because they're compelled to report to us because we fund them, but because there's value in it. (U2_7:127)

The stock represents the average level of engagement for all members, and is expressed as a percentage. A very high level of Engagement (such as within extreme religious cults) is indicative of complete dedication to the ‘cause’53.

Network Spectrum

The Spectrum of a network are the major ‘poles’ of member types consistent with the premise, and an EKT network with a good Spectrum will therefore contain a mix of academics, business professionals and entrepreneurs. If the network counts the best available personnel from these arenas as members, then Spectrum is approaching its maximum.

But we specify that teams should have a mix of local and overseas students but it's a good learning experience for overseas students to look around them, to see the local businesses to understand that they have [community] contact overseas students are not as likely to have as large networks of contacts with businesses. (U2_2:85)

We get [the academics] involved with the work program and make sure there is a good relationship with the company we're going to work with. That interaction [originally] happened with an academic attending one of our events talking to one of the guys in the company. I have a colleague that calls it engineered serendipity so you need to create an environment where you get VCs talking with academics and entrepreneurs and companies. Get them to physically interact with staff here through setting up our own events. [Sometimes, however] it can be a bit ad hoc -, it needs to be a bit more purposeful and better supported. (U4_4:184)

The process underlying EKT is novel, and this will occur most readily when creative ideas abound. For this reason the data showed that systems open to a diverse variety of participants generally had greater success, while those that imposed conditions such as ‘students only’ or ‘no technicians’ (in one case) experienced difficulties generating the

53 It can be dangerous when the premise is embodied by a person, meaning that the member will blindly follow the dictates of that person without recourse to internal judgement or external measures.
Chapter 4: Results

anticipated level of activity. However, increasing diversity brings complications that require deliberate action to overcome.

**Network Coordination**

Coordination is the most abstract of the constructs and represents in effect power - power to induct members, power to dictate the premise, power to approve activities and power to dictate how members participate in the network. In sum, power to control, coordinate and manage a group of people.

You need to have an incentive for the universities to engage until they start to see the results. The pump-priming was essential to get them on-board, and it also enabled us to build the network where we can gather the data about what is happening in the universities and share the knowledge - so we have positioned ourselves as that 'front door' of authority on enterprise in the Higher Education sector. We've proactively positioned ourselves as a leading authority. (U2_7b:108)

[Seed Fund] took a kind of fairly conservative investment policy: slow to start for the first couple of years working out what kinds of models were going to work, talking to all the academics and HODs (Heads of Department): making sure they understood what the fund was for telling the academics what was going to happen after they had gotten the money; in other words, there was going to be a commercial expectation.

(U4_5b:63)

We have the student interns networking, the interns are charged with either coordinating, or linking in with existing, or starting, an entrepreneurship society and again we can get 'feed in' to all of that. They're actually organising regional networking *incredulous* - they're actually having different institutions getting together for networking event! (U2_7a:232)

Being an entirely virtual construct, it is difficult to identify the dimensions to apply to Coordination.

### 4.1.3 Model Boundary

The variables listed here are those that arose in the data but were not robustly affected by the network itself. They might exert an effect on the network, but if this is not returned it is considered exogenous. Non-systemic (isolated, random) effects may also be evident, but if the effect is not apparent at the level of aggregation employed, they
Entrepreneurial Knowledge Transfer

are also deemed exogenous. Of course, this is not an exhaustive list of all possible exogenous factors, but only of those suggested by the data.

**Contravention of the Premise**

When dealing with a group of people undertaking diverse economic activity, mistakes are bound to occur. If these mistakes are systemic rather than one-off, then deeper questions may need to be asked. The network as conceived in this research is seen as ideal in the sense that the premise is assumed to accommodate all eventualities. Of course, reality is more complex and mistakes may be made in how the premise is manifested.

*There are some things that university entrepreneurship centres get involved in where frankly they are competing with either private or public sector suppliers. Any time we wander off on peripheral and marginal activities I think we've got to be quite careful about what we do. The only reason universities run these programs is to bring in money - it's ill-conceived from the start. Given the overhead structure of the university I would argue that it's uncompetitive for us to compete anyway as soon as the income stream dries up, jobs are lost and the courses close down.* (U2_2:48)

*The big challenge also, in this country, I guess, for small companies there has become a bit of what you might call subsidy dependence.* (U2_5:173)

*I think universities should be aware of doing too much for a spinout. All a university can do is to get a company formed and funded and establish that it has the potential to be a viable business and management team. The university has a responsibility to act professionally and commercially but not to do [the spinout company] any favours.* (U2_1:94)

When premise betrayal occurs, the network overall ceases to perform at an optimum level and undesirable outcomes begin to arise. Very often it can be difficult to reverse these outcomes because no one knows how, or if they do, people do not wish to make the effort to adapt their behaviour and perception.

**Management Decisions**

The decisions taken by those in power can have incredibly powerful impacts on the network, and obviously a good manager will be more likely to make the right decision.

*When the [KT grants for universities] all around the country were first announced, they had all different approaches. Some of the challenge funds spent all the money by giving*
it to the influential academics straight away without real conditions or selectivity. I don't think it worked very well particularly because after they had spent out their $250k, they were sitting on an array of opportunities. They hadn't eeked the money out; teased out the best opportunities - by just going for the obvious key professors. (U4_5b:57)

We (at the Tech Transfer Office) appeared to be almost unmanageable and out of control because most people weren't delivering at that speed but we're actually very tightly controlled as my staff will verify in that everybody has their own budget centres, own tasks, lead-on projects. And that means we can multi-task and the next project comes along, and that next and the next and the next. (U2_7a:143)

...you have to have some kind of management structure in universities that grabs that and deals with (the new invention). Generally science and technology are a little bit away from the market - you've got to get it closer to the market. You've got to make your decisions on what to invest in terms of science and technology to be able to move it forward more quickly. (U1_3:47)

Unfortunately the data did not indicate an easily-modelled linkage between management strategy and specific aspects of the network. While good leadership was the subject of numerous comments, there was no indication of what factors might have brought it about. However, in the more general case of skills and ability, which includes leadership, it is more-easily incorporated into the model.

**Individual Staff**

Similar to the question of individual leadership, it is difficult to capture the step change resulting from a key employee leaving or a mass exodus prompted by any number of contingencies. In general, long-term trends in staff quality and turnover may be captured, but individual standout effects are regarded as exogenous.

It's difficult to make inroads into the university because there is no continuity. Like the student union - they change every year. You get used to dealing with somebody and then they're gone. You get different people with different ideas, by 'smuggling in' expertise - a fresh pair of hands, a fresh pair of eyes,- into small companies through the auspices of a seconded graduate that sort of smuggling in is in many ways - in my opinion - better, because its on a full-time basis - than a consultant who comes in and out. (U2_4:35)
Entrepreneurial Knowledge Transfer

**Information Systems**

This concerns change to the availability of information due to provision of infrastructure such as modern telecommunications or dedicated ‘portal’ websites. The use of the internet (or in one instance a filing cabinet) to disseminate information was mentioned a number of times, but more often in the context of internal communication rather than the deliberate provision of information regarding members and activities to parties external or internal to the network. There were a number of mentions of databases accessible to the public, but none were mature enough to provide a reliable indication of their effect.

*I think one thing [small business would like from the university] is easier access to information. Glasgow University has been doing a lot of mapping to put on the internet full details of who’s doing what. (U2_3:95)*

The relative popularity of information systems may simply be a passing fad, but the mere fact they are contemplated suggests that the complexity of large networks can become a problem for the staff responsible for coordinating it. If such systems prove worthwhile, no doubt they will be seen more often over time, but at the moment there is insufficient information to include them as an endogenous factor.

**Intellectual Property**

As mentioned in the Scope, unfair agreements can create tension that distract from the project itself. Yet such situations do not necessarily indicate duplicity, and in fact often happen as a result of poor planning or familiarity with contract law. To remove this as a factor, it is presumed that agreements are always fair and reasonable, and that the rewards of EKT are shared fairly. This means that regulatory issues such as relating to academic ownership of intellectual property54 as well as conflicts between them and (for instance) corporations sponsoring research are deemed systemic rather than particular in nature. In other words, conflicts only arise as a result of real concerns rather than misconceptions or ignorance, such as would be the case with unrealistic expectations that from anecdotal reports sink negotiations on a regular basis.

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54 Such as the Bayh-Dole Act in the USA, or patent law in Australia.
Chapter 4: Results

**Economic Conditions**

Serious effects on the network were often attributed to economic conditions, but given their effect are completely external they can be considered exogenous.

...since the [Dotcom] collapse you are seeing a tightening of the belt, and the VCs have become much more cautious and sophisticated. (U3_1:120)

### 4.2 Linkage Justification

Linkages explain how categories affect one other, but from the perspective of communication to the reader, and more importantly therefore, how the model impacts on the reality. While the constructs are perhaps abstract and vague, and a little meaningless, linkages provide strong contextual grounding. They provide a point of entry into the theory, and as such it is important they are explained and validated convincingly.

#### 4.2.1 Impact of Network Activity

Figure 17: Linkages from Network Activity
Entrepreneurial Knowledge Transfer

The level of Activity present in the network has a wide range of effects, and can perhaps be considered the most accurate sign of a healthy network. It indicates how effective the network is since a high level of Activity implies the rate of failure of projects is low relative to the rate of their commencement. This then flows on to the external reputation of the network its members are seen to be productively engaged. It also allows skills to develop, and interaction to cement relationships. Finally, since personal information regarding members and their activities will tend to go out-of-date quickly, an industrious network is also likely to keep itself well-informed.

<table>
<thead>
<tr>
<th>Network Activity</th>
<th>establish reputation</th>
</tr>
</thead>
<tbody>
<tr>
<td>An established track record attracts interest</td>
<td>External reputation of the network is built over time</td>
</tr>
<tr>
<td>The level of activity indicates the health of the network, on which reputation is inherently based</td>
<td></td>
</tr>
</tbody>
</table>

Companies are often one of the most difficult targets for universities to attract, but they will respond positively when given the right impression;

*We don't have to recruit the companies, they come to us because they know they get treated well, we respond quickly and don't leave the company waiting around.*

(U4_4:61)

Knowledge transfer partnerships (KTPs) are a particular form of academic-business collaboration that place recent graduates into a company under academic supervision to work on a specific problem. These also require time to establish a reputation;

*Name of university* has a 25 year history of doing KTPs. *We started off doing 1 or 2, and then began doing 3 or 4, then 5 or 6 at once. We're now doing 20 odd all continuously. It's kind of endemic within academia that this is a good way to work with industry, but it's taken some time to get there obviously.* (U4_2:68)

Another perspective on reputation is word of mouth, where personal recommendations help establish credentials;

*I think to start we had quite a difficult time because people saw that we had no track record and said 'well how do I know I can trust you?' . You couldn't say 'oh well go and talk to 50 other clients that I'd dealt with’ but now I can.* (U2_6c:200)
Chapter 4: Results

Or even that the facilitators themselves, or at least their activities, are a ‘marketing exercise’\textsuperscript{55} for the university;

\textit{...in some ways we're a marketing exercise for the university - the be all and end all is that [name of university] gets its name around. Through that you get contacts; we make our own contacts. (U1_2:21)}

\begin{tabular}{|c|c|}
  \hline
  \textbf{Network Activity} & \textbf{constructive interaction} \\
  \hline
  Activities allow interaction that are constructive relative to the premise & All structured activities within the network will have an aspect of interaction \\
  & Enjoyment of this interaction will add to the sense of engagement with the network overall \\
  \hline
\end{tabular}

All EKT activities will have an aspect of relationship development through interaction;

\textit{So we're trying to be proactive in forming networks with whomever...You're developing a relationship - that doesn't come overnight. It's based on developing a level of trust with the companies. The interaction will take time} (U1_2:24)

Keeping in touch with academics is a valid activity if on the presumption that EKT is the intended outcome;

\textit{First of all I keep in touch within the physical science, or contacts in the advanced technology institute here or through contacts in one of the other schools related to physics and engineering. So all the time it's the people - developing the people - making sure the networks are strong - and it's relationships. (U1_4:14)}

As is holding networking events, although strictly speaking they do not satisfy the criteria for EKT (see Appendix B);

\textit{Once students get involved they really love it - you get to meet like-minded young people... We have a weekend workshop where we have 100 students there - working together, running ideas off each other, from all the institutions and that will encourage them next year to engage in some of the workshops and what-have-you. So it's leading by experience, and leading through giving confidence and knowledge. (U2_7c:298)}

\textsuperscript{55} Tying in with advertise resources in ‘Network Capacity’ since facilitators are also a major asset.
Activities create the opportunity to capture information that allow for effective coordination of the network.

Data may concern individual members or it may be non-specific and/or systemic.

Note that this is not accumulating information or learning, only instantaneous data on the capabilities of network members.

Capturing information includes keeping up to date with the network membership;

*I understand that [the technology transfer office] is very active within the different academic departments and faculties. They maintain a high profile in terms of making academics aware of opportunities to commercialise their research.* (U3_2:51)

*It's about networking - networking is one of the most important things to do. To get yourself out there, to understand what is going on at the ground level.* (U2_3:145)

Networking events provide opportunity for peer-to-peer communication;

*Its all about deliverables to develop our Wessex innovation network so we can create a network of businesses, public and private sector organisations that we can regularly communicate with, and stimulate new opportunities, and so we're learning that we've got to get the mix of attendees at those events to get those interactions.* (U4_4:176)

Information gathered from the coal face may also contribute to deeper, strategic insight;

*One of the most interesting things about [the regional entrepreneurship program] is that it is a pilot. If it works it could spawn a lot of other programs. When we understand from [the regional entrepreneurship program] what the optimum models are, then those can potentially be shared with other regions and universities.* (U1_1:68)

*It's only after a period of time [researching the company from within] that you can expect [a student intern] to come up with a decent proposal. Until you spend a couple of weeks with the people, you won't understand where the gaps are - where you can add value and where you can learn* (U2_3:126)

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56 Information held in a central repository is likely to provide greater efficiency of access than that held on a peer-to-peer basis, but the provision of such is regarded as exogenous
Chapter 4: Results

<table>
<thead>
<tr>
<th>Network Activity</th>
<th>build proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in activities builds the capacity of individuals</td>
<td>Undertaking a task allows skill and know-how to accumulate within individuals. This interacts constructively with the abilities of others - confer knowledge. Financial capital may also be included within 'capacity' insofar as innovative activities generate a return on investment.</td>
</tr>
</tbody>
</table>

Experience in EKT will build entrepreneurial capability, even at the student level;

> There is now a growing pool of individuals with direct commercialisation experience coming out of universities ready to work on successive projects – ‘serial entrepreneurs’ we call them. The sort of people who are interested in starting things, getting them off the ground, bringing in the money. (U4_5a:85)

However, initially participation may be restricted by a lack of experience;

> ...in the first 3 months [the students undertaking 12 month company internships] really were quite lost. In the last 6 months they were really useful - quite often companies don't want them to go back to university. Having done the industrial year, and when they come to find employment, the experience makes the student more employable. (U1_5b:39)

This also includes management expertise, where the ability to read people is learnt;

> It's very much a judgement call - we don't use any scientific approach. We use judgement based on many, many years of experience - and we have to make it very quickly [upon meeting the person] and we get it right a lot of the time. Whether that person has entrepreneurial flair; or more importantly, whether there's some technology that's innovative that can be taken to market. (U2_3:21)

<table>
<thead>
<tr>
<th>Network Activity</th>
<th>diminishing returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities consume resources</td>
<td>Ongoing activities tie up resources, limiting the scope of further activities. It is reasonable to presume that a level of latent capacity will always be required to provide flexibility in turnover of activities.</td>
</tr>
</tbody>
</table>
As with all members, the time and energy of facilitators constitutes a finite resource;

"I've got far too much work on really it's very difficult to do a project thoroughly. I don't know what the volume of well-done projects one would anticipate here. It's very difficult to know how much time to spend on a project; it's very easy to get yourself too involved... (U4_3:50)

"I have 20 projects at the moment and half a dozen are 'beginning to bubble'. They're taking quite a bit of my time in terms of negotiating with people, getting agreements done and so on and so forth. (U1_4:131)"

In general, under-resourcing places limits upon the activities that can be engaged in;

"...could openly say that in his experience the office was extremely under resourced and with more resources could do some very significant things. (U3_1:16)"

Thereby encouraging greater efficiency in their use;

"[University name] is more of a research-based university, and we wanted a model that encouraged interface with business without consuming their research/teaching time. (U4_2:7)"

4.2.2 Impact of Network Capacity

Figure 18: Linkages from Network Capacity
Capacity is concerned with resources, and as such is a measure of the ‘wealth’ of the network. For this reason, it affects how much is available to ‘spend’ (on activities) and how tempting it is for people to join the network to get a piece of it. At the same time, possessing the ‘wealth’ feels good, while it can also teach others have to ‘save’ through mentoring. Unfortunately however, people with ‘money’ have a temptation to think they’re somehow better than the rest, and act accordingly.

<table>
<thead>
<tr>
<th>Network Capacity</th>
<th>supply resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources enable activities to be undertaken</td>
<td></td>
</tr>
<tr>
<td>Activities require the input of capital - primarily human, knowledge and financial.</td>
<td></td>
</tr>
<tr>
<td>Such a contribution is related to, but separate from, the emotional commitment implied in assume responsibility</td>
<td></td>
</tr>
</tbody>
</table>

People are the most important resource, but the activities they can undertake are limited by what they actually know;

*In the graduate version they tend to be a bit more technology-advanced. At school it was more about running discos - things that 6th-formers know about.* (U1_5a:143)

Insofar as knowledge transfer is concerned, communication skills are often a necessity;

*I think the important thing about anybody joining a small company is having the ability to 'rub along with' the entrepreneur.* (U2_5:59)

As is the capacity to take the initiative - often in novel situations;

*[We want to find] someone able to build a rapport with an academic team, an understanding that you have to roll your sleeves up and do things yourself.* (U2_1:51)

*You have a dynamic of people; you have a dynamic of money. The people are the most important in that they have to be entrepreneurial.* (U1_3:108)

<table>
<thead>
<tr>
<th>Network Capacity</th>
<th>buy loyalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resources are an incentive to join the network</td>
<td></td>
</tr>
<tr>
<td>New members are attracted to a network that can offer resources to them, which includes knowledge resources.</td>
<td></td>
</tr>
<tr>
<td>Even resources already in-use are attractive as they indicate a wealthy membership base</td>
<td></td>
</tr>
<tr>
<td>Does not affect peer induction since people are joining on the basis of social ties, peer expectations and sense of identification</td>
<td></td>
</tr>
</tbody>
</table>
A technology park that promotes itself as a ‘community’ has an underlying reality of a desirable mix of valuable resources;

If you come on to this park, there is this network you can join - there is this community - to what extent do you think this will be of value to you? (U1_5b:96)

On the other hand, companies will advertise to universities on the basis of their resources – typically (but not exclusively) implying money;

[Universities aren’t] particularly good at [working with] SMEs - but that’s across board. [However] they engage EXTREMELY well with large corporations because they’re the ones with the money. (U2_6a:248)

Reversing the direction, companies seek involvement with universities to gain access to their intellectual resources;

As you go up the scale you have larger companies that want to form a relationship with the university to be part of understanding the future - technological colonialism - they want to get in and see where things are going. (U1_3:83)

Moving into the student realm, who are more likely to be attracted by comparably-pedestrian resources such as a social space and computing facilities;

If I can give them something - help them out - they don't care that I’m a student. [We have a] drop-in centre and resource library with computers rented from the student union. (U2_4:3)

<table>
<thead>
<tr>
<th>Network Capacity</th>
<th>gain recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accomplishment</td>
<td>engenders further engagement</td>
</tr>
<tr>
<td></td>
<td>Achievement by members provides a sense of personal reward that creates further engagement in the network</td>
</tr>
<tr>
<td></td>
<td>The achievement is defined by what is valuable to the network.</td>
</tr>
<tr>
<td></td>
<td>Recognition of one also allows others to see what they themselves can achieve</td>
</tr>
</tbody>
</table>

From the perspective of facilitators, there is a comprehension that members appreciate being successful, which in the individual case translates to achievement;

57 with any ‘warm and fuzzy’ feelings generated by seeing of people similar to yourself and succumbing to their enthusiasm, as per peer induction.
Chapter 4: Results

It’s only after that period of time that you can get some sense out of whether something is having a positive impact I guess. As far as the participants and companies are concerned, it’s if they perceive they have been successful at that time. (U2_5:76)

In the case of entrepreneurs giving lectures, there is an appreciation of empowering others rather than just themselves, meaning that the group can revel in the achievements of one of its compatriots;

...ask [the entrepreneurs] - and they'll give up 1 or 2 hours to help instruct a course at the university - they won't do it frequently but they'll do it once or twice as long as you use them and you've got a decent audience that is responsive they'll do it again. (U1_3:92)

As far as students are concerned, whether as facilitators or entrepreneurs, the sense of achievement is identical;

His line was 'I thought I wanted to be an accountant, and then I discovered [regional enterprise organisation]' - 'its people rather than spreadsheets that I enjoy' and so suddenly he's just completely changed career track (to facilitating student entrepreneurship). (U2_7a:247)

If you can show that the students who have taken entrepreneurship electives get real jobs, [then] that might help you to recruit better (U2_5:158)

<table>
<thead>
<tr>
<th>Network Capacity</th>
<th>abuse position</th>
<th>Network Coordination</th>
</tr>
</thead>
</table>
| Members abuse their standing within the network | As a network grows in strength, members to abuse that strength will inevitably become more prevalent  
Another perspective is as a disconnect between power and responsibility, where a member is exercising power under cover of the network, yet betraying its’ central tenant.  
Agendas may be on an individual or group basis, but the difference with external obligations is they are not intrinsic, formally recognised nor unavoidable. In other words, corruption is a choice. | |

Excessive focus of one aspect of the process, such as legal considerations, can be detrimental.

So often the legal people obstruct deals. Sometimes the solicitors obstruct for good reason, but sometimes [the 'entrepreneurial deal'] doesn't happen because they have obstructed the deal to death. (U4_3:11)
Entrepreneurial Knowledge Transfer

Commercial property must be managed to generate a return. If too much attention is paid on this aspect, the balance can be lost and the overall operation distorted.

What they found is that by funding the incubation space excessively, it actually diverted a lot of the attention away from the business support & into property management. (U1_5b:289)

If the originating department of the academic has undue influence over the project, it will attempt to divert resources from their intended destination.

Funding something within a university department is tricky. It is difficult to 'ring fence' the funding for a particular project. Departments will claw back money if they can, and take 'overhead fees' from funding for an internal project. (U4_5a:19)

Part of a commercialisation project is maintaining solid communications within the team – which includes financiers – regardless of the fact that immediate self interest perhaps dictates secrecy;

You're not doing business with a bank; you're doing business with the guy sitting behind the desk who's talking to you. Full information to him, keep him on side, keep him on your team, keep him aware of the progress and the problems. Don't save your cash flow problem until the cheque gets bounced because that’s just going to tick him off. If you're up front with as much advance notice as possible, people will appreciate that. Therefore the relationship works better and you'll find people will go the distance for you. (U2_6c:230)

<table>
<thead>
<tr>
<th>Network Capacity</th>
<th>share experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>The capacity within a network has a reinforcing effect as knowledge is passed between members</td>
<td></td>
</tr>
<tr>
<td>Sharing knowledge within the network</td>
<td>This may occur casually or under a formal mentoring arrangement, and between individuals or groups (such as firms)</td>
</tr>
<tr>
<td>In all cases however, activities are necessary to provide the circumstance for the transfer to occur</td>
<td></td>
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</tbody>
</table>

Entrepreneurship is a difficult endeavour that can benefit from mentoring;

We're a small business ourselves - we only employ 6 people. We very much understand the stresses and the strains they have because we had them ourselves, therefore some of the advice and assistance we're giving is aligned very much to what they're capable of doing. (U2_6b:29)
Chapter 4: Results

What’s really interesting is who [the] mentors [of new spin-outs] have been this year:
the entrepreneurs whose businesses are in the [business incubator]. (U1_5a:133)

However there are industry-, or even product-, specific lessons to be passed down;

...swap best practice and get advice on where you might go with technologies. We had
a few one-day meetings centred around things such as drug delivery or neuroscience.
(U4_1:24)

And so is facilitation, as evidenced by this statement by a student facilitator;

[Head Facilitator] is a good mentor and someone you can go and talk to. He has really
good knowledge ... It’s the quality of people working in the KT office that's important.,
(U2_4:30)

4.2.3 Impact of Network Engagement

Whilst the notion of Engagement is essentially qualitative, nonetheless it exerts a
powerful influence on the network. In the first instance, it encourages members to
contribute themselves to activities in the sense of accepting part of the responsibility for
Entrepreneurial Knowledge Transfer

delivering success. Engagement is also necessary before members will submit to the authority of the network, and allow themselves to be coordinated as part of it. Regarding perceptions and image, strong Engagement will be transmitted to those both within and outside the network, the latter more than likely involving peers. Finally, Engagement has a detrimental effect as it acts to discourage those regarded as a potential threat from joining.

<table>
<thead>
<tr>
<th>Network Engagement</th>
<th>accept responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>The decision to commit oneself to participation</td>
<td>The emotion based choice to dedicate oneself to an activity</td>
</tr>
<tr>
<td></td>
<td>Has resonance with the concept of accepting risk or taking responsibility</td>
</tr>
<tr>
<td></td>
<td>Without enthusiasm and energy to go along with physical resources (supply contribution), participation is empty</td>
</tr>
</tbody>
</table>

Accepting risk is often part of taking responsibility;

_We need guys who can be in there, working away, doing bits and pieces and [can] be much more flexible. SME companies move in different directions constantly and they have to be able to adapt and be flexible. Now I know that in order for people to start up a venture they must truly believe in it. Therefore some people say 'well you've got to take the risk'. Some of those kinds of things can be done that will allow people to say 'right, I will take the risk'. (U2_3:104)_

This means finding people willing to become part of the team;

_The [large scale government funds for innovation systems] came along and gave it a leg up. One of the first concerns raised early was how do we find people who don't act like a consultant. Instead we wanted people who actually acted like an interim manager and [were] able to bridge academia and the market. (U4_5a:82)_

Recognising that people cannot be forced to participate;

_I don't believe a scheme that marries up academic X with student Y who's interested in commercialisation would work. If things are to come about they are to come about through someone's initiative. (U2_1:101)_

Of course, if a member withdraws, the consequences can be serious;

_...within days of that I had another project that I was given that I got very excited about. In that case the academic was incredibly unhelpful - it just died a death because the academic didn’t have the energy for it. (U1_4:105)_

76
Chapter 4: Results

<table>
<thead>
<tr>
<th>Network Engagement</th>
<th>peer induction</th>
<th>Network Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recruit new members through the peer-to-peer network</td>
<td>Enthusiasm for a cause leads the member to encouraging their peers to participate as well. Since peer groups consist of members similar to each other, peer recruiting adds resources similar to those already present.</td>
<td></td>
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</tbody>
</table>

This is reminiscent of the previous linkage, and certainly they reinforce each other, but with the difference that this is an inclusive effect whereby members are encouraged to engage. In the leadership scenario, this will occur via the enthusiasm of someone senior;

[Head Facilitator] has a great personality, is a very straightforward and talented guy. He has been a fantastic, inspirational effect on the TT office and to some extent with [the university] academics as well. He has made a massive difference. (U3_1:22)

However, the person need not be in an active leadership position;

Every hub has to have a business champion who encourages the other entrepreneurs to bounce back from failure and change their strategy. The founder is still part of the company but he has stepped back from the CEO role. (U1_5a:297)

And simply meeting one’s peers can also provide encouragement;

We always invite [new or potential tenants] down to the innovation centre to meet with some of our advisors and some of our tenants who have been through that process. (U2_3:145)

In fact, peers can work very well, perhaps partly due to ease of communication;

So we actually ask[ed] the students for their ideas about how we would communicate this message amongst their peers and [the interns] are far more effective at communicating our materials that’s been hugely effective - it’s probably been the most effective thing we’ve actually done. The energy, the vision, being in touch with the market, it's all just totally there - so that's worked. (U2_7b:91)
<table>
<thead>
<tr>
<th>Network Engagement</th>
<th>recognise authority</th>
<th>Network Coordination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement necessitates recognition of authority</td>
<td>Part of the deal engaging with the network is submission to a central authority</td>
<td></td>
</tr>
<tr>
<td>On the other hand, without submission, the network cannot coordinate itself and membership is useless</td>
<td></td>
<td></td>
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</tbody>
</table>

Here the concept of altruism is broached, and is especially important in overcoming the divide between academia and business when expressed as submission to a higher ideal;

> While people aren’t going to be completely altruistic all the time, you don’t need that - you just need them to have a little bit of a social conscience. It doesn’t take that much, and if you start it, it's self-perpetuating. I went over to Copenhagen to one of their incubators and science parks and saw that kind of attitude and framework built in. Places I found with very good interaction with SMEs is Denmark and Sweden. (U2_6a:248)

Facilitators typically hold a significant proportion of authority, and this is reflected in the willingness of academics to consult them;

> Academics know that when they have an idea *ding*, they know to come and talk to [name of facilitator], myself as bioscience or [name of facilitator] in the physical sciences. (U4_1:44)

Nevertheless, if those holding authority experience poor relationships, there is an impact on Network Coordination;

> It’s helped a lot that I get on well with most of the academics. You have to be approachable, you have to be interested. I can approach various academics and say ‘what are you working on’ and so on. It’s that sort of relationship you're building up. Because you've built your personal relationship [you are in a position to ask someone to contribute]. (U4_3:33)

> ...if you tap into [the network it] can be very beneficial - but if you screw up [it] makes your job not worth doing. (U1_2:124)
Even in the free-thinking environment of academia, lack of conformity is subject to remediation;

*If you look at the real classical entrepreneurs in Scotland, the vast majority that I can think have never had a university education. It was the best thing that ever happened to them - otherwise their entrepreneurial flair and willingness to take risks might have been knocked out of them.* (U2_3:73)

Or a range of other actions;

*If the company is seen as being external to the department, the overheads may increase, support from the department waver and the academics’ focus reduced.* (U4_5a:22)

To find acceptance it is best to have the right background;

*...although it was a long time ago, I’m familiar with the university and some of the people I used to be students with although I’ve been out of it for a long time, I’m still familiar with how the university runs [meaning that] it’s a lot easier for me to get involved with how the universities' run...*(U1_2:5)

The same applies to industry;

*Because I fully understood the industry, I was able to apply the research and slot it in, and I knew what they wanted. I've worked in mining, agriculture through to retail, so I have a very broad experience. Only if you’ve been in industry will you really know what they want and how they evaluate the opportunity you are giving them.* (U4_3:33)

Ostracism can also be achieved by refusing to broaden one’s perceptions to encompass greater diversity, meaning that barriers are erected to their involvement;

*I think that's quite important for the client [to not be put in a position of being made to feel inadequate]. A lot of the time they will have big consultants or banks or advertising agencies waxing lyrical to them and a lot of the time they'll say ‘well what*
you have to do is resource-up for that' [but the client says] 'well that's great, but what you're suggesting I cannot do'. (U2_6b:29)

Whether negative or positive, when a situation is regarded a certain way, an experience will tend to reinforce perceptions already held. This is due to the mind actively rejecting information that clashes with prior assumptions, with negative experiences downplayed and positive accentuated.

This quote is a general indication of the reinforcing nature of engagement, where an improvement in the culture tends to improve investment, which in turn influences culture;

Every time you invest in something and it is successful, word gets around. Our rate of investment increased as the culture changed - it's a building thing. (U4_5b:63)

Even to the extent of investors being willing to place their money in research that is as-yet unknown; meaning that confidence in the network is having an effect before any details concerning actual projects are known.

We're always getting overtures from [venture capitalists] who would like to get access to what is happening at the university - because of growing awareness, track record and some successes we've been having. They don't come along and say they want to invest in a specific thing, they say we've got this money and would like to invest in some of your research. (U4_5b:103)

On a similar note, here it is stated that businesses will join a technology park simply in the knowledge that collaboration with the university is possible, implying that should the opportunity arise, it will be assessed in a positive light;

If you wanted to develop [university-business collaborations], not make it part of the contract, but make it a clear part of the proposition - but it doesn't actually mean that you're coming here to facilitate those links. In principle, they're not going to come to something like this because they're thinking 'oh, I want to be somehow connected to the university'. (U1_5b:98)

Typically it will take years to build up the esprit de corps within the network due to the serious nature of the activity, but as it accumulates, the increased engagement tends to
create a positive perception of the network. In turn, this means they are more likely to have expectations that they seek to fulfil.

[TTO] has a very good reputation as a technology transfer operation. The network has been going for a decade. It’s a ‘catch-22’; where one has to develop a reputation for a successful network before one can be a successful network. We built up a reputation and a body of investors who are active and serious and interested in things that come out of [name of university] and other universities...when you make successful introductions and people invest, companies see the network as a place where they will meet people who will invest in them. (U3_2:20)

4.2.4 Impact of Network Spectrum

The impact of Spectrum of the network is almost equally-balanced by positive and negative linkages. On the plus side, diversity provides the opportunity for both greater creativity and specialisation while acting as an advertisement for itself in terms of indicating how welcoming to further diversity the network is likely to be. Alternatively, it increases the potential for tension between members due to differences in perception.
Entrepreneurial Knowledge Transfer

and values, while making it more difficult to coordinate the network as a result of clashing obligations arising from the member’s life outside of the network itself.

<table>
<thead>
<tr>
<th>Network Spectrum</th>
<th>generate novelty</th>
<th>Network Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverse perspectives</td>
<td>breed fresh solutions</td>
<td>Diversity of membership allows fresh and original ideas to arise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>New perspectives on old problems.</td>
</tr>
</tbody>
</table>

It is claimed that EKT benefits from novel preparation, and here is evidence of academics combining with businesses to create new opportunities;

Most of our programs are brought to us by academics (who already have a relationship with the company). [The academic] has done a couple of placements (of short term students) for [the company], and they've got some technology that we have some expertise in. (U4_2:62)

And this one between students and business, where the ‘very interesting’ is achieved through combining capabilities;

One of the programs I came across that I really liked was called the [name of scheme], [which involved] embedding an understanding of small business within the undergraduate and postgraduate population. It's also a way of getting university expertise into a small business. Lots of very interesting learning and skill-based objectives. (U2_2:31)

However, this does not mean that only students benefit;

The problem is we’re all so close to our businesses and we can't see the wood for the trees - having someone questioning things can be mutually beneficial. (U2_5:107)

Yet, diversity of membership is wasted unless people are given the freedom to exercise their creativity (accept responsibility);

So they've come through the process of the [successful] group dynamics. So far every single [student developing a marketing plan for a business] has come back with a fantastic business that I would never have thought about! (U2_2:95)
Chapter 4: Results

<table>
<thead>
<tr>
<th>Network Spectrum</th>
<th>suitable expertise</th>
<th>Network Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diverse membership allows for a wider range of expertise</td>
<td>Access to a wider range of ideas, cultures, knowledge, skills etc. provides greater potential of finding the right person</td>
<td>EKT will typically involve those who are entrepreneurial and socially adept</td>
</tr>
</tbody>
</table>

Related to concept of diversity breeding creativity is diversity breeding resilience, where different types of people bring different, but complementary, contributions to the process. The first quote is a simple example of technologists and marketers – noting there is no added creativity – only complementarities;

*We had one occasion with a technology company who weren't selling very well. These couple of guys who were very good salespeople, we brought them together, and they've now merged as one company as they're doing very, very well.* (U2_3:56)

Next is the suggestion that the social skills and financial stability of the older entrepreneurs can be joined with the energy of the younger;

*The original model was post-graduates with bright ideas [however instead we had] forty five year old guys. Perhaps it's the social skills even - that give them that kind of edge... [but the question remains] ...is there some way for these new post-grads to become involved that isn't risky but that still taps their energy, new ideas, new ways of looking at things.* (U1_1:94)

And the same question arises when dealing with resource-poor small (young) companies;

*...if you're dealing with small companies; how can we do what a small company does but without them having to pay for it? How can we find finance - government finance, EU finance, business finance? We get the research, our academics get their papers, we get new PhD/MSc students being trained? The (small) company gets a solution to the problem they have - or they can progress. So everybody is happy.* (U1_2:30)

Or rather than youth/maturity, there is also the question of balancing skills

*[The entrepreneurship program] has not caught the attention of the accountants and the marketers. Therefore I would like to see a bigger cross-section of individuals going into the entrepreneurship program.* (U2_6a:133)
And getting away from human resources, flexibility in ‘hard’ resources (such as leases) is also of benefit;

*Simple monthly license (lease) agreements, including flexible expansion, have helped...companies to grow [within the incubator]. (U3_1:57)*

<table>
<thead>
<tr>
<th>Network Spectrum</th>
<th><strong>interpersonal conflict</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflict arising between people</td>
<td>Differences between people on the basis of age (generation gap), perspective or personality types can lead to conflict.</td>
</tr>
<tr>
<td></td>
<td>This may be due to communication difficulties, or more generally differences in expectation</td>
</tr>
</tbody>
</table>

Conflict between participants was a recurring them, and these quotes are representative of a much larger body of data. The most often mentioned conflict was that between academia and business, here concerned with timetables and perceptions of urgency;

*One of the difficulties, as far as the company is concerned, is that when they have a need they usually have a need *clicks fingers*. That doesn't necessarily fit into the academic timetable. (U1_5a:6)*

Students working with business can have trouble for similar reasons;

*There may be some friction or impatience [with the student intern], or the MD wants someone who’s a self-starter, and the graduate has not worked very much in industry before and is a bit slow to find his feet. (U4_2:30)*

Rather than cultural or situational however, conflicts may be simply generational;

*The relationship between those two people is absolutely critical to success [however] the downside to all this [artificial formation of teams consisting of different generations] is age - the entrepreneur is typically 45 and the student is typically 25. (U1_1:67)*

Meaning that peer-to-peer communication is sometimes preferable;

*It’s important to be able to relate to students - which is why it's better having people like us (student interns) [acting as a facilitator for students]. (U2_4:33)*

Regardless, for some kinds of people, there is nothing for it but grim tolerance;

*These entrepreneurs are, by definition, very awkward individuals to deal with - they can make you tear your hair out. He totally alienated [the technology transfer office] but ...they've got to learn to deal with them, and deal with that awkwardness and irrational*
behaviour. They're not businesspeople, they don't know how the business world works, and they are a bit irrational. (U2_6c:128)

<table>
<thead>
<tr>
<th>Network Spectrum</th>
<th>external obligations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased diversity makes coordination difficult</td>
<td></td>
</tr>
<tr>
<td>Highly-diverse networks are more difficult to manage as the members will have other obligations that must be considered.</td>
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</tr>
<tr>
<td>Underlying reason is an increase in combinatorial complexity due to more dimensions of freedom in the network overall</td>
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</tbody>
</table>

This linkage is similar to the one just previous, with difference being circumstantial or systemic rather than personal tension. Since these result in coordination and management problems instead of disagreements between members, they do not lead to disengagement of members, at least not directly.

Facilitators who have experience being faced with unfamiliar subject matter realise how much harder it makes their job, and rather limit their exposure;

*If we only have one school to focus on then we can do our job better.* (U1_2:116)

*I'm a biologist so the biologists got a lot more of my time [acting as a facilitator] than the mathematicians.* (U4_1:7)

Complications can also arise from external bureaucracies that have an inertia that can prove difficult to overcome;

*The problem is that students are placed within a faculty and they have to graduate within a faculty. There [are] no cross-faculty courses that are assessed - it would require faculties to talk to one another.* *laughs* How revolutionary! (U2_2:110)

One way to manage diverse expectation is through good communication (as per foster coherency) but it can still be observed that managing the situation incurs a cost in terms of lost productivity of the network as whole;

*We have a quarterly meeting between the angel and venture capital investment community and commercialisation directors of universities. Just trying to bring the understanding closer together of barriers and what they're both looking for to ease that process - and that's been very successful.* (U2_7a:229)

The goal is to reach a state of ‘embeddedness’ where diversity, although it remains, has effectively been nullified by the group strengthening Coordination enough to resist it;
Entrepreneurial Knowledge Transfer

What does work are programs that are fully embedded within its curriculum or within its research base. (U2_2:36)

The complications of an equity break-up, even while they may not lead to tension, still consume Coordination ‘capital’ that could otherwise be used elsewhere;

The big drawback in any of these schemes is that there's intellectual property and who's going to get a stake in it. The interesting thing is what would you do about equity - that gets very complicated - the important thing that as long as the stake holdings are sensible. (U1_5a:201)

<table>
<thead>
<tr>
<th>Network Spectrum</th>
<th>demonstrate inclusivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-existing diversity will reinforce itself</td>
<td></td>
</tr>
<tr>
<td>Already-present diversity fosters acceptance, and therefore still greater diversity. Low levels of diversity will have the opposite effect, however.</td>
<td></td>
</tr>
<tr>
<td>A diverse membership will be perceived as welcoming to someone from a group as-yet unrepresented</td>
<td></td>
</tr>
<tr>
<td>Each person or organisation has their own circle to draw upon, and a more diverse group means less overlap in extended circles</td>
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</tbody>
</table>

Often, a network finds new members via introductions. This generally occurs because a contribution can be made, and from the perspective of academia, will typically involve someone from the private sphere;

...or you might speak again to the academic and ask who he would recommend would be a good person to speak to in the marketplace. (U1_4:33)

Venture capitalists have their own contacts, and here the entrepreneurs are highlighted;

[Name of venture capitalist] also has a very big network of contacts: so they can introduce successful entrepreneurs to the academic teams to become a part of the team. (U4_5a:68)

Students can also be accessed with friends-of-friends, and bodies such as the student union can provide an avenue;

The student union allows us to hit a wider range of students, allowing them to learn all about it and get some support. (U4_4:87)

If done successfully, the benefits can be tangible;

Since I took over the course in the MSc marketing program I've taken quite a different approach which I really, really like. That is, the students find their own businesses [to
4.2.5 Impact of Coordination

As stated earlier, Coordination is an emergent property that expresses the ability of the network to manage itself, and of its four impacts, all are positive. This means that Coordination is universally a ‘good thing’, which conceptually makes sense because the network was originally created to systematise collaboration, and the more effectively the network achieves this, the more valuable the network is to those members who made the decision to join it.
Entrepreneurial Knowledge Transfer

This is in the context of finding management students to assist with start-up companies within a technology;

*In fact, [facilitator]'s involved in trying to source people (MBa students) from the management school [to assist companies within the incubator]. (U1_5a:5)*

In a reversal, here is an attempt to attract people from the private sector to work with academics in start-ups;

*We have quite a vibrant program of events run by our innovation centres, and that attracts the right type of people we want to interface with our academics. (U4_4:179)*

Finally, to attract companies to the park in the first place;

*[Facilitator]'s role has been to attract companies to the park - and companies come here for all sorts of reasons: closeness to London, geography and so on. (U1_5b:70)*

Invitations can also be extended by proxy, such as through marketing, although the 'judgement' aspect is delayed in that case;

*More technologists are coming forward because of awareness-raising, and that's our 'stimulate' bit. If you've got an idea or you think you might be the sort of person who is moving towards that, here are the opportunities; here is a network to plug into. (U2_7a:214)*

In fact, if those perceived to hold responsibility for encouraging new members do not exercise it, the repercussions seem to point towards network breakdown;

*We (the entrepreneurship researchers) aren't sharing contacts with [name of technology transfer office]. My supposition - and I can't prove it - is that they're there administering and not, if you like, 'selling the university'. (U2_5:165)*

58 On the other hand, peer induction does not need to be approved in the same way since people are comfortable in getting ‘more of the same’ and do not feel their conception of the premise is threatened.
A coherent network - expressed as a premise - is important because it defines and guides membership. One aspect of a premise is performance measures, and if these do not reward innovation, then innovation will not be the result;  

_If anyone puts targets in front of you, you will naturally gravitate towards those targets because that's how you're rewarded. If people were measured on being more commercial then they would shift towards being more commercial. [Currently] the measures they use are very much academic as opposed to commercial. (U2_3:87)_  

In this case, the premise concerns what it means to be part of the technology park, and it is important enough to decline membership if not followed;  

_We're talking about the park as a whole; but [the early stage incubator] companies can only become members if they understand what’s on offer and they buy into that._  

(U1_5b:96)  

Within the university, senior staff need to ‘buy into’ the premise, and making that happen is a major concern of the facilitators;  

_What we're trying to do is educate the deans with regard to all the component parts of the commercialisation process. We went to meet the principal and one of his vice-principals to join all the dots up and make it a fairly seamless process. There's a lot of misinformation even within the university and academics with regard to what is out there - that's even within [the] very closed framework [of the university]. (U2_6b:89)_  

Students engaged in an entrepreneurship program also need to understand and adhere to what is expected of them;  

_You're showing [the students] that this is one of the critical factors in your potential success - that team bonds and it feels very loyal to each other. In our [student entrepreneurship] program, one of the things we've said is critical is the team._  

(U2_6b:98)
Entrepreneurial Knowledge Transfer

Giving it a physical manifestation such as a common room adds to the unifying effect of the overall premise.

A key focal point in every university is absolutely critical for the students so they know where to go. (U2_7b:96)

The price paid for lack of coherence may include aimlessness;

It’s hard to identify quantitative results, but last year's business plan competition had 5 entries and this year's had 40 - just because I am there to inform people and drive it. The old [regional entrepreneurship organisation] - had no leadership and achieved nothing - it turned into a committee. (U2_4:15)

Or where a unified, organised framework\(^{59}\) was replaced with individualisation, disinterest;

[University name] has a unique approach where we focus on the support for (the student undertaking the) KTP. We have a professional business 'framework' for operating KTP. Others do it singly and they ask academics to make applications for bids, and they tend to have fewer numbers. (U4_2:7)

<table>
<thead>
<tr>
<th>Network Coordination</th>
<th>allocate roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exert constructive oversight concerning the roles individual members can play in the network</td>
<td></td>
</tr>
<tr>
<td>There are two aspects of this linkage; suggestion and approval</td>
<td></td>
</tr>
<tr>
<td>A prospective match between member and role must first be identified by the network, which then approves it</td>
<td></td>
</tr>
<tr>
<td>The better coordinated the network, the closer to optimum will be the match between roles and personnel, and the higher the resulting capacity</td>
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</table>

An aspect management is the control of roles people undertake. In the context of EKT, where roles are dynamic rather than static, people must be matched to the roles, and may indeed create them.

If the workload does increase you'll have a lot more of us [facilitators hired]. (U1_2:114)

In order that the resources of the network are used efficiently, detailed information concerning members is required. When that is available, it becomes possible to find more than one candidate, thereby also making allowance for interpersonal ‘chemistry’.

\(^{59}\) This ties in with advertise network since the framework probably includes assistance (aka resources).
Chapter 4: Results

Such is the case next, where a small start-up is seeking the advice of the manager of their incubator in finding quality assistance;

*If you need certain expertise we can put 3 or 4 in front of you and then it comes down to personality and that's why we say to people that at the end of the day you're not dealing with institutions or organisations, you're dealing with people. As far as we're concerned, we can put forward various organisations and say 'yes, we've worked with them' 'yes they offer a good service'.* (U2_6a:229)

A similar thing happens when an academic needs a business partner, even when (as mentioned below) the two already know each other, indicating that the ‘nomination’ from a recognised authority is important;

*Sometimes we do end up introducing them, even if they have a history of working with the university the work they want done may be with a different academic. We'll look for the relevant expert, and then we'd like to see the chemistry build up with the company over the period of preparing the bid.* (U4_2:74)

Occasionally the investor is not up to scratch, and this is also unique knowledge;

*The investors involved with [name of business angel network] can bring their own problems, such as the desire to be involved on a day-to-day basis... I’d like to see an angel rating [system] - as in what kind of angel are you??* (U3_1:121)

Nevertheless, some kinds of people are simply not appropriate for certain roles, which needs to be watched, especially when leadership is concerned;

*[Venture capitalist] would never expect the academic to become the CEO - he doesn't have the background. So they also bring a reality check about the team heads.* (U4_5a:68)

Obviously, for a partner to be nominated, first the innovation offered by the academic must be understood.

*My job is to understand the commercial potential of new jobs in ICT and electronics [and] then marry that to commercial organisations outside.* (U1_1:2)

*[Academics ask if] they are suitable for a KTP. We then look to set that up with them. Is there enough work content? Is it technically challenging enough? Is it really going to develop a graduate?* (U4_2:62)
And the value of information is reflected in this comment made by a facilitator regarding the informal network within the university – between technicians, staff and academics.

*I mean the information’s' all here - its finding it and finding the right people - that’s the internal network.* (U1_2:121)

Gathering of information occurs as a result of activities, and the two most often mentioned by facilitators are networking meetings and the paying of social visits;

*That’s why networking meetings are so good - I know what everyone's doing so if two have similar ideas, I link them up.* (U2_4:5)

*When there’s an indication of something new and innovative happening I go along and see the academic and try to understand what it is he has done.* (U1_4:15)

<table>
<thead>
<tr>
<th>Network Coordination</th>
<th>structure activities</th>
<th>Network Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weave activities into mutually-supporting arrangements</td>
<td>The network must structure activities are undertaken within it in order that they can constructively interact</td>
<td>This includes vetting for quality, but also interdependence, meaning greater longevity and therefore a higher level of activity sustained</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Better coordination means information is available to design the activities, as is the power to ensure decisions are then acted upon</td>
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</table>

The network must endeavour to ensure that the activities undertaken by its members are effective in overall terms. Whereas allocate roles was concerned with particular details of individual members, structure activities is related to the bigger picture;

*[The head facilitator] is extremely good at the detail of designing a company structure to keep it moving forward, but [also] keep it innovative.* (U3_1:116)

This example relates to facilitators investigating companies to ensure they are appropriate for a student undertaking their internships;

*We are skilled at setting the environment up and managing it. We do all of the normal credit/financial checks at the outset before we almost bother to visit the company. Make sure they've got sufficient funds, are stable enough: it’s a challenging program; it’s going to take a lot out of the company.* (U4_2:71)

On the same topic, standards also need to be applied to the students as well, making sure there is likely to be a workable relationship;
Chapter 4: Results

The riskiest part of the venture is finding the right graduate. 10% of our recruits don't make the grade, which isn't bad and probably a normal recruitment risk. You're assessing skills and how they will fit in from an interview and a tour around a factory. [If it doesn’t work out, you must] end their program, tell them it hasn't worked out and start the program again from scratch. It’s quite hard. (U4_2:30)

In general however, there should be a mix of skills appropriate for the intent;

I would like to see teams picked more carefully in order to create a more-balanced team. (U2_6b:98)

When there is too little oversight, things can go badly wrong. Entrepreneurs entering into untenable, and ultimately doomed, arrangements with financiers;

I've seen a number of extremely bad deals done from the entrepreneur's perspective but because they're so desperate for money, they'll sign their life away. (U2_6b:55)

Or academics putting their career at risk should their company fail;

I would like to see people given the ability to take more risks without ruining their lives. Maybe the university or government part-funding that salary - and the business part-funding it - within its first year (of operation) they can be taken back into their position within the university. Once the companies' a certain age, then it must stand on its own and the university can cut its ties. (U2_6c:46)
5 LITERATURE

Partly but not solely a result of its intractability, EKT has amassed a body of work that is extensive in both size and variability. While being complex, it is also a subject of great economic importance, and fertile territory for research therefore. However, there persists a lack of general theory that can fully explain behaviour across the full range of manifestation. Nevertheless, the elusiveness of the subject has only encouraged academics from a diverse range of fields to make the attempt, and the intention here is to take full advantage of that.

5.1 Preliminary Considerations

A thorough literature survey benefits from broad reading, and given that the model spans so many aspects of individual, as well as group behaviour, this is doubly desirable. However, to render the task manageable, it is better to invest effort where it will be most productive. As such, consideration is first given to what literature is deemed most relevant, and by what means it may be reliably compared to the results.

5.1.1 Explanation of the Approach

Since a conceptual delineation chosen by one frame of reference is never identical to another, establishing consistency of logic requires that only one be chosen to build this chapter around. However this can occur in two directions; the paradigm model can be defined via another body of theory from the literature, or the literature made to fit the research. The problem with the former is making a difficult choice between theories (a couple of potential candidates are mentioned in Appendix D), especially given that they must overlap the research substantially for the exercise to be worthwhile: this also requires that the author becomes expert in all pertinent bodies of work in order to select those that the literature comparison will be built around.

Unfortunately, ‘cherry picking’ other work in isolation to provide ‘substantiation’ is admittedly not as rigorous as the alternative just discussed, but is nonetheless regarded as sufficient for the purpose. This chapter is intended to provide not just substantiation but also (supplementary) explanation of the paradigm model and a greater diversity of sources allow all aspects to be expanded upon. While there exists the risk of taking literature out of context, effort is made to avoid this occurring, but in any case the
author, not being a proficient academic, is not assumed to be in a position to be sure either way. In general, this work is generative in nature, therefore highly provisional, and is not expected to constitute the final word on the subject.

One advantage of using existing theory (as opposed to the paradigm model) as the frame of reference would allow the research to be categorised (and published) into available field/s rather than standing aloof. However, the reality is that this work has been accomplished with coal-face data by a researcher without a relevant academic or professional background. Given that, it is thought excessive to expect the results to be correlated against other bodies of work as well as against the data itself, although such would indeed be valuable from an epistemological perspective.

**Literature Selection**

The initial identification of potential literature was primarily accomplished with a combination of internet searching using ‘Google Scholar’ and recommendation from the supervisor with experience in the field. Supplementary to this was the re-evaluation of papers examined early in the research as well as incorporation of references from books and magazines, primarily ‘New Scientist’.

Taken together, these sources provided the material for the literature comparison, and similar to the validation process described in Methodology, were selected on the basis of resonance. Quite honestly, the author can submit that only on rare occasions was direct refutation of the paradigm model found in the literature. However these incidents are not found below since, as detailed in the final stage of the methodology, the literature comparison is a form of validation, and prompted changes to the model. To illustrate, when it became evident in the literature peer groups are self reinforcing (and self recruiting) these mechanisms were included in the model.

### 5.1.2 Premises within Cooperative Groups

Given that this is a literature comparison, it is reasonable to investigate how the concept of a network is *itself* treated. Among the many references found, two indicative examples are selected. The first contrasts the two alternative norms of a social group, while the second discusses implications of a premise on the actual behaviour of the group.
Chapter 5: Literature

**Social Norms**

In contrasting a network concerned with innovation and one that maintains the status quo, Macri (2001) identifies the alternating roles adopted by core and peripheral actors.

*When the norms of a particular social group favour change, progressive behaviour seems to be vested in group leaders who act as early adopters. If, on the contrary, prevailing norms support the maintenance of the status quo, core actors assume a conservative approach, while peripheral actors take on the role of innovators.* (Macri et al 2001 p. 2)

Overall this is evidence that other premises are possible, and depending upon the form taken, members of the network will be induced to behave differently. Thus, if the premise changes, so does the meaning of the constructs. Linkages such as *generate novelty* are recast as opportunities to advance the premise rather than economic or technological innovation per se. If the premise is maintenance of the status quo, *generate novelty* implies novelty relative to the premise, meaning for instance a new way to suppress change. Similarly, and by extension, all constructs and linkages are defined relative to the premise rather than holding an absolute meaning.

**Systems and Institutions**

Kaufmann and Todtling (2000) differentiate between ‘systems’ and ‘institutions’, but we see that our understanding of ‘network’ is actually a combination of these two;

*We apply the term ‘system’ to entities based on common standards of communication and information, a common set of interpretations, and a shared view of values and meaning (‘Sinn’). In some sociological concepts ‘institution’ is operationalised in a very similar way. To keep a clear distinction between the terms ‘system’ and ‘institution’, we are going to use ‘institution’ (and ‘organization’ as a synonym) for entities which are based on membership, specific tasks of the members (participants), certain methods to perform these tasks, explicit and impersonal rules, power to enforce the rules, and a formalized structure.* (Kaufmann and Todtling 2000 p. 3)

A network has ‘Sinn’ – which is “a shared view of values” since all members must internalise (to a greater or lesser extent) the premise in order for them to behave in a manner appropriate to their membership of a network with an agreed premise.

Yet, one cannot depend entirely upon individual judgement, meaning there is a need for more structured control, whether a ‘system’ or an ‘institution’. Examining above, it
Entrepreneurial Knowledge Transfer

seems that an ‘institution’ will place more emphasis on this aspect, reflecting the contention of the existence of Coordination (as previously defined), whether as an emergent entity or as a set of “…explicit and impersonal rules, power to enforce the rules, and a formalized structure.”

By the same token, and similar to the concept of a ‘system’ meaning “…a shared view of values…” the proper functioning of the institution is damaged when this is not present. As such, the concept of a ‘network’ advanced by this research may be seen as effectively the simultaneous combination of both a system and an institution.

Expanding the Scope

This research is concerned with examining EKT, and the literature that most directly relates to it is that regarding technology transfer (TT). However, this area is relatively narrow in comparison to the breadth of the results, some aspects of which would otherwise be ignored. Rather than perceive that as indication of a flawed paradigm model, the scope of literature can instead be broadened to allow the inclusion of these missing aspects. Unfortunately in much the same way as using multiple frameworks reduces the veracity of the comparison, so is allowing the premise flexibility in what literature it is compared to, but this remains a better option than no comparison at all.

To recap, the premise is a common outcome desired by the group as a whole, with the network being the embodiment of their cooperative endeavour. Thus, if we hypothesise that the other premises are possible, then the paradigm model can be used as the basis of networks apart from not explicitly for EKT. It then becomes possible to justify including literature from similar fields (such as intra and inter-firm cooperation), as well as other, more general, work from the social sciences. Nevertheless, before investigating the paradigm model proper, there will first be an examination of literature relating to the network itself.

Premise Betrayal

One potential problem is behaviour arising within the literature ostensibly or apparently on the premise of EKT, yet without this actually being the case. Such contravention of the understanding of EKT adopted by this research forces caveats to be placed upon the behaviours in question. There are three specific instances of ‘premise betrayal’ occurring within this chapter; two regarding the impact on Activity via accept responsibility and supply resources while a third affects Capacity via suitable expertise.

98
Chapter 5: Literature

Now there has been an explanation of the circumstances in which allowance is given for the premise to extend beyond the original constraints of EKT, the literature comparison proper can commence.

5.2 Comparison to Linkages

In structuring this comparison, the opposite format to that employed in Results, whereby linkages were grouped by effect rather than cause, is used. It is hoped the change will allow a more intuitive presentation by focusing upon the collective impact of the contributing linkages.

5.2.1 Impact on Activity

Activity represents the sum of actions being undertaken at a point in time that fall within the aegis of the premise. The linkages impacting Activity are diminishing returns; supply resources, accept responsibility, generate novelty and structure activities.

**diminishing returns**

In undertaking activities, resources are utilised, with the remaining spare capacity available for new endeavours. While the data highlights the cost of imposing an excessive workload on practitioners in terms of sacrificing quality, there is broader resonance with the law of diminishing returns. Well known within economics\(^{60}\), the law invokes the inverse relationship that is often seen between the addition of further inputs to a manufacturing process, and its marginal increase in production. In the context of knowledge transfer, this means that a network approaching full utilisation of its resources will experience difficulty maintaining the level of activity. This is not only because of overwork, but perhaps more importantly due to a reduction in flexibility as any new project arising is less likely to find the exact resources it requires. Similarly, the reverse will occur should there be a low level of utilisation, making this linkage an S-shape rather than always negative.

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\(^{60}\) Originally proposed by Jacques Turgot in 1767
Entrepreneurial Knowledge Transfer

supply resources

Research on organisational performance (Appleton 1994, Deeds et al 1999) asserts the criticality of human capital, with Appleton highlighting the sometime poor acknowledgement of the fact - especially “…in areas where production depends more on skills than on hardware”. In the particular case of technology transfer, statistical research undertaken by Powers (2003) found that variation in performance was;

... indicative of the importance of strong skill sets and sufficient staff to manage the complex and time-intensive tasks associated with technology transfer. (Powers p. 41)

When resources such as people, knowledge or equipment can be identified, defined and valued, they become capital (De Soto 2000, Burton Jones 1999; Etzkowitz, Webster & Healy 1998). However, even when resources are known to be available, their owners still need to make the decision to engage them in a specific activity. Since EKT implies entrepreneurial risk, to dedicate resources implies accepting a share of that risk. In other words, the potential and the delivery of resources are separate\textsuperscript{61} attributes, and are drawn from different aspects of the network. Dew et al (2004) explain this from the perspective of entrepreneurial opportunities (given that IP can be considered a form of resource);

The intersection of an individual and an entrepreneurial opportunity can occur either through a search process or fortuitously. However, the acquisition of knowledge does not guarantee that the individual will recognize and actively pursue an entrepreneurial opportunity. (Dew et al 2004 p. 669)

Which implies that even given the existence of a knowledge resource (supply resources), in order to utilise it in taking advantage execute an opportunity, it must have been recognised in the first place (generate novelty), and then grasped by the relevant individual (accept responsibility). Nevertheless, given the wrong type of resources, their availability may not lead to sustainable activity.

...university administrators lack the experience to make accurate revenue and cost projections in these areas, they do not have the discipline of bottom-line profit structures to act as a brake on 'unprofitable' administrative activities, and the non-

\textsuperscript{61} For instance, a contractor retains ownership over any intellectual property developed in the course of fulfilling his obligations. This is a case of participation increasing Capacity in the form of IP (through build proficiency) but not automatically leading to the generation of further Activity. However, should the contractor be given the opportunity to take part in a project that utilises his IP, and feel so inclined (via Engagement), then this may indeed occur.
Chapter 5: Literature

profit organization of universities provides few market signals to guide their decisions. These weaknesses can explain the surge of universities into entrepreneurial technology transfer activities, and would predict a slow rate of extrication from unprofitable situations. (Dill 1995 p. 379)

Dill is claiming that throwing resources at the problem is not guaranteed to lead to success. In retrospect this warning displays substantial foresight, and given the damage to the reputation of technology transfer from such over-enthusiasm, one that should have been heeded. Notwithstanding, with regard to relevance to supply resources, the point is that both the resources and activities are not compliant with EKT due to a lack of market orientation. While poor Coordination certainly creates inefficiencies in resource allocation, it does not lead to activities that violate the premise.

accept responsibility

Moving on now to accept responsibility; and a closely aligned idea to that of networks is the ‘cellular organisation’, and Miles et al (1997) make clear their suitability for situations requiring continuous learning and innovation. Cellular organizations are built on the principles of entrepreneurship, self-organization, and member ownership. All of these require individual initiative, but within an organisational context of shared responsibility. This sense of shared ownership is effectively the same as Engagement in a network, which can be also viewed in terms of ties between individuals. These ties must be present before a member will commit to an activity, but are only valid within the context of the network62.

...strong ties have greater motivation to be of assistance and are typically more easily available. (Granovetter 1982 p. 209)

Thus, the greater the prevalence of strong ties, the higher the level of Engagement, and the more likely members will be to act when called upon to do so. In a similar way, the weight of anecdotal evidence indicates that during battle it the soldier’s regard for his fellow (rather than nationalism or discipline) that motivates acts of extreme valour. While the premise is to defend one’s country, it is lived through human ties.

62 To illustrate, a chance social meeting with a work colleague can feel awkward because the strength of tie varies between the two contexts. As such, a single number can serve to dictate the average strength of tie within the context of the premise of a specific network, in this case innovation
Entrepreneurial Knowledge Transfer

Regarding technology transfer specifically, McDonald and Gieser (1987) take the approach of dividing cooperation into a number of ‘facilitating processes’ such as open communication, mutual interdependence, respect, trust and willingness to compromise etc. It is possible to contend that all of the above occur more readily when participants accept responsibility for achieving the aims of technology transfers they are part of. Certainly, taking responsibility for the welfare of others in wartime is consistent, but underlying it is a sense of common purpose. In other words, one cannot have trust (or respect or interdependence etc.) without knowing why cooperation is being attempted in the first place (which is the definition of a premise). Even a beggar is suspicious when offered what he considers an overly-generous gift, and a soldier who refuses to salute the flag will not be as readily defended by his comrades.

However, it is useful to examine the result of policies that undermine the ostensible premise. Friedman and Silberman 2003, Siegel et al. 2003 have identified that a lack of promotion for involvement by faculty in technology transfer acts a disincentive. As posited in the Scope, EKT involves risk and reward since it has both a novel process and a market orientation. If faculty are expected to assume risk without commensurate reward, even should that reward come in the form of promotion rather than actual market profit (such as in the case of faculty secondment), then the logical result would be hesitancy to assume responsibility, or to engage in relationships with the private sector that they are then penalised for.

**structure activities**

Even should one assume responsibility for an activity, there is no guarantee it will succeed. From the networks’ perspective, the aim is to bring its resources to bear in the most effect way possible. This requires good planning and coordination of activities, both separately, and in relation to each other. The latter concern is chiefly one of interdependencies, where two activities use the same input, or the output of one is the input for another. Dallago presents these as the ‘complementarities’ of an economic system achieving social goals.

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63 Since Engagement feeds this linkage, it is reasonable to attribute the original effect of a lack of coherency (foster coherency) from Coordination rather than to a constraint on accept responsibility itself. Regardless, disincentives like this create a preference for non-EKT activities (such as publication), meaning such a policy might be considered to effectively shift participation to an entirely different network that is based upon a non-EKT premise.
Coordination produces externalities and complementarities that increase the impact of systemic capital. It is in this way that the economic system implements the crucial role of coordinating the choice, decision-making and production activity among different and possibly distant and diverse economic actors and makes those compatible with social goals. (Dallago 2000 p. 307)

Regarding the mutuality of activities, and their contribution to the network as a whole, the field of Absorptive Capacity makes a useful contribution. Nelson and Winter (1982) point out that the capabilities of an organisation depend upon a ‘mosaic’ of activities, interactions, and exchanges among a number of individuals while Cohen and Levinthalth and March (1990) suggest that the mosaic represents the structure of knowledge within a firm. This knowledge overlaps via the interaction of individuals holding it, and the efficiency with which this occurs then dictates its eventual utility for the firm that acquired it.

Since activities require contextual information in order that they may be ‘embedded’ into the broader network, it becomes clear that Coordination affects the amount of Activity a network can support. Furthermore, the relationship between Coordination and Activity is reinforcing since activities themselves generate information that allow further structuring to occur (covered in detail by capture information).

**generate novelty**

The final linkage impacting the level of activity within the network is generate novelty. Simply, access to a wider range of possible solutions to a problem makes it more likely that the solution used will be superior to that found within a smaller space\(^{64}\), providing maximum utility for a given set of resources. This does mean that the most novel solution has been chosen, only that it was available to be chosen. Considering that a property of EKT is a novel process, it is valuable to have access to fresh ideas, as it is when attempting to meet a demand in the market. Replacing ‘solution’ with ‘opportunity’, Shane (2000) points out that if the wrong ‘type’ of person is looking for a ‘desirable’ entrepreneurial opportunity, it will remain hidden;

*This study shows that before technological change can influence output, an individual must perceive an entrepreneurial opportunity. Because not all entrepreneurs will*

\(^{64}\) There is an open question concerning the cost in terms of time required to search a larger solution space, and at what point it becomes too onerous.
perceive the same opportunities, some desirable entrepreneurial opportunities may go unnoticed and unexploited. (Shane 2000 p.466)

The foundation of **generate novelty** is Spectrum, implying that a network with a diverse membership will lead to greater creativity. In support of this theory, Fiet (1996) wrote that entrepreneurs discover opportunities through idiosyncratic knowledge rather than special attributes (such as an unusual perceptive ability). In a related sense, Wyer et al (2000) warned against relying too heavily upon a single individual within the enterprise, such as the manager, since the ensuing ‘bounded state of solitary decision-making’ creates an ‘unnecessarily-tight bounded rationality’ – which effectively means that ‘the blinkers are on’.

Regarding innovation between multiple ‘systems’ (reminiscent of a ‘spectrum’ of members within a single EKT network) Kaufman (2000) writes;

> In fact, the specific advantage of what is usually called an ‘innovation system’ is not being a system in the meaning of a separate and autonomous entity, but the process of collaboration between actors who often belong to different systems. It is the exchange of formerly unrelated information that reinforces innovativeness. (Kaufman 2000 p. 8)

Which Johnson (1992) reiterates from the perspective of individual rather than ‘system’ diversity, where the stimulation for innovation results from the;

> ...clash between different modes of behaviour and habits of thought (Johnson 1992 p. 36).

Since minds are not unitary objects, this ‘clash’ may occur just as easily within a single person as time and concentration allow the correlation of previously-separated mental patterns. A similar process was followed in this research, whereby disparate information was eventually, and often subconsciously, resolved into new configurations.

### 5.2.2 Impact on Capacity

Capacity expresses the resources available at any one time that are suitable for contribution to network activities; requiring that ownership over resources is attributable to individual members, and may involve skill and experience as well as monetary contribution, all of which can increase themselves over time. The linkages
contributing to Capacity are peer induction, allocate roles, contribute expertise, build proficiency and share experience

**peer induction**

As any good game show host knows, enthusiasm can be catching. We all appreciate, and are attracted to, enthusiasm in those we meet, not least because we are often a little envious of the energy and certainty of those possessing of it. If we consider the case of enthusiasm for environmentalism, and its percolation through a firm, Petts et al (1998) discovered that success in changing culture was almost always due to a champion. However, unless opportunities are taken by management to spread the message more widely (through team building and employee empowerment), awareness remained isolated within the vicinity of the champion’s department or team. Thus, while a game show incorporates a broad cross-section of the community, generally people only interact with, and are willing to ape, their peers. In this way, passion for any idea, such as fashion, will tend to percolate within a peer group rather than between peer groups.

If EKT can be regarded as a fashion, then enthusiasm felt by those engaged in it will spread throughout the relevant peer groups, acting to recruit people similar to those already involved. Returning to the game show host, in transcending pre-existing social barriers within his audience, charm (and game structure) is employed to spontaneously create an artificial peer group for the duration of the show. Conceptually, this is similar to the formal recruiting process (broaden membership) undertaken by an EKT network wishing to improve the diversity of its member base. Nevertheless, peer and non-peer recruitment are not contradictory, and act in concert to increase the strength of the network overall.

**allocate roles**

Given its high degree of variability of process, an EKT network must endeavour to acquire knowledge of who can undertake which roles. In the context of institutions (as defined by Kaufmann and Todtling), Dallago expresses the allocation of roles thus;

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65 Why does buy loyalty not help with attracting peers as it does with establish reputation? It seems the answer calls upon the truism ‘you can’t buy friendship’ since the intrusion of money spoils it. This in turn raises the point that social networks may operate differently than those based upon EKT.
In sum, institutions and structures define what actors can do, what is expected from them, or they must do, and what is advantageous for them. In this way, they give stability and predictability to economic interaction. (Dallago 2000 p. 305)

Aside from the notion of permitted behaviour, stability and predictability also relate to knowing what assistance is available from fellow members. Taken across an entire network, these expectations accumulate into an overall appreciation of available contributions; another way of expressing Capacity.

The decision to allocate a role is made in the context of current and future needs of the network (dictated by the premise), as well as what the member themselves can offer (although intangibles such as attitude can be difficult to uncover^{66}). This combination of information and power originates from Coordination, and works in conjunction with the information supplied by the members themselves, a systemic artefact that Sarasvathy terms ‘near-decomposability’.

To summarize the exposition so far, both effectuation and near-decomposability exploit locality and contingency in the evolution of the artefact. Just as effectuation creates rapidly evolving artefacts that leverage the interdependence of parts to exploit locality and contingency, so near-decomposability in the structure of such systems leverages independence of parts to exploit the same locality and contingency. While effectuation stitches together pieces of entrepreneurial fabric into economic quilts that continue to make sense in an interactive and dynamically changing environment, near-decomposability identifies lines of ‘tearing’ so that pieces can be re-worked in synchrony with the overall pattern as the needs imposed by the environment change. Together they can provide a convincing explanation for the creation and growth of the firms that we see in the real world (Sarasvathy 2003 p. 216)

So while effectuation is reminiscent of structure activities, where interdependencies between ‘pieces’ (resources) are leveraged, near-decomposability leverages independencies between those same ‘pieces’. This is the ability of the network to dynamically re-conceptualise – rather than reconfigure - its resources, meaning the ‘pieces’ are perceived in a different way – having new ‘lines of tearing’. Doing so

^{66} Even for asset types that are ostensibly universal, such as money, office space or management ability, they cannot be completely divorced from the predilections of their owners. For instance, venture capitalists who like to invest in certain industries, administrators who prefer certain departments and a manager who is more comfortable with certain personality types. This intrusion of personal preference falls under abuse position because it reduces the ability of the network to coordinate itself freely.
requires oversight of the system, which comes from a constant flow of captured information.

**suitable expertise**

This linkage makes available specialised assets that meet the needs of EKT, which given the diversity and difficulty of its activities, can be very challenging. No two incidences are exactly the same, and supplying the optimum resources in each case is made easier by a pool that offers greater spectrum of choice. In their statistical analysis of knowledge transfer across disciplines, Landry et al (2005) concluded that researchers transferred much more actively when no commercialisation was involved. One factor could be the extra dimension of complication added by market orientation made researchers much more cautious when contemplating it. Given universities do not normally have business acumen to hand, it would indeed be sensible to select those projects that do not require it.

Given the lack of definitive market orientation for a network not based upon EKT, a different sort of membership is conceivably necessary to supply the same level of Capacity, although such things are not amenable to easy comparison. It is likely at least partly for this reason that Friedman and Silberman (2003) find statistical correlation with success in technology transfer and the location of a university in a region with a concentration of high-technology firms. Certainly Dill (1995) makes clear the cost of giving people with inappropriate expertise a leadership role in technology transfer;

> This suggests that the traditional academic bias toward appointing experienced academics to head university administrative units, or conversely, placing general managers or lawyers in these positions, may be particularly unwise in the area of technology transfer and could contribute to the mis-investments suggested by Feller (1990). (Dill 1995 p. 12)

However, it is important to restate the point made in supply resources – that the premise defines constructs such as Capacity and Spectrum, and when a non-EKT premise is guiding decisions such as who to hire in senior positions, the outcomes cannot be expected to correlate with the findings of this research. For this reason, there was a selection process applied that aimed to weed out interviews with inappropriately-skilled subjects – many of whom would fit Dill’s description.

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67 Of course, many others are possible, such as cultural resistance and lack of institutional incentives.
build proficiency, share experience

Apart from issues around contribution and codification of resources, there also exists the potential to improve their value once dedicated, with two aspects that interact constructively. Build proficiency is founded upon actual participation while share experience, like mentoring, allows benefit to flow from the ability of others.

Friedman and Silberman (2003) found the length of time a TTO had been in existence positively correlated with success, and it seems likely that both direct and indirect experience would make a contribution. Instruction is more effective when given in an applied context, and experience builds proficiency faster when not completely dependant upon trial and error. Floren (1996) makes a similar observation from the perspective of entrepreneurial learning, where one of the two most restricting influences was a lack of peers with whom to converse. Eppe, Argote and Murphy (1996) noted that a new shift of workers at a manufacturing plant achieved competency much faster – two weeks versus many months - than had the first shift, which did not have the benefit of embedded knowledge. Indeed, the benefits of EKT in developing new and comprehensive skills are evident in reports from the Australian governments’ CRC program, which fosters cooperative R&D networks around specific research topics;

...postgraduates trained in the CRC operating environment were not only technically trained, but also had well-developed business skills, effectively making them ‘workplace ready’. 

In a similar way Nohria (1992) and Saxenian (1994) find that firms within technology clusters such Silicon Valley and the Route 128 area of Boston share advice, engineering solutions, and information about new technologies and practices through professional, social, and exchange relationships. However, given the pervasive nature of American entrepreneurial culture, these relationships (even when ostensibly ‘social’) are nearer to ad-hoc networking events than a friendly chat about the weather, and therefore may be classified as fitting the criteria for EKT.

68 However, if Capacity is relatively poor, it would be reasonable to propose that a lack of superior examples to follow may lead instead to incorrect techniques being picked for lack of any other option. If true, this would make share experience S-shaped rather than always-positive.

69 Cooperative Research Centres Association, Submission to Standing Committee on Science and Innovation, Australia 2006 No. 48, p. 1-2; CRC Committee, Submission No. 11, p. 4.
Carson and Gilmore (2000) examined the issue from the perspective of marketing competencies in SMEs, and reach the surprising conclusion that individuals can even ‘mentor’ themselves;

*Over time, owner managers existing competencies of knowledge, experience, communication and judgement can combine to create experiential knowledge through the development of their experiential learning.* (Carson and Gilmore 2000, p. 17)

This adds strength to the idea that, while resources are always ‘owned’, they can also be abstracted and treated as independent entities; taken up by the network, and able to interact with each other, even when ‘owned’ by a single individual.

### 5.2.3 Impact on Engagement

Engagement results from a complex amalgam of effects that create a feeling of ‘connection’ to the network by its members, and occurs as a direct result of the members’ experience within the network. This depends in turn upon their interaction, their standing within the network (gain recognition) and how consistently the principles of the network are received by the member (foster coherency). In terms of interaction, the two factors at play are regularity of contact (constructive interaction), as well as the experience had (interpersonal conflict) when that contact occurs.

**constructive interaction**

A network is, in essence, merely a collection of interactions built around a common premise. Depending upon the quality of these interactions, they will tend to draw together those engaged in them, and this closeness increases loyalty to the network overall. In the context of European science-industry interaction, Kaufman and Todtling (2000) found that, in spite of availability of modern telecommunications, 43% of respondents indicated that proximity is important for their innovation partnerships;

* . . . interactions with science and technology often require personal collaboration favoured by short distances which enables frequent contacts.* (Kaufman and Todtling 2000, p. 12)

However, not all interactions in anyone’s day will involve EKT-type innovation, and relationships with other people will always intrude. A shared life with ones’ family or partner can also be considered networks with their own premise however it is also
possible for two people to both belong to more than one network. In other words, this connects people with more than one relationship – say, professional and social. Since a linkage is established within the context of the network, only network-relevant activities can grow this linkage. This means that a professional interaction may not improve the social relationship, and visa versa. Further, if ‘a line is crossed’ and the activity ‘becomes’ social when it is meant to be professional, it may even do damage since permission was not given (abuse position) for this to occur.

Meyer-Krahmer and Schmoch (1998) came to a similar conclusion regarding the appropriateness of activities regarding poor results by university TTOs. The problem was thought based upon a surfeit of ‘uni-directional’ activities such as advertising, training and promotion (non-EKT!) rather than ‘bi-directional’ exchange of knowledge, where both parties benefit. This makes sense considering the actual aim of technology transfer is primarily EKT, so activities that do not satisfy the criteria make no contribution to interaction and therefore Engagement. Schmitz (1998) came to the same conclusion in his recommendation for improving SME performance in developing countries. Rather than relying upon networks of ‘ascribed trust’ – typically family ties – which are ‘tightly-boundaried in their information-sharing potential’, there should be an effort to develop networks explicitly for sharing information, but where trust must be earned in the course of undertaking activities relevant to the SME in question. These may not necessarily be EKT, but given the nature of small business, probably are (and almost certainly will be if beneficial knowledge is somehow involved).

**interpersonal conflict**

While the model assumes that the linkage constructive interaction is always a positive for Engagement, in reality there is no such guarantee. In the case where individual differences, such as in perspective or experience, can create the environment where misunderstandings lead to tension. This is obviously unpleasant, and detracts from the otherwise-pleasant feeling one receives when cooperating with others.

In support of this proposition, Jackson (1991) found that team heterogeneity predicted turnover of staff, while a number of other studies (Levine & Moreland, 1990; Lott & Lott, 1965) showed that similarity is one of the most important determinants of interpersonal attraction.

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70 Further information regarding multiple networks in Appendix G: Network Propositions
confirm assumptions (aka. rose-tinted glasses)

When a member has an experience related to the network, his perceptions of the network as a whole will influence his experience of the event. Whatever its nature, a positive perception will tend to accentuate the positive aspects of the experience, and visa versa. This is reflected by the finding by Petts et al (1998) that workers who felt disengaged from their management did not take up opportunities to participate in the consultative processes.

The latter was characterized as having a top-down management with employees involved on a 'need to know' basis only, with evidence of people being seen as the weak link. Whilst opportunities were provided for workers to participate in management meetings, few took the opportunity. (Petts et al 1998 p. 16)

In other words, should they have been already engaged with management, their perception of the invitation (and subsequent meeting) would likely have been positive. Thus, poor Engagement in the network has a self-fulfilling aspect to it, and to be remedied requires compensation from the other impacting linkages. In the case above, this would mean management going to extraordinary effort to make the workers feel valued. On the other hand, high levels of Engagement are also self-reinforcing, making the linkage (similar to diminishing returns and share experience) S-shaped\(^71\) rather than always positive.

gain recognition

The next factor contributing to the rate at which Engagement changes is gain recognition, whereby members are granted a sense of achievement through their status in the network. It is partly for this reason that people who have obtained a senior position in an organisation will fight the hardest to keep the status quo – they wish to retain their sense of identity it brings them.

Regarding EKT, Cialdini (2001) found that a manager who has expended great effort to acquire knowledge external to the firm will become more committed to ensuring its value is not doubted. The manager has effectively brought about an improvement in his

\(^{71}\) S-shaped refers to a linkage whose polarity depends upon the level of the input. A ‘negative’ S-shape (such as diminishing returns) is positive for low levels of the input, but becomes negative as it increases past a certain point, in this case being relative to the level of Capacity.
position (allocate roles), and does not wish to see it diminished. He is defending the piece of knowledge, but is also justifying his own value to the network.

From the perspective of entrepreneurs, Cope (2003) recognised that their success was motivated by a desire to be validated by members of the wider community. However, success is a relative term, and in this case it is relative to what is valued by the network to which one belongs. In other words, just as Capacity is itself defined by the premise, so is a members’ position when supplying a resource, and Engagement that is born of that.

**foster coherency**

The final aspect contributing to engagement is foster coherency, which relates to the perception held by members regarding what it means to actually be a member of the network. Ironically, this raises the possibility that the historical lack of a coherent definition for technology/knowledge transfer is itself partly to blame for poor performance in the sector. Practically speaking this would occur when those attempting to participate are not able to agree on what they are there to do. This would obviously be damaging to EKT outcomes, in the first instance creating confusion in the minds of members, and limiting their ability to engage therefore.

Coherence in the network has some resonance with *Knightian uncertainty*, and the differing expectations (Dew et al 2004) resulting from uneven distribution of knowledge. It is plausible that disparity of knowledge in a network would foster misunderstandings as different people are acting upon different information, and therefore assumptions. This is related to the economic usage, where actors can not be presumed to behave reliably in the sense of knowing what is in their own best interests. When a network is formed around EKT rather than pure self-interest, Knightian uncertainty raises the prospect of members acting in ways that surprise, and perhaps even conflict with, their colleagues.

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72 Quite apart from the impact on individual members, a ‘fragmented’ premise would affect other aspects of the network, but considering that these can all be impacted by Coordination, it is reasonable to consider that the stock is more fundamental than the linkage, giving weight to the model overall.

73 Knight's interpretation of 'risk' is where the decision-maker can assign mathematical probabilities to aspects of the randomness that faces him. By contrast, Knight's "uncertainty" refers to situations when this randomness cannot be expressed in terms of specific mathematical probabilities. [www.cepa.newschool.edu/het/essays/uncert/intrisk.htm](http://www.cepa.newschool.edu/het/essays/uncert/intrisk.htm)
Returning now to EKT, in their analysis of data from four US universities, Friedman and Silberman (2003) found strong correlation between success and “a clear university mission in support of technology transfer”. Kaufman (2000) nominates ‘bridging’ as making one systems operation understandable to another, “translating system-specific rules and ways to communicate” and echoed by Harmon et al. (1997) in his support for relationship building (as opposed to advertising which is similar to the ‘uni-directional’ transfers mentioned previously). In order to bring about these ‘bridging relationships’ there must be common ground, and this is where the power of the network to create coherency works in favour of Engagement for both parties.

Regarding the broader economy, Dallago (2000) writes;

> An economic system produces consistent choices and behaviour of actors. This has great advantages for an economy. First, such consistency makes learning processes simpler and the choice and behaviour of actors more stable and predictable. This reduces uncertainty and the (co-ordination) costs for running the economy and eases conflicts. Second, by creating a consistent and coordinated framework, the system stimulates and supports specialisation of actors, their capabilities and the production and diffusion of knowledge and information. Third, coordination and the ensuing specialisation stimulate and support actors in looking for new solutions in particular directions and by coordinating their efforts. (Dallago 2000, p. 306)

While only a little of this relates to fostering coherency specifically, overall it is a powerful view of networks and why people create them; coherency making “…the choice and behaviour of actors more stable and predictable”. This reduces uncertainty and eases conflict” and counters the damage potentially done by interpersonal conflict.

### 5.2.4 Impact on Spectrum

The Spectrum of the network is the extent to which the membership base represents the full range of potentially useful participants. What may be considered ‘useful’ depends upon the premise of the network, which in the case of EKT has already been established. The rate of change of Spectrum is driven by establish reputation, buy loyalty, exclude difference, demonstrate inclusivity, broaden membership.

**establish reputation**

When participants in a network undertake successful activity then they, and by extension the network, develop a positive reputation in the minds of those yet to join.
Entrepreneurial Knowledge Transfer

This reputation acts to entice these people to then become members, and increase the Spectrum of the network. This recruiting mechanism acts in conjunction with peer induction, but since there are no close peer-group relationships to pass on the emotive impression, increasing Spectrum must rely upon formal success. At the same time however, the wealth of the network acts to assist, although this will be covered in buy loyalty.

In their examination of technology-based educational institutions within the [North American based] National Science Foundation (NSF) centres, Owen and Entorf (1989) found correlation between faculty engaging in technology transfer activities and: faculty consulting for firms, on-going internship programs, graduate students doing field work for industry projects, the presence of a clear university patent policy (foster coherency) and universities receiving gifts or grants from industry. Apart from the policy factor, these all show a distinct link between successful activity and increasing Spectrum in terms of the diversity of activities and the diversity of participants within them. The authors go on to note features designed into the NSF that seemed to promote successful interactions: cross-disciplinary research, team research, meetings on both campus and member company facilities and research priorities defined by participating firms within the broad areas of NSF program guidelines. Again, the policy mention is closer to foster coherency, but the rest are all activities in compliance with EKT.

Mansfield & Lee (1996) found that faculties regarded as ‘reputable’ were more likely to have been cited by industry as having contributed to industrial innovation, noting that in this case ‘reputable’ is a product of publication history. Further, it was shown that such faculties were able to attract higher than average licensing fees, and were more likely to collaborate with companies located more than 100 miles away (Powers 2003 p. 40). Yet work done by Rahm (1994) surveying 1100 university researchers and 130 administrators found a high correlation between those who identify as ‘spanning’ (as opposed to ‘bound’) and the rate of contact by and with firms. In other words, those actively engaged in EKT in the past were more likely to become so in the future, thereby drawing further external contacts into their network. Thus, even though repute is based upon publication, the nature of activity underlying publication matters as well. Nevertheless, having a poor publication record74 is certainly likely to be a deterrent to

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74 Ironically the reason for lack of publication may in fact be commercialisation displacing or preventing (to protect IP) publication efforts. At the same time, on the basis of conversations held by the author with
the interest of companies unless an alternative avenue of feedback exists, such as word
of mouth which can inform potential collaborators of a universities’ compensatory
history of EKT success.

**buy loyalty**

In terms of recruiting further afield to increase Spectrum, static resources remain
attractive, even when not accompanied by Activity. In fact, part of the reason why
technology clusters form is to gain access to conglomerated resource pools, typically
including skilled labour, available capital, qualified suppliers, professional service
firms, and R&D labs (Best 1990; Saxenian 1994; Romo and Schwartz 1995).

Returning to the point that marketing and promotion without ongoing activity are far
less effective, Harmon et al (1997) divides technology transfer into two perspectives.
The first “considers technology transfer as a collaborative activity occurring within an
established network of formal and informal relationships” – EKT activities that build
reputation. The second “regards technology transfer as an arms length, buy-sell
transaction”, which is more akin to buy loyalty. However, these are more akin to a
marketing and promotion of in-place resources (or as mentioned previously, uni-
directional) leading the authors to the following conclusion regarding their impact;

*There is no evidence that any of the [23] firms had a well-developed formal search
procedure. In the overwhelming majority of cases, transfers occur principally through
relationships between inventors and contacts in the business community, and those
contacts exist prior to the transfers. Thus, universities’ advertising of their available
technologies may offer a very modest return (Harmon 1997, p. 431)*

Implying that the firms did not search for resources in the university, and neither did
advertising of those resources lead to a substantial improvement in participation. This
implies that while buy loyalty is likely to have *some* impact, by itself it is relatively
weakly-acting. Nevertheless, the transfers mentioned would no doubt have been
noticed by firms not yet in a relationship with the university, and should the opportunity
arise, might influence their decision to become involved.

*businesses in the vicinity of his university, it is not inevitable that an impressive publication record will
attract the private sector. A history of failure at EKT can still prove crippling in spite of being ranked in
the top 20 of university league tables.*
Entrepreneurial Knowledge Transfer

exclude difference

Apart from the attractiveness of the network to outsiders, there are also factors relating to how welcoming it is. To increase Spectrum, someone different to those already belonging must join the network, potentially giving rise to the same reflexive phobia that minorities have experienced throughout human history. However, fear of difference may also be blunted by a network accustomed to, and therefore welcoming to, diversity.

In the context of a single company, where the network may be considered its workforce and extended array of customers, suppliers and other knowledge sources, it is observed that growth in the company does not always lead to similar growth in the ability to take advantage of the ensuing knowledge sources.

These results suggest that as start-ups grow, they may have increasing opportunities to access and exploit external knowledge, but their motivation (and hence ability) to learn from more informal sources may decrease. (Almeida, Dokko and Rosenkopf, 2003 p. 1)

These ‘informal’ knowledge sources are on the fringe of the network, yet can contribute greatly to innovative potential. Granovetter (1985) suggests the term of ‘embeddedness’, where strong ties can lock firms into the status quo because knowledge of procedure and configuration is not allowed to be renewed.

Kaufman and Todtling (2000) observed similar difficulties within even a well-working science-industry interaction, “where only few sources are used repeatedly, the interaction will likely lead to lock-ins, like sticking to long established technological trajectories and strictly intra-disciplinary cooperation” (Kaufman and Todtling 2000 p. 20). The corollary to embeddedness is what Portes (1998) and Woolcock (1998) call “autonomy”, where firms evolve networks beyond their immediate community, accessing external sources of learning, knowledge and innovation (Cooke 1998, Varaldo and Ferrucci 1996).

Given that the problem exists, what then is the cause? It seems that within any collection of individuals, ‘group think’ seems to force a focus on commonly-held information rather than on sharing ones unique expertise or ideas (Stasser 1999, Diehl & Stroebe 1987). While measures such as brainstorming can evoke creativity, people are nevertheless still encouraged to build upon the ideas of others rather than continue
their own thoughts (Parnes & Meadow 1959). Thus, given a nominal Spectrum within a

group, over time this will reduce to due the human tendency to seek conformity.

Added to this, company recruitment and promotion processes tend to encourage

homogeneity as senior members select for those who are similar to themselves. At the

same time, dissimilar members are encouraged to leave the organisation, a phenomenon

White and Langer (1999) term ‘horizontal hostility’, and founded upon a desire to

maintain the distinctiveness of the group relative to ‘outsiders’. Interestingly, this

results in greater rejection of insiders with deviant views than of outsiders who hold

similar views (Marques, Paez, and Abrams, 1998, Phillips, 2000). All this is because

people affirm with groups and bask in their reflected glory. Any threat to their

perception of the group ‘institution’ similarly threatens their social identity and self

image (Abrams and Hogg, 1990, Tajfel and Turner, 1986). Engagement is a close

approximation to the identity that gives rise to such behaviour, and the stronger it

becomes; the more likely it is to threaten Spectrum.

demonstrate inclusivity

In contrast to the exclusion of difference, there is an apposite effect caused by the

presence of diversity. In the case of low diversity, demonstrate inclusivity is the
trepidation felt when approaching a group of high uniformity, and one does not fit with
the stereotype. However, where diversity is already substantial, it is the comfort one
feels knowing your difference does not stand out.

This will tend to counter the exclusionary nature of a group highly-protective of itself.
At the same time, those already within a diverse group will be more likely to accept

further diversity, a observation often made regarding the contrast between a ‘big city’ as

opposed to ‘small town’ mentality. In the context of university-firm transfer, if
academics are accustomed to seeing businesspeople on campus and dealing with the
colleagues, they will perhaps be more likely to follow suite.

broaden membership

The final factor contributing to Spectrum regards the organisational capacity of the

network as a whole to incorporate new members. By seeking out appropriate members,
the network is able to build up its Spectrum through strategically identifying ‘holes’ in
its capability and remedying them. However, without management procedures in place,
the induction of new members relies upon chance, and is unlikely to find the needed
Entrepreneurial Knowledge Transfer

people. Alternatively, the process is mired in bureaucracy and approvals cannot be gained in a timely manner. Either way, the network is badly managed, and cannot coordinate power and information effectively enough to induct new members.

Miles and Snow (1978) identified the importance of induction in the context of SMEs acquiring external knowledge, identifying two capabilities: proactive prospecting and intra-firm knowledge dissemination. The latter is concerned with ensuring the knowledge is made known to, and accepted by, the company - while the former involves seeking appropriate knowledge in the first place. If we replace ‘knowledge’ with ‘member’, we see these capabilities translate to any well-coordinated network.

5.2.5 Impact on Coordination

While Engagement, Capacity, Spectrum and Activity are physical attributes than can be observed (although measurement is not straightforward), Coordination is a virtual (emergent) property of a network Concerned with the management of the network to further realisation of the premise, it does so through exercising power manifested as information, leadership, ideas and initiative. The four linkages affecting Coordination are recognise authority, capture information (positive) as well as abuse position and external obligations (negative).

**recognise authority**

Assuming the absence of coercive measures, the only way to control people is to gain their permission, yet in submitting to the dictates of conformity, people also gain advantages. For one, it reduces the available options, which in an increasingly-complex world can relieve substantial stress.

> The interpretations are valid for all members of the system which, on the one hand, reduces ambiguity, but on the other hand, restricts alternative interpretations of the system specific reality (Willke 1993).

However, one is wise to only surrender freedom to a trusted party and/or premise, with the alternative colloquially is known as a cult). Nevertheless, from extreme cult to

75 Which raises the question of whether the premise is simply one of ‘avoid punishment’, and the network forms around that? On the other hand, if those with the weapons are intent on using them, it will be very difficult to reconcile the aims of both groups of people, meaning they are unlikely to collectively participate in a network as described here.
respected association, the decision to recognise authority by submitting to its rules and regulations is an identical one.

Moving to EKT now, and Jolly (1997) observed in his examination of entrepreneurship that people with “lesser thoughts and more trivial intentions” (p. 14) sometimes do better than those with world-beating ideas. One reason is such people find it easier to cooperate, allowing others to support them rather than be forced to address all challenges alone, even if such people are deemed somehow less brilliant.

...appreciating these opinions, learning about the assumptions on which they are based, is usually a better attitude to adopt than deriding [colleagues] as ‘un-innovative’.

(Jolly)

In other words, putting aside one’s own strict interpretation (foster coherency) of what satisfies the premise and instead focussing upon interacting positively (constructive interaction) creates the opportunity for others to recognise your authority, and engage on that basis (whereupon a centralising influence may be exerted). This then returns to the concept of Coordination as an emergent property, where no one person has a monopoly on defining what is acceptable, but rather it arises through mutual consent.

Also, by setting aside an exclusivist mentality, one is able to recognise the primacy of shared goals. All parties are able to make the choice of committing to the network, and see each other as representative of it. At the same time however, Weick (1976) argues against committing too heavily in order to retain an independent decision-making ability. Organisational entities, such as the project team, are more adaptive if they are not overly constrained by the opinion of the majority. This gives the advantage of a ‘beneficial search position’ (generate novelty) by escaping the penalty of being enmeshed by group-think (exclude difference).

**abuse position**

Even if members genuinely commit to the premise of the network however, other factors can still intrude. There may be external obligations, perhaps to other organisations or even another culture, or there may be internal imperative that is common to all of us – self interest. Regarding the latter, the unfortunate dichotomy is that the more powerful one becomes within a network, the greater the temptation to abuse that power. When everyone is poor, there is little to argue over and peace easier to come by, however given the existence of wealth, otherwise-small differences in
distribution become exaggerated and people have the opportunity to abuse their position. Even if not taken up by some, it will be by others, and it is this abuse of power that corrodes the overall integrity of the network.

This is seen within the technology transfer literature when TTO managers regard themselves as having a more-prominent role (Siegel at al 2003) than do the scientists who are supposed to use them (75.0% for TTO managers versus 40.0 and 26.3% for scientists at two universities). Self-important delusion in the face of (in one claim) the undue imposition of bureaucracy is a manifestation of abuse of position that damages the network as a whole. In a similar case, Granovetter (1985) presents managers fighting political battles in direct opposition of their responsibilities to their company;

> While external ideas provoked knowledge valuation and hence learning, internal ideas languished because they were, at worst, threats for managers embroiled in political contests, and at best, potential opportunities that did not command much attention. What looks to the analyst like nonrational behaviour may be quite sensible when situational constraints, especially those of embeddedness, are fully appreciated. When the social situation of those in non-professional labour markets is fully analysed, their behaviour looks less like the automatic application of "cultural" rules and more like a reasonable response to their present situation. Managers who evade audits and fight over transfer pricing are acting nonrationally in some strict economic sense, in terms of a firm's profit maximization; but when their position and ambitions in intrafirm networks and political coalitions are analysed, the behaviour is easily interpreted. (Granovetter 1973, p. 27)

Another perspective is provided by Burkhardt & Brass (1990) and concerns the relationship between power and technological change. If the most powerful actors tend to be early adopters of technology, they retain their position by controlling the speed and direction of change. On the other hand, and much more likely, is the situation where the powerful people are conservative, and new technology is instead introduced by peripheral players. In this case, prevention of change preserves power. If the technology is taken up more widely, this then provides the means for redistributing power, as the peripheral player increases their status by association with the technology, and perhaps also as the experts. The point being, of course, that this all occurs irrespective of the technology, with positions taken on the basis of self interest. The fact that such opposing situations both behave like networks seems counter intuitive, since all players are following self interest, but the difference is in the outcome. One
Chapter 5: Literature

will tend to preserve the status quo while the other will challenge it, and their respective premises reflect this. Thus, abuse position exists independently of the nature of the premise.

Yet agendas come in many forms, and if we were to focus upon those mentioned in the context of governance, examples might be: corruption, favouritism, graft and nepotism. For EKT specifically, it might include torpedoing a project because another will gain from it, weakening your position; or perhaps, as was related to this author, a lawyer employed by the university deliberating inserting uncertainty into contracts in order to create future work in the case of legal dispute. Regardless, the effect is to weaken the ability of the network to coordinate itself, an effect exacerbated by the increased opportunity arising within a wealthy network76.

external obligations

The other linkage assisting abuse position in destabilizing the network is external obligations, but rather than deliberate, it reflects an unavoidable and unintentional conflicts in priorities. As mentioned earlier, people will generally hold ‘membership’ of multiple networks, and the more diverse, the more likely they will clash. For instance, conscientious objectors exist because of the conflict between defending ones’ country and refusal to commit violence. In this case, the typical compromise is to become a stretcher bearer, but this lessens the flexibility with which war may be undertaken. While necessary, such compromises always to some extent betray the premise of one (or both) of the networks in question. Regarding EKT, the conflicting obligations are well-reported;

We are confronted with a situation where, at least, three different social systems - ‘business’, ‘science’, and ‘policy’ - with different modes of interpretation, decision rules, objectives, and specific communicative standards are interacting. The business system is profit-oriented and communicates via the price mechanism. The science system...

76 If we consider that power is likely to be Gaussian distributed, then a steeper, slimmer curve has greater area but also greater disparity between the most and least powerful. Given greater disparity, those on a lower level have more incentive to break the rules, and those on top have more to protect, meaning there is both greater supply and demand to cheat. While a wealthy network need not experience such extremes necessarily, it is certainly a risk, especially when the lowest tiers are encroaching upon poverty in their lives overall. Even though Capacity ‘disparity’ is not modelled explicitly, when combined with human nature and human needs it can become a threat to the network. See Appendix F, Allocate Roles: Mature Phase for further discussion.
Entrepreneurial Knowledge Transfer

system aims at the production of knowledge and communicates via publications.  
(Kaufmann and Todtling 2000, p. 8)

Argote and Ingram (2000) talk of “reservoirs or subnetworks that, if moved, must fit or be compatible with the new context”. This is in regard to people, tools or tasks, and the more disparate they are, the more difficult to introduce to a new context. If networks are more uniform, this will be less of a problem since transplant will likely find acceptance for the new ‘subnetwork’. In other words, here the subnetwork (member) is less likely to be entangled by a conflict situation since the predominant reality is one of accommodation and uniformity.

However, that a non-uniform network is not accommodating in all situations shows how Spectrum harms Coordination. If serious enough, the conflicting obligations - whether already-present or merely anticipated - may even force the premise itself to change and evolve. A network is an artifice created by its members, and if they wish to change its operating premise to preserve their cooperative state, they will do so.

capture information

The fourth linkage affecting Coordination supplies that critical ingredient to the effective wielding of power: information. Without information, the network in unable to gain the full advantage of collaboration, which is the reason why networks form in the first place. Through communication of knowledge concerning conditions beyond the immediate, actors can coordinate with those distant in space and time, and gain efficiencies therefore. To gain such information, members need to interact on the condition that such interaction will only occur through those activities that satisfy the premise. This is because other activities will not be systematically reinforced by the network, and neither will they be undertaken necessarily by participants willing to adhere to the premise. Thus, non-premise activities can not be relied upon to supply information of either sufficient quality or quantity to the network.

Regarding specific activities and the resulting information, Petts, Herd and O’Heocha (1998) discusses the tendency of managers to be over-optimistic about their performance and that of their management systems, while Argote and Ingram (2000) present the term ‘transactive memory’ which is knowledge of who is good at what, and must be deliberately acquired by the organisation. On the other hand, Sarasvathy (2003) talks of the adoption of stakeholder’s viewpoints from the coalface, but this is
perhaps more in line with share experience (which accumulates\textsuperscript{77}) than instantaneous data.

5.3 Concluding Remarks

At the beginning of this chapter it was asserted that an approach forcing other bodies of theory to fit the results of this research was preferable. In the author’s view, considering the impediment inherent to the task, the quality of the result indicate that such a strategy was indeed appropriate. Nevertheless, the comparison has merely confirmed the paradigm model in all its ambiguity, and a number of issues yet remain to be resolved.

Arising Difficulties

In accomplishing the task, difficulties of a similar nature to those found in the research more generally were experienced. Definitional vagueness within the subject matter meant that definitions were rarely exact, hypothesises usually vague, and statistical results inconclusive. Interactions and feedbacks further confused the issue, with only thorough reading and extrapolation uncovering their hidden presence. Further, given that the form taken by other bodies only very rarely match constructs and linkages found within this research, definitive evidence of agreement (or lack thereof) was usually extremely challenging to ascertain.

While the experts in the relevant literature might have readily grappled with such a task, given the background of the author, the chapter as is would seem entirely satisfactory. It provides an exceptionally rich analysis of the subject matter, straying across many fields in delivering a substantial yet concise critique of the nature of entrepreneurial knowledge transfer.

Theory Development

In doing so, a mixture of common-sense observations and peer-reviewed theory allowed a comprehensive review of all the cause-effect linkages that, taken together, constituted

\textsuperscript{77} It is an open question whether Coordination should accumulate rather than be instantaneous, but considering that the data relevant to network coordination is subject to constant change, this is conceptually inappropriate. A relevant example is perhaps the internet, which is accumulating information at an exponentially-increasing rate, but in terms of relevance, only the very latest news and opinion need be considered. Deeper lessons (such as the best websites or even how TCP/IP works) are more akin to build proficiency or share experience and are accumulated via Capacity. This would mean that knowing the best websites on the net is itself a knowledge resource that then supplies activities.
the paradigm model. Indeed, as mentioned in the chapter’s opening remarks, the literature also prompted a small number of very substantial (and larger number of less substantial) alterations of the original derivation from data. This then necessitated a rewrite of the relevant parts of, not only Results, but of most other chapters. For instance, with the ability of literature to contribute alongside the data unanticipated, there were substantial changes to the methodology. Eventually, the literature came to be regarded not only a source of comparison, but another form of data, albeit processed to a far greater extent than that extracted directly from practitioners, giving the advantage of completeness that allowed gaps (and resulting flaws) in earlier theory to be remedied.

**Remaining Issues**

However, there remain many aspects still to be analysed, such as how an EKT network might be best ‘grown from seed’, and how modes of behaviour seen in the real world can be explained by the model. The questions first posed in Methodology also demand examination, and in addressing these concerns, the following chapters will build substantially on work here.
6 ANALYSIS

This chapter has the intent of developing an understanding of how to optimise a network formed around the premise of EKT. Optimisation implies that an external agent has discretion to improve performance, yet the paradigm model as it stands makes no mention of such an agent. All constructs are endogenous and leave no scope for external control to be applied, meaning that for network optimisation to occur, exogenous forces must be found.

To begin this process, there is a static analysis of exogenous factors on the (simple) assumption that negative linkages are undesirable and should be minimised (and vice versa), leading to the identification of a number operational environments. Following this is a dynamic analysis that attempts to maximise growth of the network over time, which is examined in the context of management policy and feedback loops.

6.1 Static Analysis of Behaviour

It is reasonable to suspect that the paradigm model will be affected by forces aside from those endogenous to it, and that they would not invalidate linkages already in existence. However, they would certainly be presumed to affect their magnitude, but since there is a high preponderance of positive linkages, it would appear generally desirable to increase the level of all constructs. The rationale for this is that allowing any single construct to become permanently minimised would, assuming all linkages have equal influence, act to retard the growth of the rest. Based upon this simple logic, the network is optimised when positive linkages are maximised and negative minimised, giving the most favourable immediate improvement in perceived ‘success’.

6.1.1 Linkage Mediation

If it is regarded as legitimate for linkages to not always exercise their full effect, then something other than the two constructs intrinsic to the linkage will govern this. That being the case, a reduction in the effect of a linkage in system where all other constructs

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78 In the dynamic analysis later in the chapter there is consideration of temporary suppression of constructs for the purpose of optimising development over the long term.

79 Given a lack of finer grained data linkages cannot be differentiated by anything other than polarity.
Entrepreneurial Knowledge Transfer

are already fully saturated raises, if not the certainty\textsuperscript{80}, then at least the possibility that linkages are mediated by forces exogenous to the network.

**Assumption of Linear Relationships**

If we allow the assumption of exogenous mediation, the question becomes what form it will take in the relevant linkages, which in turn prompts an examination of the mathematical basis of a stock and flow model. Given that, in spite of attempts at computer simulation (see Appendix E), the actual relationships remain a complete mystery, it is better to keep things simple if at all possible.

The most basic form of mediation using exogenous factors is achieved through linear coefficients\textsuperscript{81}, as shown by equation [1] for a stock (Activity, $A$) and [2] for a variable (Coordination, $O$), as shown by Fig. 22.

\begin{align*}
\Delta A &= [-Aa_1 + Ca_2 + Ea_3 + Sa_4 + Oa_5] \quad \text{where } 0 < a_i < 1 \text{ and } A \text{ is Activity} \\
O &= [Ao_1 - Co_2 + Eo_3 - So_4] \quad \text{where } 0 < o_i < 1 \text{ and } O \text{ is Coordination}
\end{align*}

\textsuperscript{80} It is also possible that linkages are only mediated by each other, and exclude all exogenous factors. However, this recreates the same dilemma that Analysis is designed to address: understanding how to constructively intervene in network behaviour.

\textsuperscript{81} The coefficients are real numbers bounded by 0 and 1; less than 0 switch polarities of the linkage while greater than 1 implies the originating construct is larger than it actually is. The nonclamature is not important, and is merely a sensible way of label coefficients to associate them with the construct they are impacting.

Figure 22: Illustration of linear coefficients mediating linkages
Note that Coordination is an instantaneous variable rather than a stock, and so has a direct relationship to the inputs as opposed to accumulating or dissipating at the specified rate. The presumption of coefficients mediating via linear relationships can be applied in either case; however a stock will still behave as an integral regardless.

Fig. 22 shows linkages mediated within the confines of equations that, while simplistic, are nonetheless valid representations of the mathematical interrelationships inherent in a system dynamics model. Yet a group of mediated linkages can be based on any criteria deemed necessary, as will be shown by the short and long term exogenous affects discussed in the next section. Please note that when these exogenous affects are shown to mediate linkages, it will be in terms of strengthening and weakening. If the linkage has a positive polarity, weakening is unlikely to be desirable, while if negative, it probably is. On the other hand, if the linkage is S-shaped (as all the ‘self-referencing’ linkages appear to be) the effect will be one of damping the amplitude of the ‘sine wave’ relationship between input and output.

6.1.2 Mediation by Operational Environment

The operational environment includes exogenous factors that can be assumed to endure unchanged for considerable periods of time relative to the response time of the network. In other words, the likely time between step changes in the operational environment is much longer than the time taken for the network to settle into a new state in response to an initial step change in the environment. There are three environmental factors considered; leadership, market structure and discordant networks.

Quality of Leadership

The benefits of a strong leader are manifold, but when it comes to an EKT network, it is the ability to centralise coordination that is of greatest benefit. With a single individual responsible for resolving all problems, the inefficiencies of committee-style leadership are avoided. In terms of linkages, centralised leadership maximises the effectiveness of information capture (see Fig. 23) by providing a single point through which all data must pass, as well the cohesion of a single individual in whom members may recognise authority. Furthermore, if the network is still immature, then an appropriately skilled leader can represent a significant proportion of both Capacity and Spectrum, meaning that abuse position and external obligations are less of a concern. Thus, a strong leader
will act to increase the positive linkages to Coordination and reduce the negative, but the effect will perhaps subside as the scale\(^{82}\) of the network increases.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{linkages mediated by leadership.png}
\caption{Linkages mediated by leadership}
\end{figure}

In the absence of centralised leadership, compensation can be provided by the ability of network members to store and retrieve information in a dispersed but coordinated fashion. Effectively, the internet uses information access to distribute decisions amongst a large group, and in so doing artificially duplicates many of the functions of a leader. Information capture is obviously enhanced, but in trusting a database to safeguard personal information while reliably supplying it, so is recognise authority. With transparent reporting on the activity of members, it becomes more difficult to abuse position, while the opportunity to undertake database searches in identifying potential collaborations allows external obligations to be worked around since the member does not require the same reliance upon (say) familial connections in order to build the collaborations that EKT entails.

An information system becomes more appropriate as networks reach a size where the scale of operations outweighs disadvantages such as the initial set-up, having to learn a new system and the overhead of entering and retrieving data that otherwise would occur as part and parcel of interactions within EKT activities. In general therefore, since the

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\(^{82}\) This conclusion is based upon a premise of EKT where, due to its inherent properties, scale leads to intricacy. However it is entirely possible that, given a different premise, scale will not exclude the utility of centralised leadership.
members have not joined the network to interact with a computer, it must be made apparent there is no alternative to (at least the partial) adoption of a distributed information system or it will be resented as an imposition rather than an asset.

**Loss of Market Access**

Entrepreneurship requires a functional market to succeed. Markets dominated by one, or perhaps two, vendors can present barren ground for innovative ideas. Typically the reason for this action by large established players to restrict market access to newcomers employing means such as artificial price distortions\(^{83}\) or regulatory intervention\(^{84}\) designed to favour the status quo. In terms of its effect on the paradigm model, with customers effectively being in ‘collaboration’\(^{85}\) with a knowledge transfer activity, price distortions force a reconsideration of their decision to buy a product or service produced on the basis of EKT, signifying a strengthening of external obligations (see Fig. 24). On the other hand, if the regulatory authorities are seen as overseers of a larger economic network, then corruption of their independence is effectively a case of abuse position.

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**Figure 24: Linkages mediated by market structure**

83 Artificial price distortions can be undertaken in many ways. A large company can offset localised price reductions using profitability elsewhere and so bankrupt a small competitor in that area (as was done by Buttercup bakeries in Australia). On the scale of national governments, trade barriers are used to inflate the price of imports and/or reduce the price of its domestic production.

84 Such as through lobbying (funding) political parties or ‘stacking’ technical standards committees, such as Telstra employed to ensure radio spectrum was not made available for any competition to arise and so preserve the value of its copper landlines.

85 Discussed further in Appendix F, Broaden Membership: Mature Phase
Entrepreneurial Knowledge Transfer

Aside from the effects of price and regulation, established market players are effectively acting to prevent the rise of that which may challenge their dominance, meaning those undertaking EKT are now faced with disproportionate risk, and cannot accept responsibility (in spite of their Engagement) since the risks have been increased disproportionately to the likely reward. Furthermore, given the ‘cards are stacked’ against new entrants, the resources of an EKT network (at least for that particular market) become less enticing since they cannot be brought to bear as effectively if the reality was one of an ‘even playing field’, meaning buy loyalty is effectively weakened. In contrast, success in such an environment might appear more impressive to those both inside and outside the network, thereby increasing its perceived import; not only to potential members (establish reputation) but also to those actually belonging to it86 (gain recognition). In principle, if the relevant market/s functions effectively, innovation will be sought after as the path to success, either to compete or to satisfy an otherwise-ignored market. In the former, established companies will endeavour to innovate internally as new arrivals are able to pose a direct competitive threat since collusion or other monopolistic practices cannot price them out of the market. Whatever the case, a functional market is essential to providing the path to a potential reward that balances the risk inherent in EKT, but should it not, the impact is not completely negative, at least in the short term87.

Discord between Networks

Utilising a process of logical induction (Appendix G), it was established that, as dictated by the premise, a network has an activity space of permitted activities. However, a project can involve participation by people from multiple networks, and to reflect an awareness of potential contravention of one premise or another, there arises an ‘intersection space’ between the individual activity spaces and the project space (also from propositions developed in Appendix G). Whether a single member belongs to a number of networks, or a number of members each belong to different networks (in addition to the one they hold in common that is ‘sponsoring’ the project), to avoid any

86 This is similar to the increased sense of accomplishment that adventurers feel ‘beating the odds’, and when in a team environment, creates a camaraderie greater than had the challenge been less.

87 The author’s experience as member of a telecommunications project (mentioned in the preamble) indicated that the team was willing to deal with, and even gained strength from, confronting an inaccessible market (due to an unwillingness of regulatory bodies to provide access to unused radio spectrum in regional areas on a commercial basis) for a few years but eventually the futility became tedious, and the exercise unjustifiable.
conflict of premise, the project they are collaborating on must restrict itself to the intersection space.

This then implies that membership of networks with widely-varying premises (for instance, a pacifist soldier going to war) can remain a valid participant by voluntarily imposing restrictions on their behaviour (refuse to fire a rifle) but therefore leaves only limited options regarding the projects they can embark upon without potential for conflict (stretcher bearer). To take the analogy further, should potential collaborators come from more antithetical, ‘discordant’, networks (such as opposing armies in the First World War) then their mutual activity spaces become constrained to only a very few projects (collecting the wounded, singing carols at Christmas).

In general therefore, it is important to consider how other networks impinge upon the one under consideration, and should the premises of other networks lead to substantially different activity spaces, there will be a deleterious (strengthening) impact on external obligations (see Fig. 25). Furthermore, if to gain personal advantage a member takes action in excess of that demanded by his membership of another network (such as being paid by your country of origin to spy on your adopted home), then abuse position is also incorporated.

At the same time however, there should also be consideration of the potential for mutual benefit, such as that identified by Siegel et al.
Entrepreneurial Knowledge Transfer

... involvement in UITT (university-industry technology transfer) may actually increase the quantity and quality of basic research (Siegel et al 2004 p116)

The understanding that research will benefit from the input of those interacting directly\textsuperscript{88} with the real world makes a clear case for closer involvement between EKT and research.

\section*{6.2 Dynamic Analysis of Behaviour}

When used in conjunction with short term exogenous factors, the structure of the model itself can allow further conclusions to be regarding growth of the network. If the policy levers are combined with rationale based upon the structure of the model itself, a strategy for optimising the growth of an EKT network arises.

\subsection*{6.2.1 Short Term Mediation of Linkages}

This class of exogenous factors are collectively characterised as consistent with internal management in that they are fast-acting and within the discretionary control of members. This is in contrast to forces mentioned in the previous section related to the operational environment that, even should they prove amenable to influence by the members of the network, will not be within a timeframe relevant to the premise. However, when dealing with a network of people, excessive delays can prove critical. Anyone who has dealt with office politics knows there may only be a short timeframe within which damaged egos or relationships can be soothed and retrieved, and managing people usually requires the capacity to respond within minutes and hours rather than days or weeks. Thus these short term exogenous factors are important to understand since, unless a network is consistently managed (sufficiently) well, disintegration will have occurred long before a conducive operational environment has an opportunity to bear fruit.

\textbf{The Four Policy Levers of Coordination}

When the model is examined for short term effects, we are trying to identify linkages and constructs that are conceptually amenable to management decisions, and it becomes apparent that Coordination has promise in this regard. The remaining constructs

\textsuperscript{88} Through a close relationship with the primary industries CSIRO has an impressive history of fundamental, yet highly relevant, research in areas such as plant breeding and control of feral species.
constitute reflections of physical realities of the network, and altering their state requires physical changes to be enacted, implying long term measures\textsuperscript{89}.

Mediation of the following linkages (Fig. 26) may be seen as the ‘levers’ through which management exercises discretion. At any one time, the pattern of emphasis amongst the four can be interpreted as the ‘strategy’ adopted. As the network progresses, requirements would conceivably alter, meaning it would become desirable for this pattern to change also, requiring (again) that the exogenous forces can respond within a short period of time.

Conceptually, of the four policy levers, the linkage able to be applied (or removed) most immediately is foster coherency since this is concerned with symbolism and promotion of ideas rather than making substantial changes. By the same token, responsibilities for undertaking roles may be distributed (or withdrawn) relatively quickly, although should it be sufficiently senior, the arrangement of necessary pomp and ceremony may be required.Launching (or cancelling) projects via structure activities is somewhat more involved, but given sufficient reason to do so and commitment from management, can occur relatively quickly. On the other hand, recruiting new blood into the network (broaden membership) is likely to be the most time consuming since it depends upon people currently outside the remit of the network, but will nevertheless be able to

\textsuperscript{89} For instance, broadband telecommunications is likely to increase the efficiency of information capture, and desirable as this may be, physically laying cable is nonetheless a time-consuming and costly exercise.
address the vast majority of challenges. At the same time, ejecting people from the network, equivalent to a weakening of the linkage, will require similar time allowances if undue disruption is to be avoided.

Assuming simple linear coefficients, the question then becomes what weight should be allowed to each linkage in a given situation? In providing an answer this admittedly-broad problem, a clue provided by the structure of the model itself, and will be addressed later in chapter.

6.2.2 Feedback Loops

Given that the only distinguishing feature of the paradigm model is linkage polarity, then this information must be investigated for potential to exert control over the size of Coordination. However, maximising Coordination through policy levers means consideration must in turn be given to the affect of feedback on Coordination. Therefore, in order to then predict which linkages are likely to exert substantial force, feedback loops must first be considered.

Polarity and Order of Loops

Feedback loops occur when an action comes back and affects the source of the initial action, and may be either negative or positive. A negative feedback, also called a damping effect, acts to combat the original impetus and introduce a stable state. On the other hand, a positive feedback adds to the source, which in turn increases the size of the feedback, which again increases the source and so on. Here, there is no guarantee that a stable level will be reached and as a result you have to be careful of positive feedback. Indeed positive feedback will theoretically lead to exponential growth which is inevitably stopped by physical constraints such as lack of resources.

To distinguish between positive and negative feedbacks on a system dynamics model simply requires the number of negative linkages to be counted. If odd, the feedback is negative, and if even, positive. Furthermore, a rough guide to the likely influence of the feedback loop can be gained by the total number of linkages, with fewer implying a more immediate, therefore significant and dangerous, effect.
Chapter 6: Analysis

Regarding notation, a single linkage connecting back to itself (such as diminishing returns) is a ‘0th order’ feedback while one consisting of two linkages is ‘1st order’ and so on. Due to the imprecision of this approximation in the absence of more detailed knowledge regarding the relationships involved, only first-order feedbacks are considered further. There are four 1st order feedback loops from Coordination, two positive (red) and two negative (grey) as shown by Fig. 27, compared to the twenty 2nd order feedback paths that are henceforth (by and large) ignored.

Feedback from Management Decisions

The two management actions with an immediate positive effect on Coordination are foster coherency and structure activities. Adjustment of the former reflects the desirability of establishing an overall policy direction (such as a ‘corporate identity’) earlier rather than later, and will lead to increased loyalty (Engagement). The latter illustrates that well-targeted activities will also pay dividends, but in the form of information rather than loyalty. Furthermore, both stocks positively reinforce each other, while Engagement negatively impacts upon Spectrum; which is actually preferable from the perspective of Coordination (due to the positive 2nd order loop consisting of exclude difference followed by external obligations).

Feedback detrimental to Coordination concerns broaden membership and allocate roles. The former creates problems via external obligations (and also indirectly via the 2nd order negative feedback supplied by interpersonal conflict) while the latter through

Figure 27: First-order feedback loops from Coordination
Entrepreneurial Knowledge Transfer

providing members with status and authority that can then be abused (potentially including those making the actual management decisions). The alternative is to not assign people to roles unnecessarily, and this is indeed what organisations in order to maximise their ability to coordinate, at least until circumstances force their hand,

Regarding Spectrum for instance, there may be a conscious choice by management to not expand the network beyond the members necessary for ‘core’ activities in order to minimise potential for conflict. In this case, those in control decide to not fully utilise their power to direct the network (specifically through not assigning roles and not broadening membership) which, assuming linear coefficients, means setting those affecting assign roles and broaden membership closer to zero than to one.

6.2.3 Phases of Growth

The aim of this part of the analysis is an examination of a hypothesis regarding changing modes of behaviour in the network as it grows, but uncertainty precludes its use in formulating recommendations beyond a general suggestion (§7.2.3) to remain aware of phases of growth when funding EKT.

By examining the feedback loops surrounding Coordination, it becomes possible to justify maximising or minimising certain policy levers depending upon the relative sizes of the other four constructs, the pattern of which will change depending upon the maturity of the network (see Fig. 28). The initial phase of development are characterised by a theme of nurture and protection via strong Coordination. With growing maturity there is a move to equalise all constructs, and finally emphasis is placed upon maximising Capacity and Spectrum as the network matures and the requirement for central Coordination becomes less straightforward.

![Figure 28: Theorised optimum levels for stocks during phases of development](image-url)
Chapter 6: Analysis

It is acknowledged that what follows is highly-conjectural in nature, but considerable rationale has been developed (see Appendix F) in order to gain the maximum degree of confidence given the data available.

**Early Phase of Development**

The aim for management in the early phase of a network’s development is to accentuate the positive feedbacks and downplay the negative. Thus, it becomes important to place emphasis on coherent policy and productive activities by ensuring all members understand why they are there, and are given an opportunity to make an active contribution that is both constructive and meaningful.

In this early phase, sound, coherent policy direction (foster coherency) will focus individual perceptions (recognise authority), and prompt a willingness to contribute (accept responsibility). Activities then entered into will provide two types of information; on individual talent and skills, enabling division of labour to be implemented more efficiently (allocate roles) and also regarding which combination of what activities are most effective (structure activities) given available resources. Overall, and in general, the intention here is to inspire confidence in the leadership (Coordination) of the network, whether distributed or personal.

Further, as any training sergeant knows, keeping his green recruits busy is never just an exercise in ‘make-work’ designed to keep them out of trouble (external obligations) and instead focused on why they are there (recognise authority); it also serves to bond teams (constructive interaction), increase skill (build proficiency) and engender self confidence and self belief (gain recognition). In this way, the interrelated nature of the network creates a multiplicity of impacts for any action taken in the name of managing a group of people, demonstrating the delicacy of such responsibility.

At the same time, until the initial cohort have finished being put through their paces, holding off on further broadening of the membership base may be preferable. Yet as activities become more advanced, they require specialised personnel, but in the early phase simple tasks need only vague roles with little differentiation or seniority. However, without the benefit of a wide Spectrum of perspectives to generate creative

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90 From the author’s military experience, the group’s ‘pecking order’, pursued through socialising, teasing and generally mucking around, became the foremost consideration when not engaged in actual training. If females were also present, showing off and flirting were introduced: in other words, trouble.
Entrepreneurial Knowledge Transfer

approaches (generate novelty) activities will tend to towards the mundane. While this may seem contradictory to the premise of EKT, maintaining coherence to allow for the network to develop sustainably is more important in the long term.

In any case, availability of specialised contributions (suitable expertise) at an early stage on is not necessarily desirable as there is unlikely to be insufficient information (Coordination) regarding who has the ability to perform what role. Furthermore, until respect for the leadership has been established (recognise authority), weak Coordination will be devastated by any ensuing abuse (abuse position) of newly-granted authority. Similarly, further broadening of the membership can be postponed until the first cohort is settled; otherwise it risks disruption of both leadership decision-making processes (external obligations) and group cohesion (interpersonal conflict).

**Interim Phase of Development**

As the network grows out of the early phase, the theme becomes one of rebalancing the constructs. Carrying on the military analogy, once recruit school has instilled loyalty and obedience (Engagement), the interim phase is akin to then providing specialised training that increases skills (Capacity) while also increasing differentiation between those skills (Spectrum). This training is necessary to equip soldiers for the more elaborate Activity (compared to recruit school) that constitutes its peace time role. Furthermore, spare⁹¹ Capacity (diminishing returns) is important for maintaining a respectable level of Activity since there will be substantial turnover of projects given the high risk inherent in EKT. At the same time, Spectrum provides creative opportunities that are a prerequisite for novel approaches, which become more valuable for penetrating the market. In this way, without disrupting Coordination excessively, the interim phase sees Capacity and Spectrum gradually increased until a conceptual ‘parity’ (accepting the dimensions are not equivalent) is reached with Engagement and Activity.

Another perspective on the interim phase is that of an emerging economy not yet able to compete on an equal footing with its more advanced brethren. Until its human and

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⁹¹ It is said that armies work ‘in threes’: one is doing ‘it’, one is getting ready to do it next and one is recuperating and re-equipping after having just done it. ‘Failure’ in this case is simply the cessation of a particular deployment, whereas in the case of EKT it is the cessation of a project, which given the goal is penetration of the market, is unlikely to have been scheduled.
physical capital is advanced to a sufficient depth and diversity to be competitive\(^\text{92}\) the economy will require\(^\text{93}\) protection in the form of trade barriers such as subsidies and tariffs. While this is a distortion of the market, it is actually a reverse of the exogenous force proposed earlier (§6.1.2: Loss of Market Access) as it impacts the access to the domestic market for competing (discordant) networks. As such, the mediation of linkages is also reversed, implying that establish reputation and gain recognition are weakened (rather than strengthened) while the opposite is true of buy loyalty and accept responsibility. If we take the rise of Japan’s economy for the purpose of illustration, it will be recalled by some that during the decades after the Second World War, Japan was known for producing poor quality manufactured goods on the back of protectionist policies, which customers in developed nations (‘members’ of the Japanese ‘network’) felt disdain for (weak establish reputation). However, within their own population, domestic enthusiasm driven by the favourable market opportunity created both private investment\(^\text{94}\) (buy loyalty) and a willingness to take entrepreneurial risk (accept responsibility). However, it may also be contended that the rewards won did not engender a true sense of national pride (gain recognition) until the barriers had been removed and the economy thereby competed on its own merits. Nevertheless, the strategy paid off, and paved the way for Japan to resurrect its ruined economy and become the world’s second largest economy in a mere fifty years. However, in order

\(^\text{92}\) Protectionism was indeed the strategy followed by economies that are now the most successful, including the United Kingdom in the 19\(^{\text{th}}\) century, the United States until the early part of the 20\(^{\text{th}}\) century, but most recently Japan whose car makers (notably Toyota) are now poised to outsell their American competition. More recently still the same strategy has been adopted by China through artificial devaluation of its currency, and by Indonesia through subsidisation of fuel and plantations of palm oil for biofuels. However, in the latter case, since there is little or no advanced component to these endeavours, it does not develop Spectrum and so dooms the economy to remain in a state equivalent to the early phase of an EKT network.

\(^\text{93}\) When protectionism is not adopted during development of an economy, the results are made evident by the collapse of South American and African economies under direction from ‘economic rationalists’ at the World Bank and International Monetary Fund. These strategies were recommended during the last decades of the 20\(^{\text{th}}\) century but the indictment continues to be manifested by a persistent lack of genuine (as opposed to mining or oil driven) economic activity.

\(^\text{94}\) As China’s first experiments with its stock market have shown, private investors are the primary driver of its rise. This stands in stark contrast to the ruinous strategy followed by the Chinese state of investing trillions into the United States, effectively creating a lose-lose where they must continue to prop up US consumption through provision of cheap credit or risk a collapse in the value of their investments. At the same time, investment in their own economy is foregone. However, considering the vulnerability of non-democratic systems of government to corruption, it is perhaps not completely inadvisable to remove the opportunity by not investing wealth domestically in state-owned companies (thus keeping Capital and therefore abuse position low). As a consequence however, the strategy led to the ensuing ‘subprime’ financial crisis as a result of banks having access to excess credit (Capital) and abuse the position so created by offering loans to high-risk mortgagees.
for an economy or network to achieve success at this level, it must first enter the mature phase of development; characterised by Capacity and Spectrum growing ahead of Activity and Engagement.

**Mature Phase of Development**

Maturity is marked by a preponderance of activities that compete successfully in the marketplace, a state that carries a number of connotations. First among them is that sources of competition – including other EKT networks - have effectively been ‘beaten’ in terms of having the ability to supply the market in a superior fashion. From the perspective of a spin-out, this is no easy feat, especially without an established market presence (meaning it has formed a network with consumers already) and deep pockets otherwise available to large corporations. Both of these serve to attract the best personnel; otherwise a challenge for a loosely-organised network originating from a university. Aside from capacity to pay a competitive salary (buy loyalty), also necessary is a strong reputation for both success (establish reputation) and member satisfaction (peer induction). Thus before a network can consider itself mature, it needs an ability to find the right people.

As more activities find success, emphasis shifts from to maximising Capacity and Spectrum. This is the reverse of the formative stages, but reflects the necessity of maintaining strong growth to give activities addressing the market a realistic chance of success. Nonetheless, Capacity and Spectrum have their dangers (abuse position, external obligations, interpersonal conflict), but the alternative is stagnation, and new recruits will fail to supply the means (supply resources) of fuelling more adventurous activities. Thus efforts are focussed upon finding diverse new talent (broaden membership), and then ensuring it has a reason to stay once arrived (gain recognition, constructive interaction, build proficiency etc.).

Nevertheless, should too much emphasis be placed upon recruiting and assigning roles to the detriment of Coordination, a tipping point may be reached that can have a lethally destructive impact, perhaps leading to the breakup of the network. While Capacity provides a real advantage in attracting good personnel (such as the level of pay), a mature network can still fail if insufficient attention is paid to coherency of policy.

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95 It is said that for a new product to succeed it must be ten times better or ten times cheaper, ten times better quality, ten times more useful, ten times more attractive, and perhaps even ten times more fashionable.
(foster coherency\textsuperscript{96}) and efficiency of structure (structure activities) provided by Coordination. In other words, greed is not (always) good, and especially when it manifests as abuse of executive responsibility (abuse position).

However, a mature network might also wish to experience legitimate fragmentation born of a desire for autonomy in the context of the network having a restricting influence on creativity and innovation (generate novelty). In this way, a successful network formed expressly for the purpose of entrepreneurship actually becomes a victim of its own success. Firstly, management have explicit motivation to preserve their own power by choosing to not use the policy lever (broaden membership) that increases Spectrum because of the complications it brings to them (external obligations) and to the members (interpersonal conflict), who constitute their power base (recognise authority). In addition, the linkage under their responsibility that does increase their own power (foster coherency) can be maximised, which acts alongside those not under their immediate jurisdiction but are nevertheless characteristic of a successful network (gain recognition, constructive interaction) and which will further increase Engagement. Problematically however, this will begin to suppress Spectrum (exclude difference) through marginalising the most diverse (and therefore innovative) members.

Finding a remedy to this eventuality effectively requires ‘creative destruction’ of the network in terms of diminishing Engagement without anarchy eventuating as a result of excessive disempowerment of Coordination. A solution is proposed in the following chapter, one that (perhaps ironically) draws upon the phenomenon of ‘asymmetric warfare’ at a time in human history that some world leaders – generally those actively colluding with the forces arrayed against genuine entrepreneurship (§6.1.2: Loss of Market Access) - wish to characterise as an age of terrorism. However, in building towards this analogy, the entirety of this chapter is included; static as well as dynamic exogenous factors, and the combination of the two in optimising network growth over early, interim and mature phases.

\textsuperscript{96} A company that award their executives excessively, and subsequently find themselves in a state of dysfunction born by a disconnect between the treatment of ‘shop floor’ workers and those in the upper echelons, and the former feel a loss of Engagement with their employer.
7  RECOMMENDATIONS

Now that the paradigm model has been compared to literature and analysed, it becomes possible to make recommendations with the intention of informing policy makers in both government and universities. In so doing, it is instructive to first return to the original research questions that framed the methodology.

**Question 1:** What university policies will promote EKT?

**Question 2:** What role might facilitators play?

**Question 3:** How might greater investment be attracted?

All three questions are asking effectively asking the same thing: how can EKT be systematically implemented? Given its inherent novelty, as well as the need for interpersonal trust and market penetration, this would almost seem a forlorn task. Novel projects cannot be repetitively churned out, trust can stubbornly resist developing and if consumer demand was predictable, companies would never go bankrupt. Thankfully, it would appear that a way forward is emerging from within Analysis, only requiring a little more coaxing to bring it into the light. However, before tying the strands of logic into a viable solution, they must be grounded by concrete examples, which then also provide a contextual background from which the recommendations proper can be made.

### 7.1 Examination of Extant Networks

It was mentioned in Methodology (§3.2.1 Fostering Disclosure) that data revealing what hasn’t worked is often salutary in its warning, and with that in mind, two instances of inherently flawed systems are now examined. The first is a representation of the Australian system of awarding grants, neither explicitly for commercial or research purposes, but a generic mixture of the two. Before moving on to the second salient example, there is a short discussion of an experimental approach to public funding of science infrastructure that draws a powerful distinction. Perhaps unexpectedly, the second example is concerned with networks for the purpose of terrorist action, and while included for the purpose of illustrating a more fundamental point, any additional focussing of attention provoked by way of the subject matter is not entirely unwelcome.
7.1.1 Public Grant Allocation Networks

Two major difficulties public agencies experience is identifying *what* to spend money on, and once it has been distributed, ensuring it is spent in the *way* anticipated. In grappling with both these, the Australian (and most other nation’s) grant approval system contravenes the 2nd and 3rd criterion of the premise of EKT (§2.2.3), causing (it will be contended) breakdowns in specific aspects of the network. In addition, other problems arise on the basis of failures of responsibility and leadership, as well as discord with other networks.

**Rejection of Novelty**

As things stand with public funding of a wide range of commercial, community, artistic and academic work in Australia, applications are in written format, and must satisfy arduous\(^\text{97}\) conditions such as formulaic standards governing substance and type of information (in the case of science the former involving the National Research Priorities). In addition, with publication history considerable weighting, a researcher in a novel field is less likely to win a grant than one with a proven track record. In essence therefore, however replete with detailed information, the process would seem to be seeking perfect form and safe hands rather than novelty, and represents a diminution of generate novelty (see Fig. 29) therefore.

**Inability to Build Trust**

Without the freedom to from interpersonal relationships as the primary means of communication, grant officers rely upon written applications that only convey a small proportion of the information that one would absorb through direct interaction. The reality is that the person who writes a good grant proposal, and perhaps has a distinguished research history or successful business experience, may not necessarily be the best person to undertake EKT. There are so many considerations relevant to this decision that cannot be communicated by a written form, or even in one meeting. Lack of capacity to build trust means the grant officer cannot inform him to extent required to satisfy the 3rd criterion and creates a breakdown in constructive interaction and capture information (see Fig. 29).

\(^{97}\) Anecdotal evidence from a number of academics at the ANU both with and without a history of being awarded grants indicate that over any one year, grant application processes potentially consume up to one third of their time. This situation has arisen due to the ‘bar’ being raised as researchers learn to optimise their applications, in turn requiring more effort to write one that is successful.
Chapter 7: Recommendations

**Responsibility Disassociation**

One of the founding principles of networks (§4.1.2 Network Capacity) is that resources are always owned by individuals, and it is these individuals who then take responsibility for the risk of dedicating that resource to an EKT activity. However, when a funding agency approves a grant, there is no personal ownership at stake. The public servant will not personally suffer hardship if they make the wrong decision, assuming of course that the approval process was followed faithfully. Grant officers place substantial consideration on satisfying formal criteria as opposed to developing a comprehensive understanding of the project they are to invest in. In this way, inability of grant officers to assume a share of the risk inherent in the projects they approve constitutes a breakdown of the accept responsibility linkage (see Fig. 29).

**Leadership via Bureaucracy**

With direction effectively provided via policy documentation and legislation that the grant officer is required to arbitrarily interpret, inconsistency would seem inevitable. Unless the relevant minister or department director was unusually hands-on, there is effectively no centralised leadership in the sense discussed in (§6.1.3: Leadership Strength), and without transparent information systems, neither does it resemble the dispersed alternative. That being so, the typical grant system would seem to constitute ineffective leadership, and therefore mediation of linkages that have been asserted accompany this ‘static’ exogenous variable.

**Discord with Academic Networks**

There is also concern where academics are given authority to approve grants on the basis of their familiarity with the subject matter, but who then show favouritism towards their previous research colleagues, placing a bias on their decisions that appears as an increase in external obligations (see Fig. 29). This is not to say such situations are unavoidable, and in fact a different approach was attempted in funding large infrastructure through the National Collaborative Research Infrastructure Investment Strategy (NCRIS), it was intended to allow shared access to infrastructure amongst researchers from across the nation.

* A key element in achieving this consensus across a diverse research community was the use of “facilitators”. These facilitators were experts chosen for their breadth of knowledge and the respect they commanded in the relevant research sector. From the
Entrepreneurial Knowledge Transfer

beginning they were able to interact with participants from research institutions and governments, and chair the discussions required to achieve a consensual outcome. In turn, facilitators were supported by expert reference groups and specialist advisors drawn from the research community. The use of workshops, discussion papers, bulletin boards and email discussion forums, combined with extensive electronic mailing lists allowed any party who registered an interest to be engaged in the process... Perhaps the major lesson was that one should not underestimate the effort necessary to engage researchers in a process markedly different to normal research funding processes.

Even though NCRIS hired active researchers to ‘facilitate’ the process, it managed to avoid conflicts of interest (as indicated by the wide acceptance of its funding decisions) by giving those individuals active leadership positions. In this way, the tendency towards external obligations was counteracted by forming a network around the individual on the basis of extensive interaction, a network that the facilitator then feels an overriding responsibility towards.

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Figure 29: Linkage mediation by public grant system

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98 Sargent, M., ‘Unified approach reaps rich reward’, The Australian 14/2/2007. Mike Sargent chairs the NCRIS committee, and while not exactly independent, is one of the few people both sufficiently well placed and willing to pass comment at these early stages of the experimental approach taken by NCRIS.
7.1.2 Multiple Layer Conglomerate Networks

Aside from the static degradation of a network’s linkages, it is also important to consider what is relevant to network growth as presented in Analysis. These have been divided into short-term (*policy*) and long-term (*environmental*) issues, with the question of *who* is making the policy decisions remaining important in either case.

**Achieving Critical Mass with Dispersed Assets**

Depending upon whether the decision making is centralised or dispersed at what phase of development, the quality of decisions may be affected. For instance, a mature network may be too unwieldy for a single individual to manage while, if too small, a dedicated database in information system may present as an impediment rather than an asset. Nevertheless, if an EKT network is to have a serious chance of market success, it must aim to reach a phase of maturity whereby the scale and diversity of accumulated resources reach what may be considered critical mass. Critical mass is also a matter of the network able to satisfy the expectations of its members in terms of opportunities to participate in projects with a realistic chance of market success, or if this does not eventuate, in the meantime a professionally valuable experience. So, while critical mass is the goal, the question remains how the growth required to reach such a point should be managed.

**Multiple Layers of Operation**

Given the contention made in the analysis that small (early phase) networks are best led by a single individual, assuming he is successful, what then happens once the network grows too large to manage? Furthermore, given that the various stakeholder groups have a responsibility to take risk into account, how could they justify committing resources where failure at a single point (this individual) could mean catastrophic failure of the entire network? The solution that springs immediately to mind is to spread the risk by investing across a number of networks. However, this then raises the issue of coordinating across those small networks so as to achieve the critical mass that effective EKT requires, in other words allowing them to share resources so as to constitute a large, virtual (*oversight*) network.

Achieving both the aim of localised, small-scale individual leadership and widespread coordination across those networks requires a conceptual shift, but is nevertheless
possible if consistency of the functions of Coordination can be maintained across both layers (see Fig. 30). In other words, when an individual network leader makes a decision, or captures information, these must be transparent to, and consistent with, the oversight network. Identically, when a policy decision is made at the oversight level, it must translate accurately down to the various local networks so that coherence\(^{99}\) is maintained.

![Figure 30: Layers of operation of a conglomerate network](image)

Conceptually, layers are reminiscent of the strategy adopted by terrorist organisations to combat security measures, especially since the 9/11 attack. Here, critical mass, in terms of perceptions of a unified and real threat, is created by the leadership group through releasing occasional video and press releases. On the ground however, the organisation is made up of a large number of small, otherwise disconnected, groups, otherwise known as *cells*. With open communication between the cells posing too great a risk, overall ability to coordinate is limited. This means that physical (coalface) operations have become restricted to those not requiring the large scale planning and resources. So rather than having the ability to (say) recruit and train personnel to a hijack civilian aircraft in western countries, terrorist cells are instead limited to less complex activities such as suicide bombs, remotely detonated devices, and shooting video footage of same.

**Availability of Open Communications**

By contrast, EKT *can* allow the free flow of information between cells (small networks) on the coalface. This information flow then creates a larger, oversight layer that can effectively marshal the combined resources of its constituent networks. Furthermore,

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\(^{99}\) The need to maintain consistency between layers is reflected by Proposition 11 (A project space may be an amalgam of activity spaces from a number of networks) from Appendix G where every activity engaged upon must satisfy the premise of both the coalface and oversight layer.
Chapter 7: Recommendations

since the upper layer is not engaging in the minutiae of EKT, but is rather a simplified abstraction, this then can be overseen more efficiently by a bureaucracy. This raises the requirement, both in perception and actuality, of a system that encourages bureaucrats to carry out these responsibilities, discussed further in the next section.

7.2 Grant Officers as Facilitators

It is the recommendation of this thesis that priority should be given to fostering the creation of EKT networks around selected individuals. To satisfy the ideal of a facilitator, they should possess a mix of skills appropriate to EKT, including social awareness and capacity to grasp unfamiliar knowledge quickly, but also a high degree of integrity. This being so, they may then be entrusted with the allocation of public monies, as well as personal details of participants, both of which serve to displace the requirement for bureaucratic measures currently in place.

Considering the need for those who distribute money to be given the ability to take ownership of the outcomes discussed earlier in the chapter, an information system could be designed to facilitate transparency and accountability at the oversight level such that projects can be assigned to individual grant officers. If sufficiently well-designed, this would also allow the network to overcome problems associated with scale, while at the same time acting as a symbol of coherency across the various environments in which projects were enacted; enabling the network overall to grow to a size that transcended the limits imposed by individual leadership.

7.2.1 Facilitator Regulation

In finding the right people to become facilitators, a number of steps should be taken to formalise the role. This will give protection to those involved, but also serve as a basis around which to coalesce a large-scale virtual network.

Licensing Process

To ensure the most appropriate people are selected for the task of facilitator a licensing process or similar is required. This would involve investigation of references, assessment for suitability as well as training if certain aspects were missing. As only rare individuals would already possess all the requisite knowledge and skills, training
could be targeted into areas such as IP law, group psychology and the fundamentals of engineering and science.

**Legislative Standing**

It would be helpful if facilitators became as ‘institutionalised’ as possible. This implies that facilitation of EKT should come to be seen by the public as similarly normalised as (say) a lawyer or doctor: a credible and esteemed profession with value to society whose practitioners can be expected to perform a set of duties reliably. Gifting facilitators with status and credibility will help to change the perception of EKT more broadly. This will then trickle into the relevant stakeholder groups such as corporations and academia as well as, critically, venture capitalists and other forms of private investment that historically have difficulty justifying risks that are exacerbated by marginalisation from social institutions.

**Transparent Feedback**

The other critical aspect is ensuring participants are provided with sufficient information regarding the track record of a ‘network’ they are considering becoming involved in. Since these are ‘represented’ (led) by individual facilitators, their past performance is important information and should be accessible. Just as the government requires numerical metrics, so potential members should also be able to compare and contrast facilitators using hard numbers in addition to any qualitative evidence that might be available, such as word-of-mouth or published recommendations.

**7.2.2 Performance Metrics**

Given that it has been found that the status (success) of an EKT network can be fully described with four constructs (Coordination being emergent), then it is logical to investigate their use as a basis of performance measurement. As mentioned a number of times, difficulty is encountered when translating essentially-qualitative constructs into quantitative numbers in a way that does not lose accuracy entirely. Nevertheless, just as governments demand accountability for public monies, so do people dedicating (at minimum) their time and energy to an EKT network, and metrics are necessary to satisfy both demands.
Chapter 7: Recommendations

**Activity**

The level of Activity is perhaps most readily indicated by the cumulative budget of active projects. While spending money does not necessarily mean commercial outcomes will eventuate, it is nevertheless both the most accessible and appropriate data that will be readily understood by the public.

**Capacity**

Capacity is probably one of the most difficult to quantify because of the huge variation in type and quality of resource. However, one approach may be a register of members who individually nominate what they consider will be their contribution to the network. To *at least* deliver consistency within the remit of individual facilitators, this could be made responsible for ‘signing off’ these competencies. While initially these estimations will be highly variable, not forgetting the tendency for both facilitator and member to exaggerate, but over time there will be a convergence towards accuracy as standards are developed (assisted by the licensing/training mentioned already) but also critically by the correcting influence of systemic rejection of facilitators whose performance (Activity) is significantly out of step with the resources (Capacity) they *claim* to have at their disposal.

**Engagement**

Engagement is a highly subjective indicator, and the only way to discover it is to ask the members directly. This would require surveys of the membership done on a regular basis. However to compensate for variability due to culture or short-term effects (such as recent success or failures) the survey would need to be designed so as to capture deeper sentiments regarding the network. This would also then feed in to the two previous measures, whereby members who feel they have been ‘duped’ into joining a particular facilitator by extravagant claims of Activity and Capacity can register their disapproval via Engagement.

**Spectrum**

It was mentioned in Results that the Spectrum of a knowledge transfer network would consist of three major ‘poles’; academia, business and government. Regardless of whether this is accurate or not, in establishing the Capacity of the network, it should at the same time be possible to indicate the Spectrum, and enact similar checks on fraudulent claims. The hope is that members will present from a diverse range of
Entrepreneurial Knowledge Transfer

backgrounds, and that this should be represented by a categorisation system offering sufficiently high resolution; discussed further in the next section.

7.2.3 System Refinement

In implementing the system as recommended, a number of further areas of concern have been identified, and solutions proposed.

Development Phase

Given that it has been recommended for the emphasis to change depending upon the phase of development, it is reasonable to apply the same standard to measuring performance. Thus, when assessing the health of the network, consideration should be given to its maturity as indicated by the level of the constructs. In other words, establish whether the network is at early, interim or mature phase and adjust the funding formula accordingly.

Resource Proximity

In general, EKT benefits from easy access to resources. Thus, if proximate to infrastructure such as major transport hubs, or to people with command over resources, a network will gain greater benefit from its activities. This benefit of proximity to resources and infrastructure is reflected by the regularity with which cities develop where major trading routes cross. However, if governments want to allow networks to grow in places other than these few locations, they need to adjust their expectations to account for lack of access to resources, and this may indeed lead to positive outcomes.

South Korea and Japan are examples of what is possible when a population is given the opportunity to develop its’ own wealth through cooperative and innovative endeavour. Similarly, nations are not doomed to seeing their regional areas gradually disintegrate from cities draining their human, financial and physical resources. Governments can overcome this trend, but it requires deliberate intervention with sensitivity to the vulnerability inflicted by poor access to resources.

Non-financial Incentives

Mentioned in the data was the desirability of giving facilitators a ‘cut’ of the eventual profit of a successful commercial project. Unfortunately from the perspective of grant officers as public servants, such reward schemes may cause resentment among their colleagues, as well as clashing with the ethos of a university. One solution might be to
Chapter 7: Recommendations

report more transparently on the individual performance of facilitators/grant officers, giving them a ‘social’ rather than financial reward. As stated, all aspects of the network must be consistent with the premise, and gain recognition was conceived as a mark of status or respect rather than money\textsuperscript{100}.

If the role of grant officer was merged with that of facilitator, such recognition would provide an incentive to take responsibility for the projects they approved funding for. Alternatively, the grant officers could be placed on contract to reduce the similarity to public servants while also keeping the reporting system in place and base renewal of their contract upon it.

\textit{Improved Categorisation System}

If an information system is to be useful, it must be have functional mechanisms of both retrieval and storage of data. Since the user must interface with the database to achieve these, there is a requirement for a logical and efficient ‘language’ covering all manifestations of EKT. Similar to the set theory approach to creating a definition, power and brevity can be achieved with a small number of independent properties\textsuperscript{101}. This allows any aspect of EKT, and there are a wide range of participation types to be defined, to fit naturally within a combination of these attributes. To then allow more fine-grained categorisation, the properties may be broken down into tiers of greater detail.

\textsuperscript{100} It would however be naïve to expect highly-successful facilitators to not extract some benefit from their personal network. However, there is no harm in already-established companies taking advantage of their contacts and experience by, say, offering a directorship. This occurs as an incentive now anyway, and often on far less valid grounds: facilitators may constitute a welcome addition to their ranks.

\textsuperscript{101} There exist a number of categorisation systems currently in use by western governments that hold a remarkable similarity to each other. Unfortunately there is lack of independence between categories (academic field/employment, social/economic impact and industry) and each significantly duplicates its fellow. As such, it is unwieldy to use as any one item can be defined in a number of ways, which then makes efficient database searching impossible. For this reason, the author has created a categorisation system that is entirely independent, but is not included here.
8 CONCLUSION

Before moving into the findings proper, it is useful to consider how the research questions have been addressed.

**Question 1:** What university policies will promote EKT?

**Question 2:** What role might facilitators play?

**Question 3:** How might greater investment be attracted?

In terms of university policies to promote EKT, the answer would appear to lie in finding ways to reward faculty for participation in EKT and giving facilitators autonomy to operate. Moving to the second question of utilising facilitators, they should be allowed to develop projects and encouraged to build a personal network of contacts, which includes being given discretionary control over public funds to do so. Finally, regarding the promotion of investment, providing transparent feedback of facilitator performance will allow greater public accountability and encouraging private investment. Conceptually therefore, EKT would overcome its inherent risk through a system that allows confidence to grow in the track record of individual facilitators, meaning judgement can be brought to bear at minimal risk of corruption that a lack of regimentation would otherwise encourage.

**Summary of Findings**

The results of this research are encapsulated in the form of a system dynamics stock-and-flow model, which, in the nomenclature of grounded theory, is called the paradigm model. It contains four stocks and one variable, and it is proposed that together these represent the macro dynamics of cooperative group behaviour, which we have termed a network. The real achievement here is in identifying the fundamental quantities underlying the operation of a network. These quantities overlay and transcend the individual, but nonetheless dictate the environment they will experience, and the ramifications of choices they make. While accomplished in the context of data founded on knowledge transfer from universities, these findings would nevertheless seem to have broader implications.

If indeed it was found that any human network could be defined in terms of its Capacity, Activity, Spectrum, Engagement and Coordination, this research would have provided an exceptionally powerful tool with which to build a new theoretical
appreciation of group behaviour. Even should it be discovered that the results are instead limited to cooperative activity as described by the data, they are still extremely valuable. As such, it is worth revisiting the reasons why there should exist confidence in the theory, starting with its demonstrable complexity.

**Complexity and Purposefulness**

At various times during this research, resident experts at the author’s university voiced opinions that innovation is effectively a random (non-repeating) phenomenon, and that attempts to artificially promote it would be futile. While admitting the likely difficulty of doing so (§2.3.3 Resistance to Systemisation), the author nevertheless was firm in his belief it was indeed possible to systematise EKT. Upon further reading, clarification for this position came from Crypticity with its depictions of ‘pseudocomplex’ as ‘pseudorandom’ as false instances of high complexity and high randomness respectively. Similar to the intricate patterns created by the simple rules of a Mandelbrot set, pseudocomplexity is where a system of moderate ‘effective complexity’ appears to be highly complex due to the interaction of its constituent parts. The author decided that EKT represented an instance of pseudocomplexity rather than being either truly random (as he was counselled) or pseudorandom, which did not presume the inherent complexity that it was believed EKT justified.

In parallel with pseudocomplexity is the proposition that EKT also constitutes a teleological system (Appendix C), meaning that it is possible to explicitly design a system to achieve EKT outcomes rather than, for instance, relying solely upon happenstance and individual brilliance. Furthermore, throughout the latter stages of the research, a process of revelation somewhat akin to the ‘stepped AIC’ (Fig. 37, Appendix C) was found where a gradual reduction in the number of constructs (§3.3.5 Principles of Convergence) signalled a gradual drop in apparent complexity. The lower limit eventually reached then indicated the actual complexity of EKT

To restate, this research has found that a purposeful system does indeed appear to exist, and that it is not thermodynamical (based upon statistical probabilities) but is in fact teleological. The five constructs that constitute the paradigm model can be considered to be of moderate complexity, while at the same time high interconnectedness\(^{102}\) (indeed maximum possible) would promote a perception of high complexity. As

\(^{102}\) As per its usage in Graph Theory
postulated, pseudocomplexity explains why experts would perceive the phenomenon to be random, and why subsequently there had been a failure by academia and government to develop coherent theory and effective policy respectively.

**Methodological Reflection**

The methodology was designed to answer three questions, and while each is ostensibly different, all are operating on the presumption that EKT can be promoted in a systematic fashion. However, data was required to reveal that underlying system, and prompted the decision to seek out those with systemic experience. The alternative might have been to interview academics or businesspeople, but the advantage of facilitators is that they have had extensive exposure, and were able to condense this into observations that were less vulnerable to distortion from the vagaries of a single project.

Somewhat fortuitously, a lack of awareness of more advanced interview techniques left unstructured interviews as the only available option. The author’s early theories on knowledge transfer leaned heavily towards the inclusion of student projects, which turned out to not even comply with the scope of EKT. Furthermore, it was observed that the interviewees responded well to a more relaxed and conversational style, and when in later stages a more professional approach (including prearranged questions and more serious tone) was used, the data became significantly less rich as a result. Confirmation for this may be in the relative paucity of data (quotes) utilised to validate the paradigm model from the third university visited (6%\(^{103}\)). The fourth university saw a return to a more relaxed style, and an accompanying improvement in utilisation of the data. Overall (and as theorised in §3.2.1) it is perhaps an indication of the Crypticity of the subject matter, that the imposition of constraints on the structure of the interview significantly reduced its eventual utility.

Regarding ensuing analysis of collected data, the aforementioned perception of layers being uncovered seems to indicate that the approach was indeed effective. On the assumption of complexity, it was deemed prudent to take advantage of all available resources, giving rise to the process of initial proforma creation and then cycles of

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\(^{103}\) Occurrences for other universities were 33, 40 and 20% for the 1\(^{st}\), 2\(^{nd}\) and 4\(^{th}\) universities respectively. This was caused by a refusal to allow the author access to the majority of potential subjects while those that were interviewed were not very forthcoming. The reason for both would seem to be the illustrious standing of Oxford whereby TTO staff were (apparently) regularly hounded for research data. Reticence to grant access was experienced by the author at other universities but not to the same extent.
evolution. Through a process of rejection and refinement, occurring over a period of perhaps 4 months, the number of constructs was reduced from 10 to 5. A paradigm model was eventually formed with the present constructs, but still only approximately 90% consistent with the final version. Resolving the final 10% involved exponentially greater difficulty as more sources of information accessed to reveal it. As discussed in §3.4, this included comparing the model against literature, analysing the model to produce recommendations, as well as creating the scope of EKT (not successfully accomplished until the very final stage of the research). Moving between these expended considerable mental effort because of the amount of information involved, but it revealed ever more precise and faithful versions of the paradigm model, lowering its effective complexity. Nevertheless, even now minor logical inconsistencies may persist, but identifying these will have to wait for future work; the research had to be concluded at some point.

**Future Work**

Simulation is always the intention behind creation of a system dynamics model, and as such there was an attempt by to simulate the paradigm model within software (see Appendix E: Mathematical Validation for details). However, regardless of what equations were attempted, whether multiplicative, linear or exponential, no stable behaviour could be established. Construct values either grew to the floating point maximum (effectively negative or positive infinity) of the software, or degenerated to numbers so small as to be below the detection limit: either way there was no subtle insights gained that could confirm predictions, notably those involving optimisation of growth (§6.2.3).

Nevertheless, given the inability of the human mind or mathematics to find the solution of five simultaneous integral equations, simulation remains the only viable means of accurately predicting the behaviour of an EKT network. Nevertheless doing so successfully will require numerical time-series data that accurately reflects the constructs, and acquiring such will be problematic given the immaturity of actual EKT networks that are currently in existence. It is a catch-22 that the policies this research contends are required to instigate the creation of an EKT network are themselves predicated upon the kind of definitive proof that only the long-standing existence of such networks can supply. In summary, proof can ensure good policy is implemented, but proof also requires that the policy has already been implemented.
A potential solution to this conundrum is extending the paradigm model to where meaningful data is already available, or can be generated; as alluded to in Analysis regarding protectionist economic policies (§6.2.3: Mature Phase). This would allow the additional benefit of an examination of alternative premises upon which the network theory might be found to operate. While this would not illuminate EKT explicitly, it would provide validation for the paradigm model in general, which is perhaps of greater importance given its potential for application in many areas of human endeavour.

One example of an alternative premise is the recently arisen phenomenon of online academic journals. While not constituting EKT explicitly, the promulgation of academic research certainly complies with knowledge transfer more broadly. Regarding these sites there is currently a debate underway104 as to whether the cost of access/download should be borne by the reader (via membership fees), as is currently the case, or the authors themselves (and their institutions). While in developed economies, the fees are not of great concern since research institutions can afford memberships, but those in less developed nations (or indeed private citizens) often cannot, especially with the large number of sites in existence. This then restricts the availability of knowledge in places where it is likely to bring the most significant benefits.

Should the alternative funding model be adopted, it would have a number of conceptually similarities to that recommended by this research (§7.2). Rather than facilitators assessing the skills of members, authors are reviewing papers submitted by academics. It can be assumed that facilitators are paid for this service, and in making available the member’s details online, undertake an equivalent action to an online journal making a paper publicly available. Additionally, transparent availability of performance figures for individual facilitators is the same as authors who distinguish between sites on the basis of downloads. However, the core similarity, and deviation from the typical conception of market mechanisms, is in information acting as a proxy for consumer purchasing power. Overall therefore, this debate is an instance of the dichotomy of whether an economically-valuable activity is always characterised by symmetric barter, or as contended at the very beginning of this research, whether it may not be.

104 Giles, J., “Information wants to be free”, New Scientist 22/11/07 p. 22
Musings on Homo-economicus

It would indeed be an impressive feat for this research to - at least partly - force a rethink of, not only theory relating to knowledge transfer, but the entirety of economics. Nevertheless, in advancing a separation of awareness of the donor’s goal and the recipient’s benefit, and preclusion therefore of an economic barter, that is exactly the claim being made.

**Hypothesis:** Knowledge transfer occurs when, in furtherance of personal goal/s, a donor takes deliberate action to make knowledge available to a recipient/s who only accepts if he/they anticipate benefits arising.

While the hypothesis does not, in and of itself, invalidate the concept of ‘homo-economicus’\(^{105}\) as an economic actor seeking maximum utility for himself, it nevertheless raises hope of overcoming the inherently ‘zero-sum’ nature of this view. The problem with everyone seeking maximum utility is in the advantage bestowed by pre-existing wealth and power, whereby income disparity leads to a destabilisation of society, not least because the wealthy begin to associate money with status, identity and (most damagingly) happiness. This cycle is however broken by the innate ability of knowledge to duplicate itself without cost to the donor, while at the same time its transfer represents a flow of power in the form of information.

Many people misunderstand that evolution was never purely a matter of the individual beating his brethren, but substantially a matter of competition between methods of cooperation\(^{106}\). As a result of the advantage bestowed by cooperation, humans have an evolved tendency for altruism, yet this would seem to, at least partially, contradict the utility-seeking nature of homo-economicus. In fact, the question can be recast as how utility can become a *collective* rather than individual phenomenon. Given that this research has endeavoured to discover the makeup of the archetypal ‘collective’, there is a hope that its findings will make a contribution that allows ‘collective utility’ similar esteem to that in which individual utility is held, and in so doing, advance our understanding of homo-economicus.

\(^{105}\) [http://en.wikipedia.org/wiki/Homo_economicus]

Chapter 8: Conclusion
9 REFERENCES


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Entrepreneurial Knowledge Transfer


Chapter 9: References


Entrepreneurial Knowledge Transfer


Chapter 9: References


Entrepreneurial Knowledge Transfer


Chapter 9: References


Appendix A: Modelling Techniques

Grounded Theory

Grounded theory is not generated a priori and then subsequently tested, rather, it is;

... Inductively derived from the study of the phenomenon it represents. That is, discovered, developed, and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon. Therefore, data collection, analysis, and theory should stand in reciprocal relationship with each other. One does not begin with a theory, and then prove it. Rather, one begins with an area of study and what is relevant to that area is allowed to emerge. (Strauss and Corbin 1990 p. 23)

Operational Elements

The three basic elements of grounded theory are concepts, categories and propositions. Concepts are the basic units of analysis and arise from the data – but not directly otherwise we are simply repeating observations without generalising, which is the entire point of the process. By comparing incidents and naming like phenomena with the same term can the theorist accumulate the basic units for theory. Categories result from the grouping of constructs, and are thus more abstract and less reminiscent to the raw data. The third element of grounded theory is propositions\(^\text{107}\), which indicate conceptual relationships between a category and its concepts and between discrete categories

107 Propositions equate to Linkages in my methodology, which reflects an engineering heritage.
**Entrepreneurial Knowledge Transfer**

**Theory Development Process**

Five analytic (and not strictly sequential) phases of grounded theory building are identified: research design, data collection, data ordering, data analysis and literature comparison. It is intended that they form a template for the subsequent discussion which moves from a normative or prescriptive account of recommended activities to a descriptive account of how these prescriptions were applied in the study.

![Flowchart](image)

Figure 32: Theory Development Process for Grounded Theory

Open coding is identifying concepts and categories, axial coding is identifying propositions (linkages) and selective coding is joining categories together, which gives rise to a theoretical framework. To do this, a core category (narrative/story/conversation) is examined, and its constituent parts related to subsidiary categories found within the paradigm model.

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theoretical Sampling</td>
<td>Definition of research question</td>
<td>Focuses efforts</td>
</tr>
<tr>
<td></td>
<td>Definition of a priori constructs</td>
<td>Constrains irrelevant variation and sharpens external validity</td>
</tr>
<tr>
<td>Selecting cases</td>
<td>Theoretical, not random, sampling</td>
<td>Focuses efforts on theoretically useful cases (e. g., those that test and/or extend theory)</td>
</tr>
<tr>
<td>Data Collection</td>
<td>Create case study database</td>
<td>Increases reliability</td>
</tr>
<tr>
<td></td>
<td>Employ multiple data collection methods</td>
<td>Increases construct validity</td>
</tr>
<tr>
<td></td>
<td>Qualitative and quantitative data</td>
<td>Strengthens grounding of theory by triangulation of evidence - enhances internal validity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Synergistic view of evidence</td>
</tr>
</tbody>
</table>
Entering the field

Overlap data collection and analysis
Flexible and opportunistic data collection methods

Speeds analysis and reveals helpful adjustments to data collection
Allows investigators to take advantage of emergent themes and unique case features

Data ordering

Arraying events chronologically

Facilitates easier data analysis.
Allows examination of processes

Analysing data relating to the first case

Use open coding
Use axial coding
Use selective coding

Develop concepts, categories and properties
Develop connections between a category and its sub-categories
Integrate categories to build theoretical framework
All forms of coding enhance internal validity

Theoretical sampling

Literal and theoretical replication across cases

Confirms, extends, and sharpens theoretical framework

Reaching closure

Theoretical saturation when possible

Ends process when marginal improvement becomes small

Compare emergent theory with extant literature

Comparisons with conflicting frameworks

Improves construct definitions, and therefore internal validity

Comparisons with similar frameworks

Improves external validity by establishing the domain to which the study's findings can be generalised

Table 2: Grounded theory research phases

System Dynamics

With its origin in electrical engineering, system dynamics is grounded in control theory and non-linear dynamics, and. As such, there is an elegant and rigorous mathematical foundation to the theory and models it develops. Yet, in adapting itself to solving real-world problems, human and organizational factors have been incorporated, as Sterman in his seminal work states;

Modelling human behaviour differs from modelling physical systems in engineering and the sciences. We cannot put managers up on the lab bench and run experiments to determine their transfer function or frequency response. (Sterman 2000 p. 10)

Operational Elements

System dynamics employs two methods of representation; causal maps and stock and flow diagrams. Stocks are an aggregate of homogeneous elements whose rate of
Entrepreneurial Knowledge Transfer

accumulation the relevant flow regulates. Stocks capture the tendency for natural systems to accumulate in a way that often can be clearly defined.

A subsystem diagram shows the overall architecture of a model, conveying information on the boundary and level of aggregation in the model by showing the number and type of different organisations or agents represented.

**Theory Development Process**

![Diagram of Theory Development Process]

Figure 34: Theory development process of system dynamics
<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theme selection</td>
<td>What is the problem? Why is it a problem?</td>
</tr>
<tr>
<td>Key variables</td>
<td>What are the key variables and concepts to consider?</td>
</tr>
<tr>
<td>Time horizon</td>
<td>How far in the future should we consider? How far back in the past lie the roots of the problem?</td>
</tr>
<tr>
<td>Dynamic problem definition (reference modes)</td>
<td>What is the historical behaviour of the key concepts and variables? What might their behaviour be in the future?</td>
</tr>
<tr>
<td>Initial hypothesis generation</td>
<td>What are current theories of the problematic behaviour?</td>
</tr>
<tr>
<td>Endogenous focus</td>
<td>Formulate a dynamic hypothesis that explains the dynamics as endogenous consequences of the feedback structure?</td>
</tr>
<tr>
<td>Mapping</td>
<td>Develop maps of casual structure based on initial hypotheses, key variables, reference modes, and other available data, using tools such as a stock and flow map;</td>
</tr>
<tr>
<td>Specification</td>
<td>- of structure, decision rules</td>
</tr>
<tr>
<td>Estimation</td>
<td>- of parameters, behavioural relationships and initial conditions.</td>
</tr>
<tr>
<td>Tests</td>
<td>- for consistency with the purpose and boundary</td>
</tr>
<tr>
<td>Comparison to reference modes</td>
<td>Does the model reproduce the problem behaviour adequately for your purpose?</td>
</tr>
<tr>
<td>Robustness under extreme conditions</td>
<td>Does the model behave realistically when stressed by extreme conditions?</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>How does the model behave given uncertainty in parameters, initial conditions, model boundary and aggregation?</td>
</tr>
<tr>
<td>Scenario specification</td>
<td>What environmental conditions might arise</td>
</tr>
<tr>
<td>Policy design</td>
<td>What new decision rules, strategies and structures might be tried in the real world? How can they be represented in the model?</td>
</tr>
<tr>
<td>“What if…” analysis</td>
<td>What are the effects of the policies?</td>
</tr>
<tr>
<td>Sensitivity analysis</td>
<td>How robust are the policy recommendations under different scenarios and given uncertainties?</td>
</tr>
<tr>
<td>Interactions of policies</td>
<td>Do the policies interact? Are there synergies or compensatory responses?</td>
</tr>
</tbody>
</table>

Table 3: Theory development process for system dynamics, Sterman (2001)
Appendix B: Categorisation of Activities

Here a number of knowledge transfer activities are categorised via the three properties of EKT. Using Fig. 3 (from Scope) as a visual representation, shown from left to right, are the goal, preparation and delivery of the knowledge transfer activity. Finally, tables summarise the categorisation, which are then represented in Fig. 4 (also in Scope).

Examination of Howard

There are eight types of knowledge transfer specified by Howard in the context of transferring knowledge from universities. Each will now be examined using the three questions/properties to see whether they constitute EKT.

**Intellectual Property Rights**

...knowledge property in the form of patents, copyrighted material, designs, plant variety rights and other codified and/or documented representations of knowledge.

The protection of intellectual property enables legal defence of a competitive position in the market, and is therefore enacted with the intention that the knowledge embodied will eventually have a wider impact through a good or service. In fact, any deviation from the legal strictures of patenting will potentially create a flaw that may eventually be exploited by a competitor in the courts.

The act of patenting is ritualised in that one must follow a regulatory process, a process that while involves the input of patent examiners, cannot be considered to require trust on a person to person basis. While there does exist trust in the institution as a whole, it is not what one would consider interpersonal.

**Academic Publishing**

... production, marketing, distribution and sale of books, papers, electronic material through academic presses established for this purpose
Publishing of academic material is usually for the purpose of teaching or sharing knowledge within an academic peer group. While it may be rare for an academic book to achieve high circulation, it is nevertheless the hope of the author that this will be the outcome. Regarding the process undergone in writing and publishing such material, and while the material is quite likely to be novel, the publication process itself is formulaic in so far as it uses established publishing houses and standardised processes such as editors and contracts. In terms of interaction, ‘production, marketing, distribution and sale’ are generally business arrangements that do not require a high level of trust.

**Knowledgeable Graduates**

...people possessing knowledge and skills capable of development application in a business and commercial context

The transfer of knowledge incorporated in graduates is two-fold; the first stage being to impart knowledge to the student, which is then followed by their finding a position within a firm, yet from Howard’s wording it would appear the latter aspect is emphasised. The activity becomes essentially one of knowledge embodied within a person who, once given a role, can utilise their learnt skills for the benefit of the business. This situation, in terms of being employed within a pre-existing team, is
Appendix B: Categorisation of Activities

dependant upon trust within the workplace and (by-and-large\textsuperscript{108}) undertaken for a commercial purpose.

Nevertheless, the act of hiring staff is not itself entrepreneurial since a procedure is usually followed, and once hired, the new staff member is well advised to conform to their situation rather than find a novel way of participating. This does not mean that innovative outcomes will not result from a new graduate, but that there will be a process to be followed to allow that input to be made. For instance, the employee who ‘goes over his bosses’ head’ is generally not welcome for long.

\textit{Industry-targeted Teaching}

\textit{...accredited courses, qualifications and certifications involving the preparation, marketing and sale of courses and programs that meet a specific user need for professional recognition and career advancement}

This form of knowledge transfer is the design and provision of industry-relevant (typically short) courses. This touches upon the previous problem of whether the education or the employment is emphasised, but it appears in this case – with a focus on ‘…preparation, marketing and sales’ - the former is. The process of inserting knowledge into a student, and their utilisation of it, is identical regardless of the subject matter except that there seems an implicit focus away from university undergraduate education. Nevertheless, a distinction is made involving course design and marketing, which moves away from the actual teaching itself.

This raises the possibility that novel approaches may be employed, free from the formal constraints of academia, and perhaps in conjunction with suggestions from the industries the courses are designed to service. That being the case, it would be reasonable to presume that for businesses to make the effort to collaborate, they would

\footnote{The logic here is rather weak however since markets are imperfect and many companies actually innovate very little, instead surviving through stasis of market share, or growing via anti-competitive practices such as a favourable regulatory environment.}
anticipate their competitive position in the market would likely be affected. Regarding trust, actually designing the course would preferably (if not critically) involve close cooperation with representatives from industry, yet this is not dependant upon trust for success. Failure of one party or the other to execute their responsibilities does not place the endeavour at any substantial risk, at least in the short term, since the student will still graduate regardless of competence or employment prospects\textsuperscript{109}.

**Contract Research and Consultancy**

...project-based research, advisory and consultancy services involving the sale of explicit and tacit professional knowledge as a service

Consultancy and contract research occur when researchers partner with firms to investigate an issue of commercial interest. This raises the likelihood of eventual market engagement else (similar to the logic used previously) why else would the firm bother with the expense and inconvenience?

There is also a novel aspect since each arrangement is unique and must be individually negotiated (putting aside minor levels of ritualisation introduced for instance by standardised contracts and non-disclosure agreements). Finally, since the activity requires close cooperation between the parties involving substantial outlay of time and resources without (as demonstrated by the Du Pont anecdote) the easy availability of legal or institutional protection, trust is a prerequisite.

**Staff Interchange and Faculty Appointments in Industry**

...members of staff available to assist businesses in the development of strategies, particularly in complex science and engineering areas

\textsuperscript{109} This is perhaps the reason why (at least in this author’s experience) the industry is not as professional as might be hoped
Appendix B: Categorisation of Activities

The secondment of academic staff to industry is identical to consultancy and contract research except the work is accomplished at a site external to the university, usually at the firm. Secondment is however inherently different from employment because the person is not expected to adhere to the workplace culture to the same extent, and is rather given greater leeway within the confines of their input. This is because their presence is purely on the basis of a short-term contribution of new knowledge, and comes with a certain expectation of their playing a unique role. Nevertheless, the costs and risks remain substantial, and require a high level of trust between the faculty member and local staff, not least because of potential exposure to commercially-valuable information.

**Research Publication**

...publication of the results of research in peer-reviewed academic journals

Peer reviewed publication is similar to academic publication in that there is an intent to make new knowledge available, with the major difference being a near-absent expectation (or desire) of broader penetration. However, the peer-review process is designed to cater for new material, meaning there is less necessity to comply with external standards for successful publication.

Another relevant aspect of the process to consider are multiple authors, but even here authors that do not necessarily need to trust one another greatly may still publish together. The reason for this is the highly-politicised nature of academia, where breach

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110 Putting aside incidental processes such as safety induction that are independent to the contribution the contractor have been hired to make.
of trust may render the guilty party ostracised. Therefore, as with patenting, trust may be vested within the institution and process rather than the individual.

**Spin-out Company**

...knowledge-based start-up companies, created to own and market a discovery or technology and (possibly) a product or service based on them.

The final form of knowledge transfer suggested by Howard is direct commercialisation via a spin-out company. Similar to the reasoning behind contract research, and leaving aside minor ritualisation such as company registration, each instance is unique. Further, since there is so much at stake in forming and growing a company (and so much that can go wrong), trust between the parties is absolutely essential. This includes not only investors and project members, but also customers - which often only become so on the basis of interpersonal relationships with salespeople.
Supplementary Activities

While Howard is complete from perspective of knowledge transfer involving universities, inclusion of activities from further afield allows for greater scrutiny of the principles underlying EKT. What follows is not exhaustive, but taken in addition to Howard provides a better indication of what this research is intended to encompass, and what it is not.

**Traditional Lecturing/Teaching**

![Diagram of traditional lecturing/teaching process]

In providing context for the two previous teaching-related activities (knowledgeable graduates and industry-relevant courses) from the previous section, academic teaching is itself examined. Whether the subject matter relates to industry or not, teaching has consistent characteristics. It is best achieved through personal interaction between the teacher and student, where trust is important in enabling the information to accepted at face value. Regarding the process, all students generally follow a set curriculum to enable fair assessment.

Furthermore, in so doing the aim is to instil knowledge in the pupil, not to achieve a commercial objective as such. This may of course be the eventual result, but the act of teaching is perhaps best undertaken without such a cognisance of future economic value. Nevertheless, as mentioned, academic teaching is essentially a repeated process – both between students and also from class to class. This is in stark contrast to applied coursework where, industry-specific or not, a more innovative approach, less constrained by requirements of traditional curricula, is encouraged.

**Student Projects**

![Diagram of student projects process]
As opposed to classroom instruction, student education can also be achieving using project-based participatory learning. In general, without a viable commercial path\textsuperscript{111} out of the educational environment, there can be no expectation of implementation in the market. Obviously interaction will remain a very substantial aspect, but since there is no commercial aspect, there is nothing at risk and trust is not critical. However, if a flexible assessment regime (that does not require exact duplication between projects) provides sufficient leeway, then individual approaches are likely to be novel as well.

\textit{Commercial Grant Application}

If peer-reviewed and academic publications are considered valid knowledge transfer mechanisms, then perhaps grant applications should be as well. A grant is a discrete packet of (usually public) funds earmarked to enable a distinct piece of research and/or development to be undertaken. Applications for these funds are made by researchers, whereupon knowledge is transferred to grant approval officers in order that they may adjudicate between potential projects. Being for projects on a commercial basis, these grants have a market orientation, but this is not the case for pure (rather than applied) research.

As things stand, applications are in written format, and must satisfy arduous\textsuperscript{112} conditions such as satisfying formulaic requirements of form and substance (the latter involving the so-called National Research Priorities). Therefore however replete with detailed information, the process is geared to inherently converge towards perfection, rather than novelty, of form. It is for this reason that universities hire staff explicitly to assist academics in meeting high standards of professionalism for their applications. At

\textsuperscript{111} Given an institution with a sufficiently-comprehensive and inclusive approach to commercialisation and/or technology-transfer, this could be made possible (at least for those projects showing sufficient promise), but is certainly not commonplace as things stand.

\textsuperscript{112} Anecdotal evidence from a number of academics at the ANU both with and without a history of being awarded grants indicate that over any one year, grant application processes potentially consume up to one third of their time. This situation has arisen due to the ‘bar’ being raised as researchers learn to optimise their applications, in turn requiring more effort to write one that is successful.
the same time, the formulaic nature of the process renders trust on an interpersonal basis largely irrelevant (putting aside inappropriate consideration of historical or pre-existing relationships between the approving officer and applicant, or indeed their institution).

**Social Entrepreneurship**

Similar to business entrepreneurship, social entrepreneurship involves creating an organisation for the purpose of meeting a demand, with the difference being that social improvement rather than profit is the motivating force. However, as in the case of spin-out companies, trust and novelty remain important aspects. Curiously, while the enterprise is not profit-oriented, it nevertheless meets a demand and therefore educates the ‘market’.

**Lone Inventor**

As the name suggests, this activity is distinguished by its lack of interaction, while also having commercial intent. It may seem incongruous that the lone inventor has been included given the lack of obvious knowledge transfer, but as made clear earlier, the market itself will eventually be ‘informed’ via knowledge encapsulated within new products or services. Other relationships will involve suppliers and retailers, but these need not constitute knowledge transfer since there is no impediment to a normal commercial arrangement. This process will be itself novel since the path chosen by the inventor will be made unique by dint of the nature of the idea, the market landscape it confronts and the idiosyncrasies of the individual concerned.
Entrepreneurial Knowledge Transfer

**Franchise**

The franchise model of business stands in contrast to other forms of commercial enterprise particularly because of the highly structured path to market is. However, trust is present since the negotiations between the franchisee and franchisor require both parties to assume a degree of risk that cannot be completely remedied by legal agreements. It is also important to note that the case for franchise constituting knowledge transfer is slight since the product is already in existence elsewhere, but introduction into a new region may still be considered to educate a limited market.

**Advertising**

Advertising aims to convince people to consume a good or service with a positive message transmitted via mass media such as television, radio or even non-technological methods such as billboards and moving signs. Those expert at advertising are valued for their ability to introduce novelty since consumers quickly learn to ignore established techniques. However, with the process of advertising generally being a straightforward fee for service, the development of trust is not critical.

**Telemarketing**
Appendix B: Categorisation of Activities

Telemarketing has the same intent as advertising except the transfer is achieved via a personal phone call rather than an impersonal message. As such, interaction plays a crucial role, and while not a ‘business deal’ in the usual sense, there must nonetheless be trust built up between the customer and the salesperson for a successful sale/knowledge transfer. However, in order to overcome the emotional exhaustion that a creative approach would exact, telemarketing applies strict protocols such that the salesperson has sufficient endurance to find the small percentage of potential sales.

**Networking Events**

Networking events are essentially a situation of coalescing and re-coalescing interactions as people with different contributions seek potentially-lucrative collaborations. While staged to some extent, with speakers, a meal and time to mingle, the actual benefit accrues when meeting new people, which is always a novel experience. However, as with mixing in any social environment, it is more comfortable to speak to those already known to you. While reacquainting an existing relationship is certainly welcome, the true purpose of networking events is to create new opportunities. These opportunities can only be identified when information is revealed, requiring a level of trust to be first established. Furthermore, and somewhat reminiscent to telemarketing, trust is more likely when both parties observe social norms. Overall therefore, networking events do not contain a high level of novelty, which can perhaps be regarded as a compensation for the uncertainty introduced when meeting new people.
### Table 5: Categorisation of supplementary activities

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Appendix C: Perspectives on Complexity

This chapter begins with a theoretical examination of complexity, and then attempts to translate the abstract theory into pragmatic guidelines. Following that, these grounded, but still general, observations, are placed in the context of the task of resolving the complexity of knowledge transfer. This then informs the next chapter, guiding the composition of the methodology.

Here we examine a number of perspectives on complexity from computer and mathematical sciences that have some bearing on knowledge transfer. Taken in turn, teleological systems are inherently purposeful, algorithmic information content is an abstract ideal, logical depth is concerned with the time taken to discover the inherent order, and crypticity is a measure of the relationship between the original data and its ‘regularities’.

One Page Description

There is a common perception from the business community that any idea, no matter how complicated, can be written down and explained using just one page. The truism then goes on to imply that should someone fail to do this, their ability to encapsulate with sufficient brevity and clarity is at fault. The trouble with this is the implicit presumption that no concept is so complex that the amount of information required to explain it will go beyond the words (and diagrams) legibly contained by a single piece of paper (even forgetting the ability of the reader to understand it).

“…If there is a body of knowledge that is both unfamiliar and non-trivial, not even the brightest, smartest person can immediately get the whole picture from just one sheet of paper. It takes more than one sheet to explain it, and it takes some effort on behalf of the receiver to think about it, internalize it, understand it, use it.” (Pp5 Sherwood)

In other words, the ‘one page description’ truism puts an upper bound on the complexity of any possible idea. This would seem not only naïve, but also indicative of an implicit denial of the existence of things of greater complexity than can be explained in one page. Indeed, as will be explained later, this has some resonance with the complexity limit imposed by the physiological makeup of the human mind.
Teleological Systems

The next perspective is slightly more scientific in that it distinguishes between purposeful and purposeless systems. The latter are described as thermodynamic systems, while the former are termed teleological.

*Teleological systems are systems with a purpose or goal. They are specifically designed to achieve this purpose in some operating environment, often competitive or even hostile. They are different from ordinary thermodynamical systems, such as gas molecules enclosed in a container, which are described by the laws of statistical thermodynamics. Such thermodynamical systems are not teleological in the sense that they are not designed or organized to achieve any purpose or goal. In this article, we will use the term thermodynamical systems to refer to those systems that are not purposeful or goal driven and are governed by the laws of statistical thermodynamics.*

Teleological systems are often complex systems.

As mentioned in Scope, it is contended that EKT can be assisted with better-designed systems – purposeful systems in other words. Teleological systems may be naturally evolved or a human creation, but nevertheless can be seen as an artificial ‘organism’. The system as a whole will attempt to achieve its purpose, and the impediments it experiences can come from a competing ‘organism’ (such as a business competitor) or its inherent environment.

The environment determines what functions or features, and their target levels of performance, are expected of the teleological system in order for it to ‘survive’ and continue to achieve its purpose. The environment imposes both qualitative and quantitative constraints on the design of teleological systems. Identifying ‘constraints’ (otherwise known as ‘regularities’) is a critical challenge in the design of a teleological system for the purpose of EKT.

Algorithmic Information Content

Within information and computer science, *algorithmic information content* (AIC) is used as a formal indicator of complexity. By definition, the AIC is the size of the smallest computer program that will generate (and halt once finished) the string of data that is under examination. While the AIC is an objective (conceptually at least) proxy for what is otherwise qualitative and intuitive, nevertheless it has limitations.
The problem is that a random string, with no pattern to it, requires a program just as long as the string. Yet, this is unsatisfying because there is nothing of interest, no message, in completely random data. It is not ‘complex’ in the sense of containing complicated information. To get closer to the intuitive meaning, one theorist has proposed first extracting the meaningful information (leaving behind the random ‘noise’), and then evaluating the complexity of that.

**Effective Complexity**

*Effective complexity* is the idea of splitting the AIC into two parts: one describing the random information (which is as large as the length of the random part), and one the non-random part. This latter part, being non-random, must therefore contain patterns that enable it to be reproduced by a ‘program’ smaller than itself.

While the idea of effective complexity is a better approximation to what is meant by ‘complexity’ in common usage, the question remains of how to calculate it in practice. The problem is identifying accurately which bits of data are random and which are part of the ‘regularities’. Sometimes this is made easy by the nature of the system itself (akin to non-teleological) as Murray Gell-Mann and Seth Lloyd (2003) explain;

> One of the best ways to exhibit regularities is the method used in statistical mechanics, say, for a classical sample of a pure gas. The detailed description of the positions and momenta of all the molecules is obviously too much information to gather, store, retrieve, or interpret. Instead, certain regularities are picked out. The entity considered the real sample of gas is embedded conceptually in a set of comparable samples, where the others are all imagined rather than real. The members of the set are assigned probabilities, so that we have an ensemble. The entity itself must be a typical member of the ensemble (in other words, not one with abnormally low probability). The set and its probability distribution will then reflect the regularities.

*(p389)*

Thus in a non-teleological system the underlying regularities are actually probability distributions that interact in a predictable way with each other. So even though the action of individual particles of gas is effectively random, taken as an ensemble, they behave according to rigid rules.

If the regularities of the string are collected together into an ‘ensemble’, effective complexity (given the symbol $Y$) can be defined as the AIC of that. However, in creating $Y$ the theoretical basis of the universal computer is compromised because the
Entrepreneurial Knowledge Transfer

program cannot always be guaranteed to halt (for reasons not entirely clear). To avoid this problem, the maximum running time is limited to $T$, and the universal computer has to be renamed as $U'$ to signify it has been modified from its original definition.

Restricting Execution Time

The introduction of a running time provides the possibility of varying $T$, and allows the exploration of situations where the apparent complexity (the AIC of the original string) is large but the effective complexity ($Y$) is small (assuming $T \rightarrow \infty$). Gell-Mann (2003) uses the calculation of the energy levels of heavy nuclei to illustrate;

*Fifty years ago, it seemed that any detailed explanation of the pattern involved would be extremely long and complicated. Today, however, we believe that an accurate calculation of the positions of all the levels is possible, in principle, using a simple theory: QCD, the quantum field theory of quarks and gluons, combined with QED, the quantum field theory of photons and electromagnetic interactions, including those of quarks. Thus, for $T$ very large or infinite, the modified AIC of the levels is small - they are simple. But the computation time required is too long to permit the calculations to be performed using existing hardware and software. Thus, for moderate values of $T$ the levels appear complex.* (p395)

Given sufficient time, the energy levels can be worked out using known equations, but with only moderate processor time, the equations do not converge. Thus, the behaviour
of the energy levels of heavy nuclei anyway can appear complex, but only when insufficient time is allowed to calculate them. So the rules governing the behaviour of subatomic particles are relatively simple, but because there are so many interactions, it takes a lot of processor time to get the answer. Reduce the time somewhat and suddenly the answers you get don’t match behaviour, and so the behaviour is suddenly unexpected, and appears complex therefore.

**Stepped AIC**

It is also possible for the AIC to decline in steps or plateaus with the increase of T. This implies there exists more than one pattern behind the manifestation of regularities, and some are hidden more deeply. In requiring more effort/time to be discovered, they lead to the plateaus shown below.

**Logical Depth**

Given a situation as shown by Fig. 37, the time taken for the modified AIC (because $T$ is being controlled) to reduce in number is related another concept known as *logical*
Entrepreneurial Knowledge Transfer

*depth*. Formally, logical depth is the time (or number of steps) necessary for a program to cause \( U \) to print out the *coded* description of an entity (and then halt) averaged over programs such that the shortest are emphasised. In the heavy nuclei case, the coded descriptions are the QCD and QED theories.

The benefit of logical depth is it avoids the necessity of finding ‘regularities’ without first knowing the pattern that describes them. Instead it defines itself via a process that ‘evolves’ towards the shortest program, and is actually an indirect method of identifying regularities. Since we know that pattern-following regularities allow for shorter programs, a program would have to have ‘stumbled across’ more regularities in the data string for it to be shorter than its brethren.

![Logical depth](image)

**Figure 38: Logical depth**

**Crypticity**

A quantity that is similar to effective complexity, but the inverse of logical depth, is crypticity. Formally, crypticity is the time necessary to go from a description of an entity to a short program that yields that description. In the previous terms, this is the time \( T \) required to find the minimum AIC of the regularities. A string with high crypticity requires a long time to find the minimum AIC, meaning the pattern behind the regularities is obscure and difficult to decipher. This has connotation with the stepped AIC in that the lower steps have higher crypticity.

Gell-Mann explains crypticity in terms of pseudo randomness and pseudo complexity,

*As an example of a situation where crypticity is important, consider a discussion of pseudo randomness. These days, when random numbers are called for in a calculation, one often uses instead a random-looking sequence of numbers produced by a deterministic process. Such a pseudorandom sequence typically has a great deal of*
Appendix C: Perspectives on Complexity

Crypticity. A lengthy investigation of the sequence could reveal its deterministic nature and, if it is generated by a short program, could correctly assign to it a very low AIC. Given only a modest time, however, we could fail to identify the sequence as one generated by a simple deterministic process and mistake it for a truly random sequence with a high value of AIC. (Gell-Mann p. 395)

In other words, a pseudorandom string is like someone deliberately confusing the message they are conveying, not by lying but by insert a lot of extraneous information. Given enough $T$, you could figure it out - and perhaps discover it was very simple message, and therefore low AIC. This is of course the intent behind simple encryption schemes that insert random data between the real information.

**Pseudocomplex**

Crypticity can also be applied where a bit string with a modest AIC appears to exhibit large AIC in the form of effective complexity, rather than random information. These strings are called pseudocomplex, and examples include a Mandelbrot set or the apparently-complex pattern generated by a cellular automaton. This can be interpreted as allowing a marginally complex message to allow parts of it to interact together and (before you figure out what the message is) deliver what appears to be very high complexity. This approach is used in more advanced encryption schemes or indeed in the human genome where apparently-silent genes are actually employed during the expression of other ‘encoding’ genes.

Both pseudo-complexity and pseudo-randomness can be expressed graphically, but this fails to capture the exponentially-increasing difficulty of solving the former in comparison to the latter, where a moderate level of inherent complexity plays havoc with attempts to resolve it.

![Figure 39: Crypticity](image)
Entrepreneurial Knowledge Transfer

Equipped with this theory, there will now be an attempt to fit what is known about EKT into the concept of crypticity, and in so doing, craft a strategy for its ‘decryption’. In other words, there will be a presumption that EKT is governed by a particular program that has an AIC, which can to be found through identifying data that constitutes the effective complexity (Y) rather than behaviour that is not inherently EKT.

Applying Complexity Theory

Applying the theory of crypticity for the purpose of research encounters a number of dilemmas. According to the previous discussion, identifying regularities is a critical first step in the resolution of complexity. However, if the data is not in the form of a binary string, or even numeric, the question arises of how this might be done. Assuming regularities are found, the next challenge is discovering the shortest program that would produce them. Finally, the lack of a universal machine, whether modified or original (even assuming the data was binary) prevents testing the veracity of the program anyway. Addressing these issues in applying complexity theory is the subject of the remainder of this chapter.

Selecting Data Sources

In resolving the AIC, it is important to consider the characteristics of the data available in the real world. Converse to the previous assumptions, data generally does not arrive as a bit string. Rather, the data has be won from its source, but before doing so, the researcher must consider what will be most useful.

Information Content

To expand upon the choice of data, it was mentioned that it should be rich and easily absorbed. The following quote from Sterman clarifies this.

Forrester (1980) identified three types of data needed to develop the structure and decision rules in models: numerical, written and mental. Numerical data are the familiar time series and cross-sectional records in various databases. Written data includes records such as operating procedures, organisational charts, media reports, emails and any other archival material. Mental data span all the information in people’s mental models, including their impressions, stories they tell, their understanding of the system and how decisions are actually made (as opposed to what is written in procedures manuals), how exceptions are handled etc. Mental data cannot
Appendix C: Perspectives on Complexity

be accessed directly but must be elicited through interviews, observations and other methods.

The numerical data contain only a tiny fraction of the information in the written database, which in turn is miniscule compared to the information available only in people’s mental models. Most of what we know about the world is descriptive, impressionistic, and has never been recorded. Such information is crucial for understanding and modelling complex systems. (Sterman 2001)

Fit for Purpose

This question goes to the nature of the regularities likely to be found, and the size of the AIC that will produce them. If the AIC is large, it is likely to be preferable to obtain highly-detailed, extensive data. In fact, it may be contended that part of the reason economics is so flawed is the reliance on available statistics when the phenomenon is entirely based upon human decision making. On the other hand, if the AIC is small, detailed and extensive data may not be necessary.

Ease of Acquisition

Another factor to be considered is the difficulty acquiring data against how useful it is likely to be. Throughout history, there have been researchers renowned for hoarding massive quantities of data (perhaps acquired through perilous sea voyages), only to die, run out of money or have their warehouse burn down. The aim is to find the balance between the likely contribution of certain piece of data, and difficulty of acquiring it. By weighing these two factors, an optimum balance can hopefully be found.

Identifying Regularities

Without foreknowledge of what is producing regularities in a data string, identifying them can only be a process of trial and error. While sections of the data may seem to repeat, it cannot be taken at face value that deeper patterns do not exist. This may in fact be the problem behind the analysis of EKT to date - a willingness to accept superficial patterns rather than look deeper, as suggested by the concept of a stepped AIC.

If hidden patterns are to be found, it will occur through first proposing an algorithm to find them, and then seeing to what regularities in the data are exposed by it. In this way, a theoretical pattern that might have produced the regularities is trialled by seeing
how much (and what) data it accounts for. If the data is known to be mostly-relevant (non-random) then it is preferable that the algorithm accounts for more rather than less. As suggested by logical depth, a shorter algorithm (program) is preferable to a long one as a simple explanation is both easier to investigate, and easier to defend. Given the way of such things, it is also more likely to be true.

If not all parts of the data deemed ‘regularities’ are covered by the algorithm, then either the scope is adjusted to exclude that data, or the algorithm improved. The word ‘improvement’ may lead one to assume the process is linear, but this may not be the case. Just as with a Rubik’s cube, you get to where only one square is out of place, but nevertheless have to backtrack. By ‘starting again’, improvement is abandoning and a new approach is instead tried – changing the premise.

To learn we must use the limited and imperfect information available to us to understand the effects of our own decisions, so we can adjust our decisions to align to the state of the system with our goals (single loop learning) and so we can revise our mental models and redesign the system itself (double loop learning). Yet much of the information we receive is ambiguous. Ambiguity arises because changes in the state of the system resulting from our own decisions are confounded with simultaneous changes in a host of other variables. The number of variables might affect the system vastly overwhelms the data available to rule out alternative theories and competing interpretations.

This identification problem plagues both qualitative and quantitative approaches. In the qualitative realm, ambiguity arises from the ability of language to support multiple meanings. In the quantitative realm, engineers and econometricians have long struggled with the problem of uniquely identifying the structure and parameters of a system from its observed behaviour. Elegant and sophisticated theory exists to delimit the conditions in which one can identify a system from its behaviour alone. In practice, the data are too scarce and the plausible alternative specifications are too numerous for statistical methods to discriminate among competing theories. The same data often support wildly divergent models equally well, and conclusions based on such models are not robust. (Sterman Pp25)

**Numerical Methods**

The simplest statistical methods are correlations. A sliding correlation identifies matches in data with an expected pattern. Of course, this requires one to know what pattern to look for in the first place. A more useful tool is auto-correlation, where a data

198
string is correlated with itself. This indicates the existence of regular patterns in the data, since they match each other and generate a substantive correlation function. Regression is closely associated with correlation, where dependencies between variables in the data are discovered by trialling equations, either linear or non-linear.

More advanced methods are those with feedback, where the solution is iterated towards, and include Kalman filtering and machine learning. This is similar to regression in that the format of the equation is a single solution, but whereas regression is a simple correlation against multiple hard-wired forms of the equation, machine learning and Kalman filtering allow the coefficients to be shaped by the incoming data stream. Kalman filtering assumes the data can be duplicated with a state machine of specific structure, but allows the equation coefficients to reduce the error between the predicted and actual data.

Machine learning spans the divide between digital and analogue by employing ‘fuzzy logic’ where individual pieces of data are given a confidence measure to prevent ‘noise’ from distracting the algorithm from converging upon the solution. Machine learning can also trial a number of potential forms of solutions in order to see which gives the highest ‘confidence’ using ‘proximity scores’. The advantage of machine learning is that it is not forced to adopt a ‘hard’ solution as new data comes in; instead multiple alternative solutions remain viable, and one that had previously been low-probability may indeed suddenly become predominant if supported by the data.

**Conceptual Methods**

While machine learning is qualitative insofar as it uses fuzzy variables, it nevertheless employs numbers as the basis of those variables. Grounded theory discusses how the modeller identifies concepts in the data, and it is this process that is of consequence when one is attempting to interpret information that is not expressed numerically. Nevertheless, the optimization process is remains an uncertain one, where backward steps are to be expected, whether numerical or conceptual.

*But what is the "self" of self-control? What am I? In essence, the self is a construction of the brain; a real, but brain-dependent organisational network for monitoring body states, setting priorities and, within the brain itself, creating the separation between*

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113 Using algorithms such as Least Mean Squared
Entrepreneurial Knowledge Transfer

inner world and outer world. In its functionality, it is a bit like a utility on your computer, though one that has evolved to grow and develop.

Complex brains are good at that sort of thing - creating high-level neural patterns to make sense of the world. We lack a word to describe this function, but instances abound. A simpler example is our normal three-dimensional visual perception. Here, a network of neurons in the visual cortex compares the slightly offset two-dimensional inputs it gets from each eye. The comparison is used to create an image of a three-dimensional world. Thus we literally see - and not merely infer - real depth. (New Scientist, 2002 The Big Questions)

Comparison with Data

As mentioned, the above complexity theory relies upon a number of objects that are impossible to realise. Regardless, the concept of running the program through a universal computer and reproducing the original data is a very useful. It implies testing through comparison, and raises the possibility of the data not matching that arising from ‘running the program (algorithm)’, thereby necessitating improvement.

Explicit Assessment

The idea of ‘running the program’ immediately conjures images of pressing the execute button on an actual computer, with the ensuing results able to be compared against the data. If the data is clear, often numeric in nature, the match can be evaluated explicitly. This is where a mathematical or statistical tool, such as correlation, can prove very useful. If the product is not numeric, but still explicit, it may be amenable to other types of symbolic analyses. Instances of these are presented by Sterman in his validation tools (Appendix F), including sensitivity analysis and extreme behaviour tests. They may not involve numbers per se, but certainly one is conscious of boundaries of permitted behaviour.

Implicit Assessment

As opposed to the previous approach, implicitly validating against the data is a far less exact process. More complex examples are computer games such as ‘Sims’, where the player navigates a virtual world full of computer-controlled people intended to replicate modern consumer society. It is generally agreed that gamers prefer an experience that closely copies the real world, yet on what basis is this assessed? The answer is
implicitlly – based upon a number of cues picked up within the mind of the player, but which are difficult to define exactly.

Rather than replicating specific aspects such as numbers following a timeline or a definitive behaviour, the implicit approach attempts to follow themes implicit in the data – as the grounded theory approach discusses.

*Validating one’s theory against the data completes its grounding. One does this by laying out the theory in memos either diagrammatically or narratively. Then statements regarding the category relationships under varying contextual conditions are developed and finally validated against the data...Another of their functions are to point out where the holes are in your thinking. Categories that are not fully developed in terms of the paradigm features, or whose relationships are not logical or firmly established, will quickly become evident when you attempt to do a theoretical summarizing memo or make a logical diagram. (Sterman 2001 p. 133)*

In order to identify and match these themes, the mind must be employed. While software exists that enables conceptual links to be recorded, in the end the mind of the modeller must understand how these fit together for it to maintain coherence. Without recourse to exact definitions, confusion between constructs occurs easily.
Appendix D: Policy and Theory Critique

Over the last decade or more there has been something of a zeitgeist in policy circles regarding knowledge transfer (though not then known as such), and how it may be optimised. This was preceded by a range of theories which, to a greater or lesser extent, attempted to define the phenomenon. What follows is a critique of both, with theory first and then policy. It might be thought that one informed the other, but the evidence for this is not apparent.

Theory Critique

As mentioned in Scope, the descriptive approach to definition is not regarded as an optimum basis for a matter as complex knowledge transfer. Briefly presented are four theories regarded as descriptive, along with a discussion of their value as an underpinning for research.

Absorptive Capacity

Absorptive capacity is a firm’s ability to utilize externally held knowledge through three sequential processes:

- Recognising and understanding potentially valuable new technology outside the firm through exploratory learning.
- Assimilating valuable new knowledge through transformative learning
- Using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning (Scott-Kemmis 2006 p. 856)

Absorptive capacity implicitly divides knowledge transfer on the basis of stages of transfer, each having its own ‘learning’ constraints. In turn, these are labelled exploratory learning, transformative learning and exploitative learning. Taken together, these appear to present substantial similarity to the idea of commercial knowledge transfer from universities that is the target of this research. However, upon deeper inspection reveal a lack of transferability that would allow the definition to be applied beyond firms explicitly. What, for instance, might universities do to facilitate exploratory learning even should a firm demonstrate a high level of absorptive capacity?
Entrepreneurial Knowledge Transfer

**Firm Learning**

Similar to absorptive capacity, *firm learning* is based around the concept of incorporating new knowledge into an institution as a whole, otherwise known as learning. Rather as previously there being a single generic process with three stages, here Malebra (1992) proposes six processes, each made distinct by the type of learning that characterise it\(^{114}\).

- **Learning by Searching**: generation of new knowledge via formal activities such as R&D
- **Learning by Doing**: accumulation of knowledge through repetition
- **Learning by Using**: learning through utilisation of products
- **Learning from Advances in Science and Technology**: absorption of new developments
- **Learning from Inter-industry Spillovers**: learning from competitors
- **Learning by Interacting**: ‘horizontal’ or ‘vertical’ forms of interaction with other sources of knowledge (Malebra 1992)

Examining this definition, it is not immediately obvious how it translates into specific activities. For instance, the difference between learning through ‘new developments’ or learning from ‘competitors’ is by no means clear, and conceivably may occur simultaneously. In fact, it would it would seem far more likely for the knowledge offered by a competing firm to be more valuable when it was new rather than old, but in any case the distinction would seem irrelevant. For reasons such as these, a definition such as this adds little insight of use to the development of policy. In attempting to ‘cover all the bases’ it merely creates an ad hoc list of observed behaviours that do not reflect fundamental realities, and therefore cannot provide a basis for the design of systemic policy.

**Dynamic Capabilities**

By contrast, *dynamic capabilities* employs a slightly more sophisticated approach by describing two independent attributes. According to Teece, Pisano and Shuen (1997), a

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\(^{114}\) While it is not assumed that either absorptive capacity or firm learning describe the same set of activities, it is still instructive to attempt their correlation. This author holds that the former constitutes a more thorough method of categorisation, but is let down by abstract distinctions between forms of learning that make application difficult.
firm that is ‘dynamically capable’ is able to compete successfully in a free market through effective utilisation of its resources.

“The term ‘dynamic’ refers to the capacity to renew competences so as to achieve congruence with the changing business environment; certain innovative responses are required when time-to-market and timing are critical, the rate of technological change is rapid, and the nature of future competition and markets difficult to determine.

The term ‘capabilities’ emphasises the key role of strategic management in appropriately adapting, integrating, and reconfiguring internal and external organisational skills, resources and functional competences to match the requirements of a changing environment. (Teece, Pisano and Shuen 1997 p. 515)

In so far as two independent definitions are nominated, this approach is dualistic, yet overall there appears to be a failure to take advantage of the potential offered by combining a number of simpler components into a more complex whole. While acknowledging the intention of servicing a broad scope of types and behaviours, the verbose nature of the delineation is clumsy and unclear, and by attempting to cover all bases it covers none.

However, this attempt points towards the possibility of achieving both clarity and completeness, however in so doing the independence of the components from each other must first be established. Without independence, the underlying components can be combined in multiple ways, introducing ambiguity that can only be resolved by limiting the scope so these multiple interpretations are eliminated. A definition that utilises simple components offers hope that a phenomenon that seems to have already defeated numerous efforts to descriptively identify it will eventually prove amenable to categorisation.

**Knowledge Management**

Knowledge Management (‘KM’) comprises a range of practices used by organisations to identify, create, represent, and distribute knowledge for reuse, awareness and learning. There is a broad range of thought on KM with no unanimous definition and the approaches vary by author and school. For instance, KM may be viewed from each of the following perspectives:

*Techno-centric: A focus on technology, ideally those that enhance knowledge sharing/growth.*
Entrepreneurial Knowledge Transfer

Organisational: How does the organisation need to be designed to facilitate knowledge processes? Which organizations work best with what processes?

Ecological: Seeing the interaction of people, identity, knowledge and environmental factors as a complex adaptive system. (Wikipedia)

In general, KM programs attempt to manage the process of creation (or identification), accumulation and application of knowledge across an organisation. While these programs are closely related to Organisational Learning initiatives, KM distinguishes itself by a greater focus on specific knowledge assets and the development and cultivation of the channels through which knowledge flows. However, similar to absorptive learning, it suffers from employing categories and jargon that do not easily or usefully map onto reality.

Policy Critique

In 2003, Lambert delivered his powerful review of knowledge transfer systems in light of a decade of dedicated public funding in the British university sector. Three years later, in 2006, the Standing Committee Australian House of Representatives delivered its report into technological innovation. Finally, in March 2007, the Australian Productivity Commission produced its mammoth overview of public support for science and innovation. In conjunction with this last piece was the response by leading Australian universities – the Group of Eight. All of these pieces of work make substantial contributions, however in order that the reader can appreciate the author’s position, their weighty volume is now summarised.

UK Treasury (Lambert Review)

Lambert’s remit from the UK Treasury was to identify ways of improving university-business knowledge transfer. His approach was straightforward and he did not hold back on criticism or suggestion for change.

One of the key themes was the need for universities to internally restructure in order to that decision-making becomes more ‘professional’, while devolving power down to the department level in order to improve responsiveness. Specifically they recommended the inclusion of non-academics on university boards,

Many universities are developing strong executive structures to replace management by committee. With well-defined lines of responsibility, clearly delegated authority and
cohesive management teams of academics and administrators, this approach allows for dynamic management in an environment where decisions cannot wait for the next committee meeting. This need not be at the expense of collegiality. A culture of consensus is not only achievable, but is a priority for many vice-chancellors running executively-managed institutions. (Lambert p. 93)

As well, the establishment of clear ‘entry points’ into universities for business, perhaps taking advantage of a regional approach that enables skills to be pooled.

Universities are complicated institutions, and businesses can find it very difficult to find their way around. SMEs in particular can be put off if there is no obvious point of entry to the university’s resources. Businesses generally welcome clear first ports of call on the campus. According to the latest Higher Education Business Interaction Survey, 80 per cent of universities now provide dedicated enquiry services for SMEs. In addition, some regions are adopting a regional approach. Knowledge House in the North East and I10 in the East of England are both projects funded by HEIF that provide information through a single website on the research strengths, expertise and services offered by the regions’ universities. A regional approach seems appropriate for this kind of service, since a national database would run the risk of being overly cumbersome. (Lambert p. 42)

Lambert also found that the best interaction was face-to-face, and that universities can tend to set too-high a price for their intellectual property (IP). Finally, there was some criticism of criteria for the RAE (Research Assessment Exercise) that places too much emphasis on publication and other forms of academic achievement to the detriment of knowledge transfer.

**Standing Committee on Science and Innovation**

Overall, the standing committee report examines issues well, but fails to recommend specific policy changes. Its excerpts from submissions are well reported, but conflicting opinions, generally between a government department and recipient of government funds, are not adjudicated. Rather they are blended into a ‘yes, but’ statement that precludes the necessity of drastic policy change. Nevertheless there are some interesting findings.

One is in regard to a commercialisation grant system skewed to ‘radical’ innovation – affordable primarily to large business - while forgetting ‘incremental innovation.'
Entrepreneurial Knowledge Transfer

Concern has been expressed that a ramification of a possible policy focus on radical ‘high technology’ innovations is that other types of innovation, particularly incremental, non-R&D-based and process innovation occurring in the low-to-medium technology sector, are not adequately recognised by innovation policy makers. This is of particular concern given the predominance of medium and low technology businesses in Australia and the importance of incremental non-R&D-based forms of innovation to these businesses. (Lambert p. 34)

When the high cost of negotiating and applying for grants is factored in, the effect becomes dramatic;

The Committee acknowledges the cost to businesses associated with applying for government innovation support and strongly advocates simplification of application processes and streamlining of reporting requirements where possible. (Lambert p. 45)

The recent addition of field officers is however promising and the report make clear its support for increased funding for the program.

In addition, the Committee emphasises that a clear means of navigating through the range of innovation support is essential. Given the important role of the AusIndustry Small Business Field Officers and the NIC website in assisting businesses to find appropriate innovation support, the Committee suggests that all government agencies involved in supporting business innovation ensure that the assistance available through the AusIndustry hotline number and the AusIndustry/NIC web-based resources is publicised and made readily accessible. (Lambert p. 56)

Unfortunately however, the tendency is to blunt strong criticism with acceptance of departmental excuses. Here, reduction in bureaucracy is made less emphatic by inclusion of accountability requirements, but sadly no greater insight is offered, such as how standards might be maintained through careful design of oversight;

The Committee recognises that any streamlining also needs to balance accountability requirements faced by government departments and agencies with regard to the appropriation and acquittal of public monies. (Lambert p. 394)

Also encouragingly, the report was prepared to raise the question of overall strategy, here in regard to a fundamental assumption underlying policy directly affecting rates of innovation.

Some have questioned whether Australian Government innovation policy has achieved an appropriate balance. Specifically, it has been suggested that the Australian
Appendix D: Policy and Theory Critique

Government’s innovation policy has been developed on the basis of a simplistic linear understanding of innovation founded on the assumption that basic research is the origin of the majority of innovation. (Lambert p. 25)

Overall, the committee has produced a solid piece of work that covers the majority of issues comprehensively while occasionally daring to push the boundaries and offer guarded criticism. Of course, it would have been nice to see a challenging opinion offered more often, but political considerations cannot be expected to disappear.

Productivity Commission

By contrast, at first glance the productivity commission report appears to deliver strong findings into science and innovation. On closer inspection however, it does so using doubtful yet involved reasoning strongly founded in academic jargon. In the extreme case, mathematical justifications are employed, but do not lead to meaningfully relevant conclusions. In other words, the equations are not strictly tied to real-world phenomenon, and results are expressed with obscure variables that are not linked back to actual phenomenon.

For instance, the idea that public funding ‘crowds out’ private sector investment is proposed then justified with a number of econometric analyses (some of which find the opposite or no result). However the problem is always one of understanding the factors at work, which may be lost in the mathematical process. Nevertheless, the report still makes the finding that public sector investment is a good thing overall – but based upon case study rather than econometric analysis

However, there is abundant case study evidence that public funding support for environmental R&D is associated with positive environmental impacts and, in many cases, associated economic gains. (Productivity Commission p. 166)

When it came to assessing impact of academic research, the potential indicators were as follows

Input measures, such as funding amounts, numbers of full time equivalent researchers or field coverage; research outputs, such as publication numbers and citations (measured by bibliometrics); and (thirdly) more qualitative measures of outcomes (such as gathered through surveys or from case studies. (Productivity Commission p. 172)

Two of which are numeric indicators, easily found within available data. Later, however, qualitative work is given short shrift;
Another alternative approach focuses on the subjective extent of linkages between researchers and government to measure the utilisation of social science research. For example, Landry et al. (1998) surveyed 1229 Canadian social science researchers about their perceptions of the utilisation of their own work. The survey divided utilisation into a six stage process, (described in table 4.15) with the respondent indicating the frequency that their research achieves at each stage. Despite the novelty of this technique, there are some serious methodological problems with its realisation in this case. It is based on self-assessment, with the obvious biases this could entail. The survey response rate was 42 per cent, raising a large risk of non-response bias. This problem is compounded by the progressively larger proportion of researchers who decline to provide a response for the most important types of research utilisation. The stages do not appear to be sufficiently distinct and the profile of responses across ratings looks (implausibly) very similar for stages 3 to 6. Finally, it is difficult to believe that around 15 per cent of respondents do research that usually or always gives rise to applications and extension by the practitioners and professionals concerned. (Productivity Commission p. 177)

Nevertheless, allowance is made for a subject whose inherent nature lends it to the qualitative;

*It is also important to recognise that the outputs of universities relevant to the innovation system are not isolated to published papers in recognised journals, but may take the form of informal advice, working papers, government and business contracts, and well-educated undergraduates. However, an important question is whether the generally measured indicators of academic excellence — the quality of research publications — is a complement or a substitute for these rather more elusive knowledge diffusion mechanisms. (Productivity Commission p. 12)*

Thus the problem remains that change certainly seems possible, not least because better outcomes are achieved in isolated circumstances, but the question remains how this may be addressed. While the qualitative work is commonsensical, it lacks the definitiveness of a quantitative approach. This provides the theme that continues through the rest of the document. Saying this however, the report still feels able to make findings such as;

*There are risks associated with the continuing diversion of public funding to applied science and innovation activity at the expense of basic and strategic science and innovation. (Productivity Commission p. 15)*
Appendix D: Policy and Theory Critique

A conclusion loosely supported by ‘case study’ data, and but seems to fly in the face of earlier dismissal of such methodologies. It would be understandable if a lack of data made statistical analysis difficult, but this is not mentioned as reason for not supplying such evidence.

In a further example of unsubstantiated claim, later in the chapter it goes on to make the point that National Research Priorities should not be removed for the purpose of maintaining “balance in science systems”. However, in order to avoid an unwarranted increase in compliance costs, neither should they be made more specific. Nevertheless, if not for these costs, there would apparently be advantages to such a move, since;

...the Government would be able to more precisely specify the outcomes sought from the spending of public funds based on its judgment of where community benefits are most likely to occur. Moreover, more tightly specified NRPs would result in more focused guidance to agencies as to what their expected outcomes should be, which, in turn, could make performance evaluation more meaningful. (Productivity Commission p. 369)

In other words, the PC is acknowledging that the government prefers known outcomes in research, itself something of a contradiction in terms. However, to extend this logic to asserting that NRPs are of overall benefit to science and innovation is not supported by evidence of any kind (and may in fact be contended to achieve the opposite¹¹⁵).

Similar to the process behind the findings in relation to the NRP, the commission makes similar recommendations that block funding remain as it is, and not be further diminished as has been the pattern over the term of the Howard government. This conclusion is partly-based upon the presumption of value of NPR’s,

In the Commission’s view, the rationales expressed by then Minister Kemp are sound. Block and competitive funding each have a number of advantages. For example, block funding allows institutions to specialise and develop strategic capability, can have lower transactions costs in project funding allocation, allows easier identification of outstanding and developing talent, makes it easier for resources to be pooled across projects and institutions and makes funding readjustment and reallocation more flexible. Competitive funding, on the other hand, can contribute more readily to the

¹¹⁵ The argument for which is presented in Appendix A: University Funding Based upon Outcomes, submission to enquiry into NCRIS, circa 2005.
Entrepreneurial Knowledge Transfer

*achievement of national priorities, and can place greater emphasis on excellence and impact.* *(Productivity Commission p. 280)*

If the contention concerning the unreliability of the evidence underlying the recommendation regarding NRP’s is believed, then the conclusion regarding block funding is merely compounding the original error of logic.

Aside from these selected findings, which are general in nature, much of the report regards essentially minor changes to the system, such as to the tax concession rate. Overall, this 900 page document consistently supports the status quo, while utilising an inconsistent methodology that gives higher weight to quantitative evidence when available, even if inconclusive. Due to this, in the opinion of this author, the findings of the PC are not regarded as reliable, and are therefore not considered further.

**Response to Productivity Commission (Group of Eight)**

To provide another perspective in light of the previous assessment, it is instructive to examine the reply to the draft PC report by the body representing the eight most senior universities in Australia. It was delivered to the commission approximately three months before the final version of their report was released.

In general, the tone of the response is appreciative (or perhaps relieved) by confirmation of the inherent value of R&D from public funding. However, this only remains at the general level, and quickly deteriorates when addressing detail. Specifically, there is concern over the justification of not strongly recommending an increase in overall funding for universities – known to be suffering widespread funding shortfalls. The disquiet arises from the perception that ill-formed logic introduced late in the piece is allowed to exert undue influence on the immediate finding.

*The Go8 accepts the Commission’s arguments about the need for caution in applying international R&D benchmarks and the role of national R&D targets (p. 8.1).*

*However, we would encourage the Commission to set out more clearly the decision-making framework that has underpinned the Report’s conclusion that current public investment levels are appropriate.* *(Go8 p. 3)*

This tactic can be observed elsewhere, and at the very least has the effect of seeding doubt that the conclusion was as independent as it professes to be. Given the sensitivity

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116 Note that the author did not read the Go8 response until after the critique of the Productivity Commission report was written, and any agreement is purely coincidental.
Appendix D: Policy and Theory Critique

and criticality of the issue to the Go8, it is perhaps incredible that the criticism was not acted upon in the final version.

A further complaint is concerned with a perceived lack of appreciation for the importance of access to leading international research by academics located in Australia.

*The Go8 welcomes the Report’s finding that the core role of universities remains the provision of teaching and the generation of basic research* (p. xxvi). *However the issues of Australia’s relative capacity to exploit global research advances and the role of international science linkages in providing access to these advances, do not appear in the Rationales section of the Report* (p. 3.1), *or in the list of Bottom Line reasons for public support of our science and innovation systems* (p. 3.36). *The Go8 would encourage the Commission to acknowledge these roles.* (Go8 p. 6)

There is mention of ‘efficient diffusion practices’ as improving the impact of basic research, but this is far from explicit. It may have been added, but given its likelihood of only meaning commercial diffusion, one would suspect not.

Next the Go8 criticise the conclusion of the commission that there is no skills shortage, made largely on the basis of replacement through immigration. Of course this neglects that, all things being equal, a native will always be a more valuable and desirable employee than a recent arrival with little English and no cultural familiarity. Furthermore, the commission makes no allowance for poor skills, and simply classifies a mechanical engineer as a mechanical engineer. As with immigration, this ignores issues of quality (and therefore utility for the employer); which is why the Go8 ask why the question was not addressed of giving universities greater autonomy in offering courses to meet industry demand for skilled labour.

Coincidentally perhaps, autonomy is also a factor in the offering of individual agreements to staff. Nevertheless, not withstanding the “apparent” (word used by the PC) drop in academic wages, it is claimed to be compensated by increases in flexibility (and in any case, academics love their job more than money);

*Remuneration levels are important, particularly those expected over a working lifecycle. Nevertheless, it appears that for science professionals, non-monetary rewards such as autonomy of research, utilisation of skills, peer group esteem and the*

117 This seems to be in contrast with the position taken by the industry bodies.
Entrepreneurial Knowledge Transfer

ability to add to existing knowledge are significant influences on overall levels of job satisfaction. Survey work undertaken by the Australian Council of Deans of Science (ACDS) found that science professionals rated employment that provided interesting work and valued and used their skills more highly than employment that provided job security and income (Go8 p. 265)

In response to such double standards - and even deception - the Go8 rightly conclude;

If the solution to any skills shortages Australia may face in the future relies on market agility, then it follows that Australia’s universities should be allowed to operate in a way that permits them to be more responsive to market signals. (Go8 p. 3)

Before returning to the question of block funding in light of increased draw on block funds accommodating projects launched under the expansion of competitive grants.

The erosion of university block grants and the resulting consequences are an impediment to the efficient operation of the dual funding model and therefore to the innovation system more broadly. We therefore encourage the Commission to acknowledge this impediment in the final report. (Go8 p. 2)

Unfortunately, the answer – such as it is - seems to be delivered via one of the key funding recommendations;

There is no clear objective evidence pointing to systemic deficiencies in the quality of research currently funded through the formula-based block grants. (Go8 p. 2)

This does not address the original point that overall research quality is dropping due to a general depletion of capacity; funded from block grants.

Nevertheless, on the subject of business tax concession for R&D, the commission was quite emphatic that competitive grants would be unlikely to overcome their inherent costs, and thus constitute a viable replacement for the tax concession (which the PC recommends broadening and extending).

At a more general level, other options to raise inducement levels include moving to a greater reliance on competitive grants as they may provide a more effective means of targeting socially valuable activity that firms may be reluctant to undertake. However, as discussed below, inappropriate design features can compromise project selection and heavy information requirements make these approaches costly to administer. (Go8 p. 4)
Appendix D: Policy and Theory Critique

Based upon this, one wonders if the commission would recognise any similarity between the situation business and universities find themselves in. Both want greater autonomy rather than be subjected to the micromanagement of competitive grants, and the data certainly bears out the productivity dividends of such autonomy when applied to business.

*The Bureau of Industry Economics (1993) found that the earlier 150 per cent tax concession provided a net social benefit of $56 million per annum even though up to 90 per cent of the supported R&D would have occurred anyway. ... A more recent cost-benefit analysis found the net social benefit from the 125 per cent tax concession was around $52 million per annum despite the scheme raising R&D by 10 per cent at most.* (Go8 p. 388)

Which means that a tax concession is a good investment, even if the marginal increase in research is only 10%? However, with a lack of numerical data for many ‘spillovers’, it is impossible to be definitive, nevertheless the Commission expend considerable space supporting them. This is yet more evidence of their inconsistent approach linking conclusions and evidence, seemingly depending upon personal preference.

Moving now to the Go8’s concluding statements;

*The Report would be significantly strengthened therefore, if the final version could include:*
* a concise explanation of the decision-making framework that underpinned its conclusion that current levels of public support for science and innovation in Australia are adequate;*
* a list of the economic and non-economic performance metrics the Commission considers are valid indicators of the health of the nation’s science and*
* a summary of the gaps in the evidence-base that would need to be filled before an optimal decision-making framework could be developed.* (Go8 p. 401)

This appears to resonate with this author’s observation of poor reasoning, reliance on doubtful modelling and an inconsistent methodology. While one cannot help but suspect this is partly explained by the nature of the subject matter, nevertheless it reveals the poor standard expected of formal policy.
Appendix E: Theoretical Confidence

A reading of the results from data may lead one to wonder exactly how rigorous the theory is, and whether the conclusions drawn from it are believable. Remedying these doubts requires theory to be objectively tested, and hopefully positively validated. What follows is a discussion of actions taken in this regard, including those that failed in the attempt.

Conceptual Validation

Both reference techniques employed within this research have test procedures for grounded theory and system dynamics that they recommend for validating theory. While the former are substantially incorporated into the methodology, those for system dynamics have not been. Rather than process-oriented, as for grounded theory, system dynamics tests are more focused upon objective analysis \(^{118}\) of results once they arise.

Even though the results are in a highly-conceptual form, it is possible to test for and assess veracity using tools that system dynamics has designed for the purpose. These may be applied at the conceptual level without numerical data, the application of which is presented in Appendix B.

Generally, they were found to be helpful when illuminating flaws in logic, although these were relatively rare. This was most likely due to the thoroughness of the treatment up until that point, and in fact there was often significant similarity between aspects of the methodology and the tests suggested by Sterman. Of course, this is no indication of perfection; rather it merely gives a degree of confidence in the final results. When married to reliable data, a robust methodology at least raises the possibility that results might be valid. Nevertheless, with uncertainty regarding actual mathematical relationships, aspects of the more advanced tests proved infeasible

Boundary Adequacy

\(^{118}\) Grounded theory makes similar reference to this, but in a much vaguer fashion
Entrepreneurial Knowledge Transfer

Boundary adequacy distinguishes between what is, and what is not, relevant to the model. This was in fact achieved earlier in the research when the distinction was drawn between endogenous and exogenous factors.

*Boundary adequacy tests assess the appropriateness of the model boundary for the purpose at hand... Interviews with key participants and outside experts, review of the relevant literature and archival materials and direct experience with the system may suggest some processes that perhaps should be made endogenous.* (Sterman p. 861)

The decision to create policy levers was a form of boundary establishment, where in order to make the model functional, previously endogenous linkages were given exogenous status.

**Structure Assessment**

Testing of structure asks;

*...whether the model is consistent with knowledge of the real system relevant to the purpose. Structure assessment focuses on the level of aggregation, the conformance of the model to basic realities such as conservation laws, and the realism of the decision rules for agents.*

In a very holistic sense, the test attempts to identify flaws in the model’s structure. A very similar standard was applied during the final stage of the methodology as new data is compared constantly with the proforma model. Generally, the test is designed to uncover straightforward violations of simple laws, such as those involved conservation of energy or mass, or a variable that cannot go negative. However, the complexity of the model makes it difficult to identify all flaws, regardless of simplicity. As explained elsewhere, the mind simply cannot concentrate on the entire model at once, and the only alternative is to work on pieces separately. Yet when it comes time to join them, mistakes are bound to occur. Fortunately computer simulation of the model, which necessitates a coherent whole, allows many of the remaining structural flaws to be identified.

**Robustness**

If it is a good semblance of reality, the model will behave predictably across a large range of modes of behaviour. Robustness tests this by deliberately entering extreme values and observing the ensuing response, and is described thus;
Appendix E: Theoretical Confidence

Robustness means decision rules must generate outcomes that are physically possible and operationally meaningful even when the inputs to those decisions take on extreme values.

Thus, to pass the test of robustness, the model must behave consistently with expectations. In the context of this research, this means complying with anecdotal data as well as basic common sense.

To be useful, the decision rules in models must behave plausibly in all circumstances, not only those for which there are historical records.

Thus, if a hole is left by data not illuminating a facet of the system, the best judgement of the modeller is employed to deduce what the behaviour is likely to be, and the procedure continues on that basis.

**Extreme Condition**

Extreme condition tests combine robustness with structure assessment. It is accomplished by feeding extreme values into the inputs and observing detailed behaviour. Rather than looking for general problems with output values, this test is applied by examining every equation and decision rule while being actively simulated. Each is tested individually, and then together, with the intention of uncovering hidden flaws that otherwise did not lead to obvious failure. The test can be carried out both before and after the equations are included, the former occurring through examination and mental simulation.

**Surprise Behaviour**

This test attempts to overcome unrecognised bias in the modeller by explicitly striving to identify conditions deemed highly unlikely. As Sterman states;

*Often, discrepancies between model output and your understanding of the system’s dynamics indicate defects in the formal model. Occasionally, however, it is your mental model and your understanding of the data that require revision.*

The surprise behaviour test is passed when previously-unrecognised behaviour is discovered, and when compared to the data, is found to indeed occur in reality. That it was not originally noticed is due to the inherent deficiency of cognition, but this test is designed to compensate for it.
Entrepreneurial Knowledge Transfer

Remarkably, it was found that the literature comparison generated surprise behaviour. Correlating an opinion or finding from a completely different perspective forced assumptions to be questioned and modified on many occasions. Overall, the process was found to be very beneficial, and may indeed reduce the need for this test. Considering the complexity of the model, and huge range of possibilities, which make it awkward to appreciate when one is experiencing a new behaviour, this will prove fortuitous if true.

**Sensitivity Analysis**

The final test is much more subtle than those preceding it as it involves the extent of response rather than just its correctness.

*Sensitivity analysis asks whether your conclusions change in ways important to your purpose when assumptions are varied over the plausible range of uncertainty.*

Thus it forces the modeller to understand the model well enough appreciate whether behaviour is of concern or not. While in some models, a variable might prove irrelevant or weak-acting, in this context the tightness of interconnection suggests that none can be safely ignored.

Nevertheless, sensitivity analysis has three types: numerical, behaviour mode and policy. Numerical analysis matters when the model is precise, and is therefore of no use here. However, the other two are more relevant;

*Behaviour mode sensitivity it concerned with a change in assumptions changes the pattern of behaviour generated by the model. For instance, if changing an assumptions forced behaviour change from smooth adjustment to oscillation or from s-shaped growth to overshoot and collapse.*

*Sensitivity to policy involves when a change in assumptions reverses the impacts or desirability of a proposed policy. If cutting prices boosted market share and profitability under one set of assumptions but led to ruinous price wars and bankruptcy under another, the model would exhibit price sensitivity.*

This has great relevance to the process of refining the equations, where slight changes may lead to different behaviours. Due to the interdependent structure of the model, this is highly likely, making sensitivity analysis an important consideration.
Mathematical Validation

It was hoped that the strategy just presented might be testable via software simulation. Sadly, this proved a fruitless task, but in the process of failing, a number of observations were made. Unfortunately, while a variety of dynamic behaviours were observed, no tangible correlation between it and equations were found. Nevertheless, these behaviours are themselves interesting, and perhaps to a certain extent, even enlightening. These are now included with the intention of providing insight into the difficulty of understanding and managing complex systems such as that under examination.

Simulation Procedure

The purpose of computer simulation is to apply a more rigorous standard of investigation of theory. Simulation forces the modeller to specify every facet of the model, and then allows him to simulate it over extended periods of time. Given the complexity of the model, and the qualitative, conceptual nature of the data; simulation is potentially a valuable tool. However, utilising it properly is a significant and involved process that requires expertise in the tools, as well as a degree of luck in that model behaviour is revealed as simple.

The first step is building the model within software, placing and connecting graphical objects and delivering an overall image similar to that shown here. Next, mathematical equations that define and describe interaction between the constructs are entered. Up until this point, the only equations mentioned have been generic input functions (from Results), but to be of use in a simulation, specificity is required. However, without detailed data, the relationships may only be guessed. The hope is that, through a process of evolution, even an incorrect guess can eventually lead to the right answer.

Of course, the form taken by the equations must reflect the modellers’ perception of probable behaviour as predicted by the data. In other words, there is no point inventing random equation formats in pursuit of predicted simulation behaviour. Nevertheless, there remains a degree of guesswork within any format chosen, and the temptation to add moderating variables to achieve better results must be resisted. Effectively, any

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119 Built using Powersim under a free 60 day trial license - www.powersim.com
such intervention attempts to impose accuracy beyond the uncertainty inherent in the data.

While simulation is useful to test fundamental operation, for more subtle understanding of sensitivity, a technique called optimisation is employed. Optimisation is designed to overcome the problem a number of variables interact in unpredictable ways, preventing the modeller from knowing what variables should be set where to achieve desired outcomes. Optimisation effectively is a process of automated searching for the best combination of ‘input’ variables, and once the complexity reaches a certain point, is a task best left to computers.

Optimisation enables the modeller to nominate one or more outcomes they would like to achieve within the model (such as variables reaching a certain level) along with their relative importance (weight) to each other. After specifying the input variables to be changed in achieving these outcomes, the software then uses a combination of trial and error and algorithm-based decision-making to find the set of values taken by the inputs to achieve the best possible (optimum) set of outcomes. Or, in the words of the writers of the software, the optimisation algorithm works like so:\footnote{120}{The evolutionary search method is a method inspired by Darwin's evolutionary theory about the survival of the fittest. On the basis of objectives/results that you have defined, Powersim Solver automatically generates values for decisions that are specified using the ‘IN’ operator.}

\begin{quote}
A user-specified number of decision sets (offspring) are used in each generation. For every offspring in each generation, Powersim Solver measures the deviation between the simulated result and the objective variable, and rates the offspring as to how close it comes to the goal. Powersim Solver then discards the poorest results, and selects the best results as parents. The parents are used to form offspring for the next generation. We will now have the same number of offspring, but better ones, and we start simulating the next generation.

An advanced evolutionary search algorithm is repeated until Powersim Solver finds the optimal solution, reaches a user-specified limit of generations or until the result is below the specified minimum convergence rate.\footnote{121}{Help documentation, Powersim Studio 7 Express, Service Release 4.}
\end{quote}
Thus, the software employed a technique similar to machine learning where good performance is remembered, and influences subsequent trials. It is apparently a very strong method “when the dependencies between the objective variables and the input variables are intricate” (Powersim documentation). Nevertheless, the exact details of the algorithm are not disclosed, and so cannot be examined in detail.

As the equations are adjusted, simulations are performed, and the results observed. Refinements are made as necessary, and once the model appears to behave reasonably, an optimisation may be done. Nevertheless, the model should not be optimised until the modeller is aware of what is being optimised, meaning simulations should first reveal gross behaviour. Overall, it was hoped that over many cycles of simulation and optimisation, the equation would evolve in parallel with insight into the dynamic behaviour of the model. In turn, this might allow the modeller to form a connection between extrapolated behaviour (such as that discussed earlier in the chapter) and mathematical relationships between constructs. Most optimistically, this would allow firm evidence to be found supporting the strategies mentioned earlier, or if not that then correlations between classes of equation and modes of behaviour. Unfortunately this was not achieved.

**Optimisation Procedure**

There were two variations on the equation for accumulating each stock employed during simulation, initially linear [1], [2] and then later multiplicative [3];

\[ \Delta X = [x_5 O \ast (x_1 A + x_2 C + x_3 E + x_4 S) - X/10] \]

where 0<\(x_n\)<1

The linear relationship is the most straightforward, but has the drawback of implicitly assuming that Coordination is equivalent to the other constructs, and can be added alongside them. A multiplicative relationship attempts to remedy this by conceiving of Coordination as the overall arbiter of the effect of the other four constructs upon the one under examination. This is sensible at a conceptual level as it reflects that without the inclusion of a coordinating force, any action can not be relevant to the network as an emergent entity.

After [4] became the preferred relationship, it was realised that all four stocks, if left alone, would deteriorate in time; people are not infinitely patient, memory infallible nor skills eternally sharp and up to date. Furthermore, employees change jobs (or die), students graduate and projects come to their natural conclusion. Thus, aside from the
rate dictated by endogenous influences, each accumulating construct is given a degradation rate of one tenth of the stock per year\textsuperscript{122}.

To accommodate the reality that Coordination is a variable rather than an accumulating stock, it must be given a separate equation in order that performance was uniform in spite of changes to scale;

\[ O = (A + E) - x \times (C + S) \text{ where } 0 < x < 1 \]

It was found that a coefficient (\(x\)) was required if Coordination was to be kept from becoming zero or even negative. While a catastrophic outcome need not be implied, nevertheless it would conceivably indicate that the network was fragmenting. Nevertheless, it was eventually disregarded as it did not foster sufficiently compelling results to compensate for its artificiality.

A number of approaches were attempted in order to replicate the ability of the manager to change policy settings as the system develops, but unfortunately none proved satisfactory. It is thought that the primary reason for this failure is complexity, but to substantiate this contention, clarification is required. Input variables were the four policy levers; \(s_5, c_5, e_5, a_5\), varied between 0 and 1 to simulate management of the network. Constructs being optimised changed depended upon which of the three time periods was under examination. The optimisation was run over periods of 3, 10 and 20 years to reflect early, interim and mature development stages.

The simplest approach was to run three independent optimisations from identical starting conditions, perhaps with a uniform target (activity was thought most representative) or with changing targets (as contended). However, this disregarded the distinct possibility that setting optimised over the life of the simulation may not capture the explicit need for them to adapt to each stage. In order to overcome this problem, the optimisation was broken into three contiguous elements by carrying over values for the stocks to the next stage. Unfortunately this was also a failure since after the first (successful) optimisation, those subsequent were unable to converge to any solution.

\textsuperscript{122} Another change attempted was to duplicate free will by following the logic that actors may sometimes choose to not act in ways that harm the network, but will always undertake actions that assist it when the opportunity arises to do so. Thus, negative linkages (apart from diminishing returns which is a physical reality) were given half strength on the basis that half of the people would make the ‘right’ decision and choose to not fight, or not abuse their power for instance. Unfortunately however this did not lead to superior results and eventually were discarded for the sake of simplicity.
Appendix E: Theoretical Confidence

As mentioned, the intention of simulation was to trial various relationship format in the hope of finding at least one that delivered sensible performance. Given the high order of the mathematical expression derived from a system with four interacting accumulations, deriving the relationships from first principles was not an option. Furthermore, it was accepted that small variations in the model, such as in the starting values or ‘artificial’ coefficients, would be likely to create large deviations in behaviour. Nevertheless the hope was that if the equations only-vaguely duplicated causality suggested by the data, then the model as a whole would behave similarly. Obviously, a huge range of possible relationships could conceivably be justified, in turn meaning they should not be ignored, but when the model was found to behave so unpredictably, it was deemed wiser to focus attention on [3] as the chosen format. Regardless, even this constraint still allowed a great deal of experimentation - generally prompted by optimisation results that seemed to lack sense.

If the optimisation failed to converge, the most common reason was the value of stocks growing to infinite size (or at least beyond the floating point limit of the software), which given that the desired outcome was typically to maximise at least one construct, was difficult to prevent. Infinite growth behaviour was observed throughout the simulation, and occurred with no discernable pattern, but with a slight change to the model would disappear again. Watching variables change during simulations showed that values could remain sensible for considerable time, often more than half the total interval, and then suddenly shoot upwards to infinity. This behaviour is consistent with a highly complex system with unstable states that can be entered into seemingly without cause. Unfortunately without deeper knowledge of the model, and given the limitations of the optimisation algorithm, it was not possible to distinguish and avoid such states. They are obviously unrealistic, but without understanding what prompted their occurrence, they remained a confounding issue.

Patterns of Behaviour

It is perhaps ironic that complexity, the characteristic that prompted the research in the first place, itself emerged to defeat final efforts to fully-interpret results arising from studying it. Yet, at the same time it corroborates the very same contention; that interactions governing collaborative interaction are inherently complex. Upon consideration, the resistance of the model to identification should have been expected, and might actually be seen as evidence that the results are in fact representative.
Regardless of how valuable it was, repeated failure to stabilise the behaviour of the model was a frustrating (not to mention time consuming) experience.

In general, few patterns of behaviour were discerned outright, but there were some that could be inferred. In particular, these were due to the structure of the model, and the tension between particular and overall performance. For instance, it was observed that Capacity most often took on the largest value at the conclusion of the simulation, which is logical since it has the fewest negative linkages. However, given capacity is detrimental to Coordination; a large capacity will potentially push it negative, and diminish all stocks therefore. In general, if capacity did not grow, nothing grew, while if capacity did grow, the results were most likely to be realistic.

Nevertheless, the structure of the model proved powerful in that Engagement was always difficult to make the largest. When set as the desired outcome, it would often fail to converge during optimisation, and even when a solution was produced, engagement rarely had the greatest value. On the other hand, in situations where engagement was regularly reaching high levels, the risk of infinite growth increased dramatically. Considering the positive effect of engagement on Coordination, and its multiplying effect on the model, this is not surprising.

Regarding Coordination, a great deal of experimentation was attempted with the coefficient X. This was not least because its tendency to remain close to zero was found to upset the optimisation process, likely as miniscule deviations around 0 gave wildly different behaviours. Generally, it was found that any value of X below 1 would dramatically increase the risk of infinite growth with equation [2]. Due to this, and also to avoid artificial additions, X was eventually set to 1. This may partly explain

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123 Curiously, the optimisation would not infrequently deliver a simulation that reached its collective peak early, but then degraded gradually with coordination at zero (making all linkages irrelevant therefore). This behaviour is obviously not sensible or desirable, yet suggests that the algorithm could be making interim comparisons rather than only considering values upon conclusion of the simulation interval.

124 Over time, realistic came to mean around 100-500 times the starting value of one simply because less than 100 never seemed to occur, or if it did it was less than 2. Given that in three years one would presume at least a 10 fold increase in capacity when allowed to find an optimum, a doubling was not deemed satisfactory.

125 This posed a problem for the early development stage since Engagement was deemed the priority outcome. Sometimes replacing engagement with Network Activity allowed convergence to occur, but often it too gave the optimisation problems.

126 It was partly for this reason that the half-weight for negative linkages was proposed, especially in early attempts using [4] where Coordination became irrelevant against the other constructs.
why satisfactory results were never arrived at, but at the same time, it also raised an
intriguing conceptual possibility. That is, if in reality Coordination actually does
oscillate around zero, then this might explain why good leadership is such a rare thing
since it requires constant readjustment in light of competing tensions. Sadly, there is no
way for this software to duplicate such delicate decision-making capacity.

In general, patterns such as these indicate how finely-balanced the model was. Even
considering the vagueness of the equations when presumed simple (as per [1] and [2]),
highly-subtle behaviour was evident. Conversely, on those occasions where the
optimisation converged quickly, the results were found to be extremely robust across
considerable change, in that the exact same settings were repeatedly found in spite of
alterations to the model. Given that the structure of the model suggests such
immovability should be impossible, this may be the exception that proves the rule. If
stable operation only arises when the equations somehow act to subdue the natural
dynamism of the model, then stability is perhaps not a representative behaviour.

Future Improvements

While this attempt to simulate a human network ended with only a vague awareness of
underlying behaviour, and certainly nothing as definite as a likely class of equation,
the prospect of further simulation may well prove fruitful. However, for that to occur, it is thought that
a number of difficulties must be overcome.

Data Quality

Firstly, the quality of data must be improved so that definite causalities can be
identified and tested. Whilever data remains conceptual and qualitative, it is impossible
to know with sufficient sensitivity which behaviours are realistic and which are not. As

\[127\] Given the paucity of data regarding knowledge transfer, one potential strategy is to change the
question being asked. Rather than limiting the focus to collaborative innovation with unique knowledge -
a relatively recent and difficult to measure phenomenon - broaden the scope to an entire economy across
a range of political systems throughout history. This would allow data over centuries to be used, with
correlations drawn between specific decisions taken and the ensuing outcomes in the economy, with
many incredible situations arising of poor and great leadership. Furthermore, the increased aggregation
(relative to small-scale innovation networks) would allow better representation of constructs that are
inherently- ambiguous. While this requires expansion the remit of the model beyond the authority of the
data that informed it, the potential rewards are great. If the model seems to hold up against historical
economic data, then equations are likely to be found. These can then be returned to a knowledge transfer
context and tested against relevant data. At the very worst, the exercise will prove a waste of time, but it
may also provide the means of circumventing a potentially fatal lack of data relevant to the original
context of the research.
Entrepreneurial Knowledge Transfer

suggested by the robustness test, the model must be tested across a range of known behaviours, but with the data available only gross behaviour at the level of structure assessment is possible. Given the instability of the model demonstrated across a range of equation types, this is doubly important in this case.

With better data, it may also be possible to gain some certainty regarding the format of, if not all, at least some of the equations. This will remove a great deal of uncertainty and provide a more secure basis upon which to succeed in the evolutionary process attempted earlier. Without being forced by ignorance to maintain consistency in format between constructs, a new swathe of previously-unseen modes of operation might arise, and perhaps one will prove faithful to reality.

**Optimisation Algorithm**

Apart from the data, there is also a problem with the optimisation algorithm. In order to capture the changeability of decision-making, there needs to be provision to find an optimum pattern of coefficients. This might depend upon exogenous factors, or perhaps the inclusion of randomness that provides a unique challenge for ‘management’. Perhaps the coefficients will be found to follow a predictable pattern to achieve optimum performance given any possible (within reason) permutation of the other four stocks. Conceivably, this might lead to the creation a tool to assist leaders with real-time decision-making given the level of each of stock. Further, it might also help policy makers to design exact systems for given situations after taking into account a potentially-huge range of exogenous factors.

Even given the limitations of work thus far, an effort will now be made to turn the results and conjectures into recommendations. Apart from giving the research relevance, these will hopefully also serve to shed light on the suggested strategies that simulation proved itself incapable. In so doing, other exogenous factors will be included, perhaps going some way to assisting in the design of systems for the explicit purpose of fostering knowledge transfer.

**Departures from Linearity**

Conceptually there are two areas in which non-linear relationships proffer a better reflection of reality. The first is in regard to the self-feedback loops where a construct influences its own rate of change. Presently one is negative (Activity) and the rest positive, but there is a case to be made for S-shaped equations. For instance, in the case
of Activity, diminishing returns actually predicts a positive effect when resource utilisation is low. Regarding Spectrum, a low level of diversity should actually be detrimental since it tends to encourage alienation of minorities. With Engagement, low levels will tend to cast a pall over interaction with the network. Finally, poor levels of Capacity replicate the spread of ignorance when enlightenment is rare.

As far as Coordination is concerned, it seems that a natural exponential would best reflect the fact that the construct should never become negative since to do so is effectively an inversion of the premise. In other words, a network can lack control, but never be controlled to the detriment of the premise entirely. This would merely change the premise to the opposite of its original, and since the members joined voluntarily on the previous basis, they would refuse to participate given a reversal.
Appendix F: Network Growth

Policy will be grouped into the four linkages originating from Coordination; otherwise known as policy levers. Within each a number of general observations are first made, followed by considerations particular to each of the three stages of development. While it is noted that no quantitative confirmation was obtained of the associated strategies, the stages are nevertheless indisputably evident in the data, and are therefore a valid lens through which to investigate decision-making.

Even so, the strategies represent the best efforts of this research to grapple with the subject matter, and therefore the best hope of giving rise to useful recommendations. Furthermore, and as has been mentioned, the process of crafting recommendations may itself prove illuminating. In effect, it will constitute the final opportunity to test theory which is, perhaps appropriately, most akin to a sensitivity test - the most powerful and revealing of those found within system dynamics.

As such, the recommendations are made through the prism of Coordination, and the management strategies involved with it. Putting aside explicit character considerations, the discussion will focus upon various options that can be taken in the execution of each of the fours tasks involved in coordinating a network. Thought will be given to early, interim and mature stages of network development, as well as the background - university, business or government for instance – of those holding the reins of power.

Before this, however, will be a discussion of anecdotal observations, both from the perspective of the author and the data. Since this chapter is extending rationale beyond the limits supported by the data, it is deemed to reasonable to make personal perspective explicit rather than ignore what can become a factor in the absence of objective methodology.

Foster Coherency

Coherent direction by leadership provides direction that allows members of the network to work together constructively; requiring communication of a message that is clear to all members of the network, regardless of the particularities of circumstance. This
ensures that everyone understands the same ‘ground rules’, and do not become confused by multiple interpretations. In turn, this allows all members to act in a way that others find predictable, which at an emotional level is comforting, but in a pragmatic sense means collaboration occurs more easily.

**Foster Coherency: Anecdotal Observations**

Observing knowledge transfer across Australia, it appears networks are burdened with policy that is not as coherent as it might be. In other words, policies governing participation do not mean the same thing to all people in all situations. For instance, those from outside a university are not necessarily governed by the same rules as those from within, even though in the context of knowledge transfer they are both members. Professors seeking to commercialise hear their superiors and the government voice support for knowledge transfer, but when it comes to gaining promotions or winning grants, they find themselves at a disadvantage. University staff employed to seek licensing deals find unreasonable delays in gaining final approvals, or even worse, approval is revoked at the last minute. Finally, when the government expresses enthusiasm for innovation but makes no extra funding available to the university for it to be carried out, it is not purely lack of money that prompts caution over enthusiasm. In each example, it is apparent that members are receiving an incoherent message from those with power over the network. While there may be perfectly understandable reasons for each decision, in the context of the knowledge transfer network, the result is confusion and uncertainty, which leads to disengagement.

**Foster Coherency: Early Phase**

The strategy recommended for the initial stage of network creation was to emphasise activity and engagement in preference to Capacity and Spectrum. Since *foster coherency* builds engagement then it should be actively pursued. In the early stages, this might be achieved by putting effort into designing, and then committing to, a policy framework that all members can understand and hopefully relate to. Whether government bureaucrat or member of the university executive, the following applies equally.

While it can be presumed that those it concerns have an interest in knowledge transfer, and policies concerning it, it does not mean their approval will be automatic. Rather, it is incumbent upon decision makers to examine the situation as thoroughly as possible in
order that a many permutations and contingencies are covered. Furthermore, the policy should be expressed in a format that is easily absorbed and rather than randomly ‘grafting’ rules and regulations into pre-existing policy documents, it should be rewritten from scratch on the basis of unambiguous intentions from the leadership.

In addition to reducing the risk of ‘policy holes’ (where certain situations fall outside the guidelines) or ‘policy conflict’ (where two or more different instructions appear equally valid), an ordered approach to policy creation is likely to be much easier to understand. The initial requirement for disciplined thought on the issue naturally leads to policy that is logical and well-structured, where intent flows naturally into detail. If detail is lacking, then the intent can allow the member to make a reasonable guess, and since the policy is derived from a central premise, conflicts are far less likely.

Thus, before new staff are hired or money invested, effort should be invested in ensuring the message sent by public statements, policy documents and any other form of communication correlate with each other. Just as an expression popular with the Australian army\textsuperscript{128} counsels planning ahead of action, so those charged with launching a new knowledge transfer network should also apply caution in advance of the execution of their responsibilities.

**Foster Coherency: Interim Phase**

Impersonal interaction mediums that were of critical importance in guiding early forays have begun to be displaced by more personal involvement direction from the leadership. With the impact of one-to-one conversation much greater than that of written or broadcast policy, leaders find the nature of their influence based more on actual relationships. Thus, even though Coordination may not itself be larger than before, increases to engagement change the nature of communication.

In fact, the general character of the network has been changing as some of its members prepare to meet the market for the first time. In the midst of excited anticipation, the leadership must endeavour to send a message of quiet confidence tinged with caution. As is often the case with youth on the verge of adulthood, natural exuberance must be tempered with a dose of reality. Translated into the model, this would imply a weakening of foster coherency through the introduction of trepidation and doubt. By

\textsuperscript{128} Prior preparation prevents future f**k-ups.
reducing enthusiasm through fear of the unknown, a degree of coherency, and therefore engagement is lost.

Reducing engagement serves to benefit Spectrum, but disadvantages all others. Given the strategic aim at this stage is equality between constructs, and considering that Spectrum and Capacity were initially hampered, but that Capacity tends towards strength regardless, then Spectrum is most likely in need of bolstering.

**Foster Coherency: Mature Phase**

A mature network is marked by established servicing of markets, and is focussed upon cementing and improving this position. After initial forays guided by impersonal policy documents, and then naïve enthusiasm kept in check by a sober authority figure, this time is characterised by professionalism and dedication. In such an environment, communication between the leadership and members is almost as between equals – meaning that power is now more distributed. Nevertheless, there is still strategy to pursue, and influence to be exerted to that end.

At this time, strategy dictates that Capacity and Spectrum become the priority, meaning that foster coherency is weakened further still. In the context of the network consisting of a number of projects operating largely-independently, this is not difficult to imagine. While the members remain united by their participation in knowledge transfer, they have less need to adhere to the concept of a unified network. Even junior members have allegiance to their particular projects, which themselves are beginning to form individual networks. Thus, the natural progression of the network creates the independence and dispersal of power that tends to reduce coherency. Nevertheless, this is valuable as it allows ever greater diversity, providing the specialised personnel that are needed to maintain competitive advantage.

**Broaden Membership**

Broaden membership is the process of identifying and then inducting members that increase Spectrum. This is as opposed to recruiting members that do not increase diversity; or in the extreme case no one at all. Increasing Spectrum is a process that often requires strong leadership as it can be resisted by the existing members (reject difference) but is nevertheless valuable due to the strength it brings to the network. Yet
diversity can introduce its own set of problems that management need to remain cognizant of, notwithstanding that at each stage of development considerations change.

Finding the right people, with the right attributes, is critical and requires a deft touch. Yet, at the same time avoiding the temptation to select on the basis of who the leadership is personally most comfortable with is also important. This is motivated by self interest rather than the interests of the network as a whole (and is an instance of abuse position).

**Broaden Membership: Anecdotal Observations**

From this author’s personal experience of universities, it would seem there is a temptation to ‘buy in’ staff and resources rather than developing in-house talent. As an example, over a decade ago the ANU paid over one million dollars for a one-quarter share in an industrial park located in Sydney, over two hours drive away. While undoubtedly introducing significant diversity to the network in terms of expertise and infrastructure, the fact was it remained an alien entity in terms of organisational culture (as well as distance) which impedes cooperation to this day\(^\text{129}\). An identical phenomenon revealed itself when a foreign executive was brought in to run the commercial arm of the university. Without knowledge of, and credibility within, the university proper, great difficulty will be experienced generating momentum from a standing start. Without pre-existing commitment and enthusiasm for knowledge transfer, inevitable clashes of expectations and culture with the wider network can easily prove fatal.

**Broaden Membership: Early Phase**

The preferred strategy is the de-emphasis of broaden membership in the early stages. The idea here is to reduce potential for conflict by introducing unfamiliar elements into the network. The best way to accomplish this is to incorporate people already familiar with, and accepted by, the rest of the network. This means those with current or previous exposure to the environment, and with contacts within it.

\(^{129}\) In recent conversation with a senior member of the executive, it was suggested that a strategy of engagement with the local region be pursued instead of one involving distant organisations in Sydney and Melbourne. This was rejected out of hand, seemingly on the basis of local business being too ‘pedestrian’ for an institution as illustrious as the ANU.
Entrepreneurial Knowledge Transfer

The price paid for this strategy is lack of access to exotic talent or resources, but this will be remedied later. In any case, without a track record attracting such staff is likely to prove an expensive, and perhaps eventually even futile, task. In pragmatic terms for a university, this would mean incorporating academics and staff known to be active in the knowledge transfer realm. Given they are likely to already be successful, favourable terms may need to be arranged to secure their ‘coming on board’.

Broaden Membership: Interim Phase

At this point, the aim is to equalise all stocks by holding Engagement and Activity at current levels while increasing Spectrum and Capacity. On the ground, this would mean maintenance of successful programs, but replacement of those that appear shaky. Spectrum is increased by seeking out participants from new constituencies, but without moving too fast so as to ensure engagement is not diminished. The local business community and students might constitute appropriate sources.

Regarding the latter, incorporating students into the knowledge transfer network necessarily requires a rethinking of discipline-based education. Successful implementation will involve careful negotiation with those accustomed the current approach to deliver a policy that achieves the aims of both education and knowledge transfer. This invokes early foster coherency strategy in that the policy should be in place in order for it to be enacted at the interim stage.

Broaden Membership: Mature Phase

As advanced stage of development, the aim is to grow the entire system, but with emphasis remaining on Capacity and Spectrum. On the other hand, Activity and Engagement are kept deliberately low. The principle here is expansion of the network through attracting top-quality candidates, whose unique talent represent substantial increases in Spectrum. Furthermore, addressing the market requires consumers to be brought into the network also. Whose, as the data suggested, preferences must be accommodated for products to sell, but can also serve to limit innovation and are thus only moderate contributors to Spectrum.

Regarding staff, their specialised contributions add dramatically to Capacity through contribute expertise. Attracting such people is neither easy nor cheap, and requires dedicated marketing efforts (buy loyalty) as well as a system known to be high-quality (establish reputation) to advertise in the first place. The alternative is to recruit
Appendix F: Network Growth

resources similar to those already available, which has the advantage of avoiding problems associated with Spectrum and also being less effort since pre-existing social networks will perform the recruiting themselves.

Allocate Roles

Once personnel have been recruited, they must be given roles to play. The network must endeavour to give people the roles that best suit their individual attributes so that the network can take optimum advantage of its membership. For, even should a member possess incredible skill in a certain area, if not recognised as such it is not available to the network. Allocating roles requires Coordination, and as might be expected, is carried out by those delegated to do so.

Generally, without an ability to accurately assess members’ strengths and weaknesses, the ability to allocate roles is weakened. In turn, this diminishes the rate that Capacity grows, which has knock-on effects for the entire network. Lack of familiarity with the impositions placed by the role has the same effect. Knowing the person intimately becomes irrelevant if there is a poor comprehension of the role they are given. If these are combined, and the administration fails to accurately assess both people and roles, it is reasonable to suspect the effect will be worse than either alone.

Allocate Roles: Anecdotal Observations

One trend observed at the ANU was for the university executive to intervene in selecting senior personnel; not only paid staff, but even board members of ‘independent’ spin-off companies. It was remarked to the author that those chosen tended to share the same mindset as the executive, meaning they were academically rather than business minded, which commonly led to poor business decisions being taken.

On the other hand, the data suggested that those recruited into senior positions from the corporate sector can also disappoint easily. Of course, a career business executive

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130 This is logical since why would a middle aged executive (usually a man) settle for upset and loss of status of a university post and its comparatively poor wages. Unless forced to leave involuntarily, it seems incredible that they would, especially considering the high level of conservatism in this cohort. The contention they are pushed rather than jump is certainly borne out by the data, where dissatisfaction towards their corporate recruits was regularly expressed. This was typically a combination of a ‘stuffy’ personality that rubbed the entrepreneurial types, and intolerance to risk, meaning only the safest projects were approved. The latter seems to be shared by university executives, but more on that later.
Entrepreneurial Knowledge Transfer

faces an entirely different environment and set of challenges to the entrepreneur, just as academic research is different again. However, the innovative aspect of knowledge transfer suggests that entrepreneurs\textsuperscript{131} will be more suitable than both the others for managing the process. While unique knowledge is present, managers do not require intimate familiarity to successfully utilise. And even though collaboration is the natural environ of business, the tendency of knowledge transfer towards dynamism somewhat invalidates those accustomed to following rules and procedure. Nevertheless, ex-corporates have value – they are accomplished professionals with long experience and extensive contacts (though often with a very limited scope). This begs the question, not why they are recruited in the first place, but why they are given the roles they so often seem to be. The model suggests that abuse position might be to blame, and indeed the temptation to surround oneself with like minds is strong, but external obligation might also be a factor.

Examples from the data suggest that executives accustomed to a privileged position wish to maintain that status, meaning they seek senior positions before being fully aware of (or uncaring towards) the concomitant responsibilities. In general, the private sector perceive universities as ‘cushy’\textsuperscript{132} which manifests as a superiority complex that induces excessive self belief in ones capabilities. This then creates further tension when the job is found to be very difficult indeed, in fact beyond them, and subsequently therefore seeks to escape blame for the mess they have created. Added to this is the simplistic perception university administrators often have of the private sphere.

University executives are by and large from academia, and as such regard the free market with awe and trepidation. Similarly, they have little familiarity with knowledge transfer, and the nature of roles required within it.

From the authors’ observations, this ignorance is a symptom of a lack of direct experience outside of university research. This means that both established business

\textsuperscript{131} The most successful knowledge transfer managers tended to have direct entrepreneurial experience, and possessed very energetic, adventurous, open-minded personalities. Often, the opposite was true for ex-corporate types, although adequacy and competence were more the norm than its complete lack. Nevertheless, poor performers could still do great harm to the collective performance of the team. Usually, it was a case of interpersonal ‘brush fires’ caused by offending members and colleagues with a combination of an arrogant, combative persona and lack of appreciation of (tolerable) risk.

\textsuperscript{132} Perhaps providing an incentive, implying that retrenchment is not the only factor in the decision to leave, and that the promise of an easy life is tempting for stressed executives. A further reason suggested by the data for joining a university was to make a meaningful contribution to society, something they felt had been previously lacking.
cultures and the innovation process are inherently foreign to those responsible for assigning roles. This is a problem from both the perspective of understanding corporate and entrepreneurial recruits, and also of the requirements of the positions they need to fill. Thus, the situation raised in the introduction arises whereupon those in authority are ignorant of both their personnel and the roles they are to fill.

This places the network in an extremely vulnerable position because the rate at which Capacity accumulates may change arbitrarily in line with fortuitous alignment (or visa versa) of role and member. Low Capacity manifests as poor job satisfaction that eats away at morale via gain recognition, and allows the ensuing poor level of constructive activity to do the same via collaborative interaction. As mentioned, this can be remedied through projects with provide exposure to the leadership, but unfortunately this avenue is difficult to access in the early stages. Therefore, until such time as relevant experience is accumulated, those responsible for assigning roles should exhibit caution in proportion to the limitations of their actual knowledge.

Allocate Roles: Early Phase

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133 A number of other factors may also come to bear when positions to be given to the wrong people. Firstly, the similarity of mindset between corporate and university executives may make the former appear ‘safer’ choices in accordance with their inherent conservatism. In addition, this is teamed with a desire to bask (perhaps presented as glory for the network as a whole; Mao’s Revolution or Hitler’s Fatherland for example) in what they perceive as the grandeur of large, wealthy and powerful corporations, but it is nothing more than self-interest (Note: as it supports the premise it is not regarded as an external obligation). Somewhat ironically, such eagerness to embrace personnel previously rejected from a company is more likely to engender ridicule than respect.

134 It will be recalled that Capacity is defined by actual achievement defined by the premise rather than formal appointment. This raises the question of how the model captures abuse of position by an incompetent who does not contribute to Capacity. Tentatively, this might be explained as an external obligation since the job has not been filled appropriately, is not reflective of the premise, and is therefore an external obligation. This might seem a case of splitting hairs, but nevertheless does reflect situations such as where a dictator ignores the constitution in cementing his power. In such a case, he is moving away from the premise (constitution) and therefore losing the position that would normally be ordained by it. He is becoming aberrant, which increases diversity, and invokes external obligations. Also, the ensuing maintenance of power through fear and violence could be seen as akin to an extreme case of interpersonal conflict. Nevertheless, one wonders why such treatment can also increase Engagement, such as the case with early Christians who became more fervent even when being killed en masse. Perhaps the injured parties effectively remove the dictator from the network, or form a fresh one, and their suffering is recast as a valid activity that in-turn increases Engagement.

135 Such as; involvement in projects selling to the market in the case of innovation, or corporations engaged in contract research. Alternatively, Lambert recommends hiring executives with business experience directly. This appears to contradict the strategy of keeping Diversity low early on, but it was always intended to concern practitioners rather than the administration. In fact, given the low starting level of all constructs, then the assumption of an executive filled with academics is implicit. However, it is still possible to accommodate Lambert’s recommendation by applying it at the interim or mature stage. Given that UK universities generally have more developed systems than their counterparts in Australia, this is a reasonable exception to make.
As before, the goal upon initial creation of the network is to maximise Engagement and Activity while suppressing Capacity and Spectrum. Thus, in the early stages, allocate roles should be given a lower priority, meaning members should not be given roles with excessive responsibility. Through not seeking to fill high-level positions, power effectively remains centralised in the executive. This is a strategy often employed in workplaces where a senior position is left vacant for an extended period of time, perhaps to avoid complications arising from a clash with another position with overlapping responsibilities. As already mentioned, the other advantage of keeping roles minor is that an executive without the experience necessary to allocate the right people for senior positions avoids this choice entirely.

Alternatively, a strategy suggested (but not confirmed successful) by the data was choosing a small number of ‘star’ researchers for public awarding of prestige and wealth. While not suggested by the data, this strategy may risk alienating colleagues, potentially via abuse position, but this particular practitioner took the opposite view in that it would infect colleagues with enthusiasm (confirm assumptions). Nonetheless the position of the interviewee was that any grumbling is met with an invitation to seek similar rewards by attempting commercialisation. As such, it is effectively a marketing strategy that utilises gain recognition (increase Spectrum). In addition, at the end of the previous chapter it was suggested that transfer experience has a secondary affect whereby recruiting occurs through the attraction of members similar to those already present. Regardless, while the strategy of elevating selected individuals is worth considering for kick-starting a network, it is not sufficiently supported by the data to warrant recommendation.

Allocate Roles: Interim Phase

Once the interim stage is reached, attention is turned to increasing Capacity at a faster rate. This means that senior positions begin to be allocated. A leadership who have learnt from the previous stage should be well-equipped for this task. Also, the roles need to be well crafted, especially for staff working as facilitators. It is pointless hiring

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136 In the authors’ experience, prestigious awards tend to provoke a sense of resentment rather than the desire to follow in the footsteps of the recipient. This may simply be an individual perspective, but it is not helped by the perception that the recipients of these awards tend to become very ‘snobbish’ very quickly. Given knowledge transfer includes collaboration, which is not well served by arrogance; there may be a case for declaring certain types of awards outside the scope of the network. These would be awards that grant the recipient manifestly higher status, as opposed to a symbolic prize that allow the winner to remain ‘one of the crowd’.
an excellent communicator with experience of commercialisation if the person has no authority\textsuperscript{137}.

The price of failing to incorporate roles with substantial autonomy is an increase in bureaucracy as the level of activity rises. While the leadership of the institution must take final responsibility for what occurs, at the same time people need to given limited power to make decisions on the ground. Otherwise, all agreements are subject to approval, no matter how straightforward. This can place people in the difficult position of experiencing delays that are outside their control, which in turn can mean that an opportunity is missed.

Seen from the perspective of the model, preventing members from contributing their resources (for that is what happens when deals falls through) then disallows their gaining recognition, while also missing a chance to undertake a project. Both these have a negative effect on Engagement, and while not being the priority, nevertheless needs to remain at a safe level to maintain stability.

\textit{Allocate Roles: Mature Phase}

In the mature stage, Capacity must continue to grow in order to supply resources to activities addressing the market. This is where roles such as CEO or MD are filled, and certainly it is important to choose the right people in order that high-profile projects remain viable.

At the same time, low level roles should not be forgotten as they can collectively make a substantial contribution to Capacity. Junior roles remain important for maintaining grassroots strength that provides a flow of personnel into the future. Other low-level activities, such as networking events and personal visitation, serve to capture information regarding the network.

\textsuperscript{137}Conceptually, this is a question of redistributing power and making the ‘bell curve’ of authority less pointed. The problem is the overall increase in Capacity leads to greater potential for abuse (abuse position), which accords with the scenario whereby nearly-equal stakeholders will compete to secure an advantage. It remains an open question whether this reduces temptation to abuse power. The model takes Capacity as an aggregate rather than distribution function, and an overall levelling is likely to create a higher total than a narrow peak flanked by junior positions. On the other extreme, it is often said that a benevolent dictator is the most efficient way to govern, while one who is non-benevolent is actually betraying the premise and therefore no longer abiding by this model.
Structure Activities

Networks structure activities in order to make best use of available resources. The function is performed by those charged with approving suggestions for new activities\textsuperscript{138}, which implies they are dependent upon the suggestions being received in the first instance. As such, while optimum efficiency is always sought, it is limited by options available at the time. In making this decision, resource availability and idea quality are considered first individually, and then in relation to each other.

A high level of structure activities indicates that the best can be made of the situation since the leadership has access to good information and solid support of the members. Conversely, a low level means that poor use will be made of available resources and activity suggestions due to interference by vested interests and the obligations originating from outside the network. Management policy allows structure activities to be varied up to the upper bound imposed by Coordination.

*Structure Activities: Anecdotal Observations*

One area where problems have been observed to arise is over-work of staff leading to diminution of performance (diminishing returns), and is most evident in the data where technology transfer practitioners, as well as academics, have excessive demands on their time. To avoid over-commitment, and ensuing project failure, it is preferable that consideration be given to the burden imposed by activities. The workload of facilitators should be monitored, and additional burdens not imposed unless they can be accommodated. If this is not the case, staffing levels should be expanded. Also, a trainee program would relieve some of the workload while avoiding the expense and complications of importing senior officers from elsewhere.

The leadership of the network must also decide what activities its members are to undertake. While it has been established that a degree of autonomy for the participants is important, nevertheless the institution should still impose guidelines on how that autonomy will be exercised. For instance, there may be a preference for spin-offs over licensing (or visa versa), or for waiting for ‘cure-for-cancer’ research to commercialise

\textsuperscript{138} It is important to make the distinction between ‘real’ and ‘false’ activities. Real activities make a contribution to the premise, meaning they occur within the scope of EKT. There are no ‘low quality’ activities and all are assumed to have an identical impact on the network. Examples of activities betraying the premise are collaborations engaged in purely to win grants or to satisfy institutional requirements.
over smaller, less impressive, opportunities. Every option has its’ associated advantages and risks, which then play out through the rest of the model.

**Structure Activities: Early Phase**

In the early stage of development of a network the goal is to accelerate Activity and Engagement, but leave Capacity and Spectrum behind. This obviously creates a conundrum whereby there are insufficient resources to fuel more than a couple of large projects, in turn increasing the risk of catastrophic damage to the network should one fail. The alternative to large projects is smaller, less glamorous, endeavours. Just as investors diversify their portfolio, so it is better to run a number of smaller projects since the network is not as vulnerable to chance failure.

Apart from projects centred on a specific technology or idea, activities also include those designed to foster opportunities for interaction between parties with an interest in collaboration. These facilitate interaction between the university and business, which is an important outcome at the early stage when Engagement is a priority. This is not to forget interaction with the government, often a significant financial contributor, but one whose participation is typically limited to reading grant applications and receiving status reports.

**Structure Activities: Interim Phase**

The interim stage should be characterised as ‘weeding out’ the less successful projects. In this way Activity falls behind the growth of Capacity and Spectrum, but it consists of higher quality endeavour. At the same time, new projects should still be encouraged to arise, but these will only consume a small proportion of resources, leaving the bulk for a small number designated to be worth the risk.

**Structure Activities: Mature Phase**

Given that a mature network is characterised by direct participation in the market, it is again critical to seek quality over quantity. While experimentation and involvement are focal earlier on, with maturity comes professional expectations. Student projects can afford to fail in large numbers because they do not consume irreplaceable resources, and their failure has little impact beyond the immediate team. While it is important to continue such programs, high profile, market-competing projects are nonetheless of greater concern. They interact with a large number of people, including customers, meaning Engagement is affected. Furthermore, they constitute the most challenging to
Entrepreneurial Knowledge Transfer

undertake since they must remain competitive, often on the world stage, and therefore consume the greatest proportion of Capacity.

In addition, market-addressing projects also *improve* Capacity the fastest via *build proficiency*. With their high profile, they have the greatest effect on Spectrum, while at the same time accumulating the most useful information. Rather than theoretical, the projects are being tested in a competitive market, revealing great insight into not only consumer taste but also an invaluable education regarding the power relationships of the ‘real world’\textsuperscript{139} of market capitalism and, (to a lesser or greater extent) government regulation.

\textsuperscript{139} Perhaps for this reason the first venture an entrepreneur undertakes is usually the most difficult, giving rise to research into how to identify and create ‘serial entrepreneurs’.
Appendix G: Network Propositions

Founding Principles

Considering a network is simply a group of people working towards a common goal, it is possible to draw conclusions regarding the behaviour of networks, both in the singular and the plural. This is intended to allow expansion of this research to a more pragmatic direction that presumes networks do not arise in a vacuum. Rather, the creation of a new network must consider, and make allowance for, those already existing beforehand.

Benefit of Collaboration

Networks exist to allow members to take better advantage of the potential offered by collaboration.

Proposition 1: Networks arise where collaboration is likely to benefit the participants

Or in other words, the whole may be greater sum of the parts - in essence the simple truth that has allowed human beings to create modern civilization, as well as ants and termites to become the world’s most successful insect.

Price of Membership

If people only join a network of their own free will, then by doing so they must perceive an advantage for themselves over not joining. However, the price of membership is acceptance of conformity to the rules of the network. If the benefit of membership\(^\text{140}\) ceases to compensate for the loss of freedom, then the member leaves.

Proposition 2: People leave a network if they perceive no net benefit in staying

Mutual Advantage

Taking Propositions 1 and 2, it becomes apparent that somehow all members must anticipate advantage, yet this need not take identical form.

\(^{140}\) As calculated from the perspective of the member, which depend upon purely subjective factors that are included in the concept of advantage.
Entrepreneurial Knowledge Transfer

Proposition 3: All members of a network subjectively anticipate advantage

Nevertheless, this does not exclude the possibility of a situation\textsuperscript{141} whereby not all members of the network are fully informed and operating on the same information. However, as will be demonstrated, such a network is essentially an amalgam of networks rather than a coherent whole.

Activity Space

In order that the set of all possible activities is not infinite, there must exist a function that defines which activities are permissible and which are not. We call this the network premise (P), and we call the set of permitted activities the activity space (S);

\[ \text{activity space: } S = P(\text{Set of all Activities}) \]

The question then arises as to how members calculate advantage through their participation in a network. Before they join, there must exist a way for potential members to predict the likely outcome of participating in the network. This outcome consists of two parts; what activities the member in question is likely to engage in (A) and what activities other members are allowed to engage in (B).

Generally\textsuperscript{142}, the individual knows what activities they would engage in (X) (depending upon personal morality and proclivities) but the activities of others are only bound by the activity space of the network. Nevertheless, the space of individual activity within the network for an individual member is the intersection of the activity space and their ‘personal space’.

\[ A = X^S \] where X is the personal space’

In calculating advantage, the individual undertakes an assessment (f) of the reward to \textit{themselves} of undertaking A, and the subjective impact (g) of \textit{others} undertaking B, giving the overall sum.

\[ \text{Advantage} = f(A) + g(B) \]

\textsuperscript{141} Including fraudulent financial arrangements such as ‘pyramid schemes’

\textsuperscript{142} People may not always be able to predict their behaviour, but here this assumption is made.
Appendix G: Network Propositions

If P is known, the potential member can predict what activities he might engage in. Furthermore, if others also operate on the same premise, he can also predict what activities other members can (or, just as importantly, can’t) engage in. This allows advantage to be calculated.

\[
\text{Advantage} = f(A) + g(S) \quad \text{since } B \equiv S
\]

If, however, some members operate on a different premise (Q), then a different activity space applies.

\[
R = Q(\text{Set of all Activities})
\]

Now, we don’t know what effect reducing or increasing the activity space of others has on advantage since the calculation is subjective. However, by introducing uncertainty into who is operating on which premise, no member can calculate advantage reliably.

\[
\text{Advantage} = f(A) + (g(S) \text{ or } g(R))
\]

It may be that for a particular person, it would be advantageous to have a proportion of the network operating on a different premise, but for this to apply for all members is highly unlikely. Therefore, to ensure that Proposition 3 is maintained, we introduce the concept of an idealised network.

Proposition 4: All members of a network operate upon the same premise

Manifestations

While an activity is undertaken in the real world, how it is perceived is entirely a matter of subjective experience, which we term the manifestation \((m)\). If we assume that the network consists of one person with an activity space with only one activity \((a)\) carried out once, then manifestation is equivalent to advantage.

\[
\text{Advantage} = f(a) = m_a
\]

Now assume another person joins the network, and he carries out the activity, his advantage depends upon his subjective experience function \(f'\), while the initial member experiences it indirectly as \(g\), but not as a manifestation.
Entrepreneurial Knowledge Transfer

\[ \text{Advantage} = g(a) \]

\[ \text{Advantage}' = f'(a) = m'_a \]

Now, to ensure that Proposition 3 is maintained for any possible activity and assuming that both members of the network wish it to remain intact, then;

\[ f(a) + g(a) = f'(a) + g'(a) \]

Requiring either;

\[ f = f' \text{ and } g = g' \text{ and therefore } m_a = m'_a \]

Or;

\[ f = g' \text{ and } g = f' \]

The second option presupposes an exactly opposing reciprocal effect, which is highly improbable, especially when the number of members grows. However, it also assumes that all members will indirectly experience every activity undertaken by another. Since not all activities will affect other members, this is implausible, and therefore we take the first option, which gives us the following;

**Proposition 5:** All members of a network perceive the manifestation arising from undertaking an activity identically

Furthermore, since the network is defined by the premise, we also have;

**Proposition 6:** Manifestations exist within a virtual space that is defined by the premise

Mathematically, this creates a *manifestation space*, \( M \), which is independent of the member carrying out the activity, and depends solely on the premise. Since \( S \) is the activity space, to arrive at the manifestation space requires another operation by the premise.

\[ M_S = p(S) = p(P(\text{Set of all Activities})) \text{ – where } p \text{ replaces } f \text{ as a generic subjective experience function} \]
Appendix G: Network Propositions

It should be noted, however, that while the *manifestation* perceived by undertaking activity is equivalent for all members, they will still exhibit selectivity in activities undertaken. In the example above, the activity space only contained one activity, and by Proposition 2, it must have been acceptable for the member to have joined. Any apparent difference in perceived manifestation can be attributed to use of multiple premises.

**Multiple Premises**

Any single person is likely to be a member of multiple networks at any one time. As such, any single activity – either performed or witnessed – will produce a number of manifestations. These will be perceived as an array of subjective responses, perhaps conflicting in nature.

\[ m_a = \sum p_n(a) \quad \text{where the member belongs to n networks} \]

**Significant Manifestations**

As already referred to, while activities undertaken by a member create a manifestation that affects advantage, this is not always true for those undertaken by others. Since it is impossible to predict who will undertake which activities, his gives rise to a potential difference between anticipated and actual manifestation. However, since manifestations exist in the virtual plane, they may only be affected by objects in the same plane, implying other manifestations. Given this, we can divide manifestations into those that impact other members and those that don’t – and term the former *significant*.

**Proposition 7:** A manifestation that impacts the advantage of another is termed significant

Why is it important to make this distinction? Essentially, significant manifestations introduce uncertainty into the network, allowing behaviour beyond that predicted by the anticipated manifestations. The interplay of manifestations fosters unpredictability, potentially thereby allowing the unpredictable nature of real networks to be replicated. Furthermore, significant manifestations are likely to be noticed, which provides the network with the capacity to self-regulate – which also occurs in real human networks.

**Proposition 8:** In order for a manifestation that conflicts with the premise to cause tension it must also be significant
Entrepreneurial Knowledge Transfer

To reverse the argument, is it actually necessary to capture any manifestations bar the significant? What of manifestations, perhaps an award or prize that impacts those outside the network but not those within? Well, by proposition 5, if manifestation occurs outside the current plane then it must belong to another plane entirely. How about a manifestation that impacts no one, but nevertheless is a valid part of the network? Well, returning again to proposition 5 we are reminded that the network is a virtual space, and its manifestations have no inherent value. Furthermore, the manifestation is only apparent to those within the network, so there is no prospect of impressing an outsider into joining. By virtue of elimination, only significant manifestations remain worthy of consideration. Happily, this resonates with proposition 1, implying that significant manifestations are the constituent ‘particles’ of collaboration.

Figure 40: Member behaviour in an idealised network
Projects

A network is essentially a number of intelligent, independent agents – members - who agree to collaborate under an overarching premise. However, to actually perform real activities requires a project to be formed.

**Project Space**

A project is vehicle within which members work towards a goal, and project output is measured by the sum of all activities that contribute towards that goal. In other words, projects have set of allowed activities, termed the *project space, PS*, and if a network wishes its members to undertake activities, it must create a project.

Proposition 9: A project must be sponsored by a network

Proposition 10: All activities must occur within the confines of a project space

All members of the project must belong to the sponsoring network (for that is why the network exists), but they are also likely to be members of other networks. That being so, each member has to be aware of the potential for conflict if the activity falls outside of the activity space of networks he is a member of. If this happens, the member must ensure the manifestation generated is not significant within the relevant space – that it does not impact (and therefore is not noticed) by other members of that network.

**Intersecting Space**

Rather than being restricted to a single premise, the goal (and therefore the space) of a project is generally an amalgamation of many activity spaces. While it is possible to craft a goal from a single premise, this is likely to be undesirable as well as impractical. The very act of focusing will inadvertently impinge on other premises since there must have been an original rationality guiding the initial creation of the project goal. That rationality acts like a knife, dissecting the premise, and at the same time finding correspondence with other premises. For instance, an EKT project requires concentration on a perceived market gap, which acts as the logical knife that allows discrimination of relevant activities within the activity space. However, the same knife resonates with other networks, such as developers of the technology or consumers within the market gap. If the project goal is an amalgam of premises, the networks apart from the original sponsor are termed *associated networks*. 
Entrepreneurial Knowledge Transfer

Proposition 11: A project space may be an amalgam of activity spaces from a number of networks

Why then may it be undesirable to confine a project to a single network? Well, for the same reason that a little collaboration is (potentially) better than individual effort, so more collaboration is better. However, ranging across a number of networks creates an increased risk of conflict with a premise. While previously a member might have simply hidden his activity from fellow members, the explicit cooperation of associated networks requires the project space to be amended. Therefore, the concept of the *intersecting space* arises, which is formal recognition of the sensitivities of the associated networks.

![Intersecting Space Diagram](image)

**Project Approval**

Considering that networks sponsor projects, the issue of coordination and efficiency arises. If projects are permitted to occur without central control, there is potential for duplication of effort, over-commitment or even project goals that clash with the premise. Since all activity is expressed through projects, it is in the approval of projects where judgement is required, and those responsible for this are collectively known as
Appendix G: Network Propositions

coordinators\(^{143}\). One of the roles of coordinators for a network is to approve projects, and it shall be presumed that anyone undertaking such is indeed a coordinator.

**Proposition 12:** Coordinators approve projects on the basis of the premise and other projects currently underway

By what mechanism do coordinators come to this position? Consider Propositions 1 and 2 – that collaboration *may* give rise to improved outcomes, and that members join the network in anticipation of advantage – advantage that only becomes available once the collaborative potential becomes reality. In order that this occurs, coordination is necessary – human systems are *not* self-organising\(^{144}\) - at least not when efficient use of resources is the objective.

Members indicate they recognise this circumstance through the act of joining the network, and once within will seek out those who can perform the role of coordinator. Who they choose depends upon many factors, but at this point it is sufficient to simply acknowledge that coordinators are chosen by members.

**Proposition 13:** Authority to act as a coordinator is granted by members

While such support may be forthcoming, other members of the network may find reason to disagree. While theoretically the premise can identify forbidden activities, in reality things are never that clear. Also, synchronization between coordinators is never perfect, and decisions taken for the sake of efficiency may not actually be optimal. Finally, alert for bias or irregularity, the members themselves monitor which projects are given approval. If for any of these reasons a member (or group of members) challenges the position of a coordinator, it is the same as a significant manifestation conflicting with the premise. If the conflict cannot be removed (such as through clarifying the premise) then one of the parties must leave, or (as per Proposition 4) risk break-up of the network due to differing interpretations of P.

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\(^{143}\) This does not presume the facilitators are not hierarchical, such as would be found in a traditional management structure, only that they merely exist.

\(^{144}\) Some networks do not require central control, and these are known as self-organising. Essentially, their agents operate on a simple set of instructions that allow coordination with needing to resort to a hierarchy. The networks have evolved such that these instructions lead to efficient ‘collaboration’ (projects) in the network as a whole.
Communication

The final aspect of any network is communication. In order to form projects, there must be communication between members concerning the project goal. There must be communication between members who wish to start projects and coordinators, and also amongst coordinators themselves so they can coordinate projects within the network.

Proposition 14: There must exist lines of communication between members of a network

Of course, coordinators are also members, so they are included in this proposition. However, in order for Proposition 3 to be realised, potential members must become aware of the premise and hence calculate their advantage.

Proposition 15: The premise must be in a form communicable to potential members

Even if in communicable form, there is no guarantee that all people would understand it sufficiently well that they could calculate their advantage or that some would not seek unfair advantage (by intentionally acting outside of the activity space). It is therefore beholden on the network to protect itself by imposing entry criteria, which would be imposed by coordinators as the existing authority figures.

Proposition 16: Membership must be granted by a coordinator

Considering the skill necessary to recognise an undesirable character, coordinators must therefore be expected to possess judgement in concordance with the importance and vulnerability of the projects undertaken. By the same token, those unable to comprehend, and therefore conform to, the premise should be denied membership as well.

Premise Design

In the preceding discussion, it may have been apparent that the premise is assumed to satisfy two competing requirements. It must be unambiguously comprehended to all members, while also able to inform judgement in all possible cases. The former demands explicit detail, while the latter is best served by abstract generalisations. Striking this balance is certainly difficult, and depending upon what the network is
intended to achieve, perhaps impossible. Nevertheless, the alternative is fragmentation into a multiplicity of networks with largely-overlapping activity spaces that fail to achieve the benefit of a single, coherent grouping.

**Network Break-up**

Regarding premise ambiguity, imagine a network with a premise that, given a specific situation, can be used to justify two contradictory activities\(^{145}\). Considering that networks are inherently collaborative, in order for members to be able to trust each other they must be able to predict the behaviour of their fellow members. If behaviour becomes unpredictable, the ‘advantage’ of belonging to the network is lost, as normal cautionary principles of social interaction reassert themselves. As such, a premise that allows discrepancies in individual action destroys the inherent basis of the network, while also removing the ‘peace of mind’\(^{146}\) that is commonly sought by people (and is part of the calculation of advantage therefore).

This is why any member discovered behaving contrary to the premise will be subject to a range of implicit and explicit pressures designed to encourage them to leave. If the person remains, their divergent interpretation of the premise may be communicated to others, and the network will effectively begin to break up. If the interpretations are defined by a single difference, then the network will split in two - each with a premise only slightly altered from the original.

However, the knock-on effect of significant manifestations may create permutations that give rise to unpredictable consequences; effectively invalidating the original premise. For instance, if great harm or great good is conferred, the recipient may be forced into a state of mind that allows for an interpretation that gives rise to extensive aberrant behaviour. In this case, the premise may be entirely lost as the original network fractures beyond recognition. For instance, this is indeed what many climate scientists wish to occur to the ‘western consumerism’ premise, rather than the current situation of (roughly) two premises – ‘alternative lifestyle’ and ‘mainstream consumerism’. However, the loss of a premise can also be dangerous, such as with

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\(^{145}\) Contradictory in the sense that one option sits outside of the activity space that another perceives given their interpretation of the premise.

\(^{146}\) ‘Philosophers Zone’ – Radio National 15\(^{th}\) April 2007
Entrepreneurial Knowledge Transfer

revolution, where an entire nation may be plunged into chaos by citizens who have been forced into mass rejection of the premise that characterized the previous order.

**Case Study: Lifestyle Premise**

As an example, let us examine the how a person’s life might be affected by the premise governing it. Consider a life where you are free to make consistent decisions that lead to activities which cumulatively push your life in the direction you desire. Effectively you have the luxury of following a single premise which serves you in all environments and in all situations. It leaves you without any (or at least an acceptable level of) conflict arising between yourself and the networks you belong to.

By contrast, consider now a life where you behave differently depending upon the context, perhaps you are tough at work but loving at home. Sometimes you make a decision that seems right for one context, but on consideration you realise it was a mistake in another. Alternatively, you might find yourself in a situation where none of the interpretations seems to apply, yet you are unaccustomed to thinking independently. In general, you find yourself undertaking activities that often seem contradictory, which overall means wasted effort.

**Fractal Premise to Overcome Contradictions**

One solution for improving the premise is to adopt the trick employed by fractals and self-organising networks. Fractals generate complex patterns by repeatedly applying a
clear and unchanging set of rules. In the context of a collaborative network, this would equate to identifying how the rules governing the behaviour of individuals can be crafted in such a way that following them repeatedly will result in the correct behaviour by the network as a whole. This means that the right projects are systematically chosen over poorer ones, and people within the projects all act in a coherent fashion.

Taking the previous lifestyle illustration, we need a premise that is both universal as well as detailed enough to enable day-to-day coherency. In order to be generally applicable, it must be flexible enough to suit any situation or network we find ourselves within. The premise must also systematically foster activities that are coherent, and so achieve constructive (rather than destructive) ‘interference’. If we regard our life as a project within an Idealised Network, this means we are working towards a known goal, and the intersecting space is not constantly changing depending upon the networks we belong to.

One suggestion for such a situation are a group of interrelated premises that apply to both the micro and macro decision situations. The overriding premise is to generate the greatest contentment, happiness and satisfaction in your own life. However, to do know what activities would lead to this outcome requires self awareness, which means one must also be alert for lessons to be learnt. Also, due to our evolutionary past, we have evolved a sense of empathy that allows us to experience the feelings of others as our own. Thus, if others around us are happy, we ourselves feel happy, and by implication our own actions should take this into consideration. However, learning and wisdom again come into the picture as we need to know what the effect on others of our actions might be. Taken together, these three premises generate a pattern of behaviour that is both coherent and flexible, and addresses the inherent challenge of premises in general.

Do what makes you happy

Making others happy makes you feel happy

Acquire the wisdom to do both better

Figure 43: Fractal premise for lifestyle
Appendix H: Processed Data

96 what we've actually found is that statistically really very high proportions - of middle-aged forty to fifty year old guys

101 perhaps its the social skills even that give them that kind of edge

99 perhaps the people best placed to stimulate the entrepreneurial economy are the middle-aged guys

100 middle-aged guys are reasonably stable and have a bit of a base to play from

97 I think the reason behind might be that young twenty-something year old guys are quite risk averse in some ways

98 you can understand them not wanting to be liable for a 20k loan when their student loan is already at that

102 Is there some way for these new post-grads to become involved that isn't risky but that still taps their energy, new ideas, new ways of looking at things

96 outcomes should it survive improves eventual chance project will fail but

94 The original model was post-graduates with bright ideas

93 they tend to be the technologist who wants this thing to happen - he tends to be GRISTers own idea

92 Both Brighton and Kent have put that case to SEEDA and they have had some success in getting that constraint removed

91 there is potential there for a business start-ups' strategy that says 'this is how we are going to support

89 the DTI and SEEDA have overlapped programs - so there isn't a clearly executed success

88 the issue is that if you're attracting to go to Hastings and SEEDA, but they've been confusing' - there's the SMART awards, but they've been renamed, the link funding etc.

87 In Brighton and Kent there's one particular aspect that's quite different - which is they are aiming at deprived areas

90 the issue is that if you're a new high-tech business it simply isn't all that attractive to go to Hastings

86 We also have a quarterly steering meeting

83 QUESTION do you have much focus on feeding back information

81 but perhaps the slightly scatter gun approach is right because you don't know what's going to work (free rein)

2 my job is to understand the commercial potential of new jobs in ICT and electronics

23 having to do with the commercial organisations outside

80 the DTI and SEEDA have

79 we are going to support

78 the third stage is negotiating the fit might work

77 the second bit that takes the time is the review panel

76 the first stage is assessing the fit might be

75 the loan we need a senior marketing guy, a senior technologist (in whatever relevant field), me and the head of

74 when we understand from GRIST what the optimum models are - then those can potentially be shared with other regions and universities

73 it was a very, very frustrating time when we had that constraint

72 Because support was lost in the network, which directly impacted on the facilities

71 The essence of Capacity in this context is the entrepreneurial drive, and it is a critical aspect of every KT project

69 if it works it could spawn a lot of other programs

68 one of the most interesting things about the GRIST area is that it is a pilot

67 whether these guys are really, really brilliant in marketing doesn't really matter so much - its more important how well they mesh

66 the relationship between those two people is absolutely critical to success

65 the downside to all this age - the entrepreneur is typically 45 and the student is typically 25

64 normally the idea tends to be GRISTers own idea he tends to be the visionary guy - very much the technologist who wants this thing to happen

63 they tend to be the driving force behind the technology

62 there is potential there for a little more coordination - and perhaps that is one of the roles of the universities

61 but perhaps the slightly scatter gun approach is right because you don't know what's going to work (free rein)

60 the DTI and SEEDA have

59 the DH and SEEDA have

58 I think business-link was originally designed to address that - although I'm not sure how successful it's been

57 the DH and SEEDA have

56 there aren't a clearly executed strategy that says 'this is how we are going to support business start-ups'

55 SEEDA has some clearly defined measurable that we report quarterly

54 SEEDA has some clearly defined measurable that we report quarterly

53 whether these guys are really, really brilliant in marketing doesn't really matter so much - its more important how well they mesh

52 the relationship between those two people is absolutely critical to success

51 there isn't a clearly executed program - so there's not a clearly executed strategy that says 'this is how we are going to support business start-ups'

50 the DH and SEEDA have

49 overlapping programs - so there isn't a clearly executed strategy that says 'this is how we are going to support business start-ups'

48 the second stage is negotiating and finalising the deal - granting the loan, and agreeing the milestones we'll measure success by

47 the third stage is negotiating the fit might work

46 the second bit that takes the time is the review panel

45 we are going to support

44 interviewing the potential applicant, going through the application and working out how the fit might work

43 they tend to be the driving force behind the technology

42 normally the idea tends to be GRISTers own idea he tends to be the visionary guy - very much the technologist who wants this thing to happen

41 there isn't a clearly executed strategy that says 'this is how we are going to support business start-ups'

40 the DH and SEEDA have

39 overlapping programs - so there isn't a clearly executed strategy that says 'this is how we are going to support business start-ups'

38 the third stage is negotiating the fit might be

37 the second bit that takes the time is the review panel

36 to grant the loan we need a senior marketing guy, a senior technologist (in whatever relevant field), me and the head of

35 the second bit that takes the time is the review panel

34 interviewing the potential applicant, going through the application and working out how the fit might work

33 the first stage is assessing the application to really see where the fit might be

32 the relationship between those two people is absolutely critical to success

31 there isn't a clearly executed strategy that says 'this is how we are going to support business start-ups'

30 the DH and SEEDA have

29 overlapping programs - so there isn't a clearly executed strategy that says 'this is how we are going to support business start-ups'

28 the third stage is negotiating and finalising the deal - granting the loan, and agreeing the milestones we'll measure success by

27 the relationship between those two people is absolutely critical to success

26 there isn't a clearly executed strategy that says 'this is how we are going to support business start-ups'

25 the relationship between those two people is absolutely critical to success

24 normally the idea tends to be GRISTers own idea he tends to be the visionary guy - very much the technologist who wants this thing to happen
Synergy Identification: About the quality of the synergy rather than the actual outcome of the project – although the two things are obviously related. It may be a technological problem causes failure (e.g. phoenix project) but the potential (including human aspect) will still be remembered.

107 do the technology transfer by creating the platform and then you build a business
106 start out, prove the principle, do the market evaluation, protect the intellectual capacity
105 you have to have quality in terms of management and you drive the technology up the value chain
104 you have to have availability of money

99 there’s fantastic links to the city so there’s a supply of money
98 as a consequence, people come and live here. We’re near to London
97 you’ve got investment in the region
96 you’ve got Aldershot - the home of the British army close by - and the train line to Portsmouth

83 as you go up the scale you have larger companies that want to form a relationship with the university
84 to be part of understanding the future - technological colonialism - they want to get in and see where things are going

61 entrepreneurship is based on results - it all about what can you achieve and what do you achieve

60 sits with the wiz kid who was brought in from NTL – he’s a corporate banker - not able to install a coffee shop operator
63 he’s supposed to be the entrepreneurship guru but its a myth - I think its up its arse

58 [Gives example of management school taking 2 years to install cafe operator] because he can’t delegate it or can’t think about it
56 QUESTION why don’t the systems exist already
62 traditionally universities haven’t asked that question of themselves
64 even when they do ask it they get hung up on corporate governance
57 the generation of university administrators that come across - are supposed to be clever - but they’re not
55 you’ve got to make your decisions on what to invest in terms of science and technology to be able to move it forward more quickly
54 generally science and technology are a little bit away from the market - you’ve got to get it closer to the market
53 where does the knowledge come from?
102 knowledge comes from the R&D spend
101 where is knowledge come from?
100 coal was once important, wool was once important, probably in Ireland turnips were once important, but today its knowledge isn’t it
101 where does the knowledge come from?

108 you have a dynamic of people, you have a dynamic of money
109 the people are the most important in that they have to be entrepreneurial

41 the people who are entrepreneurial drop out of the system and don’t tend to congregate in universities

19 we provide the infrastructure from the point they get formed right through to the point they can become reasonably substantial

8 I also fulfil a role as being chair of the [local] business forum
10 its the relationship between the local government and the business community of our town
16 in building a close contact with the planning authority and building a relationship with them - they recognise us as a partner in economic development

92 ask them - and they’ll give up 1 or 2 hours to help instruct a course at the university
93 again responsive they’ll do it
95 as long as you use them and you’ve got a decent audience that is frequent but they’ll do it once or twice
19 again

63 he’s supposed to be the entrepreneurship guru but its a myth - I think its up its arse

41 Entrepreneurial people: The beauty of ‘support’ is it is self-selecting. Personal interaction and experiential impression will tend to attract those with the right interests

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Facilitator Specialisation: Would be bound to affect projects as people have a tendency to skew decisions towards their knowledge and expertise – their comfort zone.

Try to Understand: This alludes to the importance of having the right attitude when approaching a participant – the interaction alone will not secure the information.

15 when there’s an indication of something new and innovative happening I go along and see the academic. 17 and try to understand what it is he has done.

139 post-grads could work in terms of maintaining the contacts with the schools or helping with the pipeline of projects coming through. 140 they could also be useful in interpreting in layman’s terms what the project is about – that would save a bit of time.

145 currently they get 70% of the net revenue - up to 50k - and thereafter 50%. 148 it also makes sense to have a fixed and fair amount that applies to everybody.

145 I have 20 projects at the moment and half a dozen are 'beginning to bubble' 132 they’re taking quite a bit of my time in terms of negotiating with people, getting agreements done and so on and so forth.

5 then if possible try to set up license agreements with commercial partners 38 do we want this company to operate worldwide or just in a specific country or within a specific region 39 do we want to specify the range of the activities as well - such as industries.

19 the first thing I would do is speak - in broad brush terms - to contacts I already have in the relevant industry.

96 sometimes he’ll come and tell us that somebody is working on something (similar to us) and we ought to get involved.

14 first of all I keep in touch within the physical sciences 10 or contacts in the advanced technology institute here or through contacts in one of the other schools related to physics and engineering.

15 there’s an indication of something new and innovative happening I go along and see the academic.

33 or you might speak again to the academic and ask who he would recommend would be a good person to speak to in the marketplace.

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126 if he’s not enthusiastic with you he’s not going to be too enthusiastic with an MBA.

31 145 I have 20 projects at the moment and half a dozen are 'beginning to bubble' 132 they’re taking quite a bit of my time in terms of negotiating with people, getting agreements done and so on and so forth.

34 the next project might be completely different and you might decide it something you might describe as a 'platform technology'.

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This could be construed as a part of systemic loss of support, this time due to aging. The MBA quote shows the universality of 'engagement'…
262
Students Placement:
39 because they were used to having a structure where everybody told them where they should be for a lecture.
40 they didn’t quite understand that in the real wide world you have to do things for yourself.
38 in the first 3 months they really were quite lost.
42 in the last 6 months they were really useful.
43 quite often companies don’t want them to go back to university.
50 which told them things like etiquettes of working, how to use email in an industrial or commercial environment, smarter, up their report writing.
52 having done the industrial year, and when they came to find employment, the experience makes the student more employable.
51 it’s a very good address - to say you’re on the Surrey Research Park implies all sorts of things.
51 we’re talking about the park as a whole, but in Set Squared, companies can only become members if they understand what’s on offer and they buy into that.
99 if you come on to this part, there is this network you can join - there is this community - at what extent do you think that will be of value to you?
104 [Name]’s role has been to attract companies to the park - and companies come here for all sorts of reasons: closeness to London, geography and so on.

Geographic Proximity:
Greater distance makes others harder to access (analogy: bringing forces to bear in war).
From the participant’s perspective, the potential available contribution is less, and they are therefore less likely to engage in interaction.

98 but if you wanted to develop that, not make it part of the contract, but make it a little part of the proposition.
95 but doesn’t actually mean that you’re coming here to facilitate those links.
91 in principle, they’re not going to come to something like this because they’re thinking ‘oh, I want to be somehow connected to the university’.

Interaction:
Includes interaction between participants, not only involving facilitators. Thus, greater engagement leads to more compelling interaction.
51 someone able to build a rapport with an academic team. An understanding that you have to roll your sleeves up and do things yourself.

84 the university would never approve a company unless it has the funding to trade for 12-18 months.

94 I think universities should be aware of doing too much for a spinout. All a university can do is to get a company formed and funded and establish that it has the potential to be a viable business and management team.

99 the university has a responsibility to act professionally and commercially but not to do [the spinout company] any favours.

74 the assumption is often that the research associate who has been employed within the university will be transferred to the company if and when it is formed. There are schemes to encourage academics to go down the commercialisation route.

80 well-known is the Royal Society of Edinburgh enterprise fellowships which gives 1-year awards to an individual [to commercialise a technology].

51 you should never conjure people out of thin air, and thus do not directly improve the quality of synergies, even though they may realise what is missing.

89 you would rarely do that without external funding - this is where the relationship with Scottish enterprise or through the synergy fund come in handy.

101 I don’t believe a scheme that marries up academic X with student Y who’s interested in commercialisation would work. If things are to come about they are to come about through someone’s initiative.

U2.1 Capacity → Synergy: Facilitators cannot conjure people out of thin air, and thus do not directly improve the quality of synergies, even though they may realise what is missing.

Support → Engagement: Policies themselves don’t increase support. They need to be delivered via personal links to facilitators.
36 I ran and founded an identical in 1987 at Stirling University called 'Research for Enterprise'.
61 it works because it’s embedded into the universities’ curriculum and it’s also playing to a particular strength, if you don’t mind me saying.
54 universities should be quite careful to target their activities towards their strengths - which is a research and learning base.
57 what does work are programs that are fully embedded within it’s curriculum or within it’s research base.

31 one of the programs I came across that I really liked was called the ‘Small Business Institute Program’.
33 embedding an understanding of small business within the undergraduate and postgraduate population.
34 it’s also a way of getting university expertise into a small business.
43 lots of very interesting learning and skill-based objectives.

65 but we specify that teams should have a mix of local and overseas students.
87 but it’s a good learning experience for overseas students: to look around them, to see the local businesses to understand that they have (community) contact.
86 overseas students are not as likely to have as large networks of contacts with businesses.

85 there were some things that university entrepreneurship centres get involved in where frankly they’re competing with either private or public sector suppliers.
64 any time we wander off on peripheral and marginal activities I think we’ve got to be quite careful about what we do.
55 the only reason universities run these programs is to bring in money - it’s ill-conceived from the start.
51 given the overhead structure of the university I would argue that’s it’s uncompetitive for us to compete anyway.
56 as soon as the income stream dries up, jobs are lost and the courses close down.

88 the communication problems are implicit. The benefit to o/s students is in learning people skills and confidence to approach businesses learnt from local team members.

67 since I took over the course in the MSc marketing program I’ve taken quite a different approach which I really, really like.
77 (that is, the students find their own businesses *cheers*).
78 I’m really stretched b/c I don’t have time to go out there and find businesses.
72 we’ve gone out and met the business owner - hustled for [the project] essentially.
75 we had to get enough project briefs for the students and let the students choose (possible but ineffective).
79 with the expansion of higher education there are more students out there than businesses.
80 I have a restricted supply of networks and contacts.
81 but students who come in have their own networks, their own contacts – they’re all the businesses that they love.

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119 there’s a tension within entrepreneurship where half of us teach ‘for’ and half teach ‘about’ and there’s very little crossover.
122 there is some resistance from within academia to enterprise - where it is labelled as ‘neo-Thatcherism’.
120 ‘for’ entrepreneurship means facilitating it’s action.
126 it’s better then to be a practitioner.
121 ‘about’ means studying it academically but not promoting it in essence.
127 here it’s better to be a theorist.

113 it would require faculties to bring students into multi-disciplinary teams.
110 QUESTION 26:15 what are the chances of launching multi-disciplinary commercialisation student teams.
111 the problem is that students are placed within a faculty and they have to graduate within a faculty.
112 there’s no cross-faculty contact.
113 it would require faculties to talk to one another “laughs”.
114 you might get that more at the MBA level because the mix is more diverse.
115 you could more easily get them into multi-disciplinary teams.

Interesting because the MBa’s are not as truly diverse as the faculties because they are united by their course, meaning that it requires less Facilitatory effort.

95 so they’ve come through the process of the [successful] group dynamics.
91 so far every single one has come back with a fantastic business that I would never have thought about “happy and triumphant”.
90 “how good is that!!! yeah it’s great - and they love it”.
92 also they generally come from small business backgrounds - a family business or an uncle who ran a business.
106 learn a little bit about the small business sector and doing work with a small business.
105 and go out and just do consultancy - learn about the consultancy process.
104 for them what they can do is take all their knowledge about marketing and all their social and cultural skills (for later).
The education establishment have got a lot to learn in terms of allowing people to take more risk, to understand the pros and cons of risk. The reality of commercial life is that you need to take risks otherwise you're not going to make any rewards. If you look at the real classical entrepreneurs in Scotland, the vast majority that I can think never had a university education. It was the best thing that ever happened to them - it was the best thing that ever happened to them - it was the best thing that ever happened to them. University education that I can think never had a university education that I can think never had a university education. When they go in from Day 1, their expectations of the company and what they will be doing is very limited. They then determine what the project is going to be - rather than go in from Day 1. It's only after a period of time (researching the company from within) that you can understand what is going on at the ground level. They find comfort in their academic rigours, their textbooks, sitting in front of their computer and sending emails. They use very much academic as opposed to the ground level. They use very much academic as opposed to the ground level. They use very much academic as opposed to the ground level. They use very much academic as opposed to the ground level. In this case, the student behaves as their own facilitator, refining the project before re-engaging.

Information accessibility is meaningless unless the external people are seen as part of the network, but it still require people to want to volunteer that information. Interestingly, Michael is trying to act as a facilitator and disempower the (powerful) academics through trivialising them.
Synergy: Interacting with others is enjoyable, but it should be noted that such interaction is part of a project as synergy identification is purely a matter of ‘fit’

Engagement: This is a complex one. It has aspects of granted authority (which is specific to facilitation) and the provision of resources (which is more participant in nature). I think that overall it is more about constructing a project in which the synergy is partly provided by facilitator, a role which overrides that of student.

Networking Meetings: Combine information and opportunity, but to attract a crowd in the first place is the real achievement. The opportunity is merely convenience, and fits into the design of a project.

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2 by ‘smuggling in’ expertise – a fresh pair of hands, a fresh pair of eyes – into small companies through the auspices of a seconded graduate

107 the problem is we’re all so close to our businesses and we can’t see the wood for the trees – having someone questioning things, can be mutually beneficial

195 the information derived from alumni should be fed back into the universities’ activities

24 then the situation changed quite a bit due to the funding govt department changing its attitude to people who could join

25 they said we have to change tack and we will only accept people who have been unemployed for 6 months

188 and then you have pressures on departments to publish in high quality journals so you get the highest rating and some extra money from the government

189 that’s fine - but its a vicious circle - like leaving the MCG after a match - where everyone is striving to get to the same place - creating huge competition

158 if you can show that the students who have taken entrepreneurship electives get real jobs

159 that might help you to recruit better, get more people through your portals and generate more money for your department

173 the big challenge also, in this country, I guess, for small companies there has become a bit of what you might call subsidy dependence

So if you don’t directly pay the project, perhaps you fund the facilitators instead? (hint hint:)

76 it’s only after that period of time that you can get some sense out of whether something is having a positive impact

37 also governments have short term planning horizons so they are going from one election to the next

38 they’ll use whatever statistical data they can to prove that what they’ve done in the short term is wonderful but then they have to move onto the next thing

61 the funds we obtained from govt were ‘hardly commercial’ because it was a government funded thing, we were paid on a burns on seats basis - and bonuses for outcomes - those being people getting jobs

54 this is the problem of using govt funding - where outputs as opposed to outcomes are important

56 they want statistical data to prove they are spending money well

60 if the financial resource was there you could have spent a lot more time ‘getting the match’

52 the problem was we didn’t give the companies any choice over who they got and the punters didn’t have any choice over where they went

58 but sometimes it didn’t work out - an absolute disaster - and that was essentially when the fit wasn’t right

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Altruism: Where From? Consider that this person employs a ‘gut feeling’ about people. If, on the basis of personal (engagement) that’s fine, but when creating a linkage, the situation is a lot more professional. When you are meeting a representative of a large company on behalf of the university, you must push your feelings away – you have a job to do! This is perhaps why large organisations can get involved without the ‘gut feeling’ check – especially considering the amounts of cash. In some ways, this explains why Engagement and Capacity are functionally separate until they come together at the project – they are entirely different. Yet, no collaboration can work without a chemistry at the project – they are entirely different. Also, this allows for the occurrence of resource providers not offering their participation in good faith (because they are not engaged).

248 they’re not particularly good at SME’s - but that’s across board (of UK universities) 247 they engage EXTREMELY well with large corporations because they’re the ones with the money.

253 while people aren’t going to be completely altruistic all the time, you don’t need that - you just need them to have a little bit of a social conscience

255 it doesn’t take that much, and if you start it, it’s self-perpetuating

256 I went over to Copenhagen to one of their incubators and science parks and saw that kind of attitude and framework built in. Places I found with very good interaction with SME’s is Denmark and Sweden

240 the difficulty is you’ve got to find an individual within a department within the university who is capable and willing to help you

242 again it’s one of the problems of us not being a university department, therefore we sit on the fringe of the campus

245 I would like to see a quicker route in to the university to resolving problems

246 for them to engage a little bit more with SME’s - 239 particularly when we’ve got sort of. technical gaps for some of our companies

228 as far as we’re concerned, we can put forward various organisations and say yes, we’ve worked with them ‘yes they offer a good service’

Note this kind of recommendation is not public knowledge since it is based on direct experience, but is added to the Network once disclosed. This raises the point that Interpersonal Communication can add information concerning others, but that while Network Knowledge represents the entirety of what is know to members of the network, not all of it is accessible, but once told to someone else, Knowledge overall goes up.

219 we do say to people ‘don’t give us any information that you’re not comfortable with if you have a problem

217 but at the end of the day - in order to communicate your idea - the validity of it, the potential of it. They have to open up 212 so there has got to be a degree of trust

207 we don’t sign non-disclosure agreements and things like that 203 at the end of the day, my success is your success

258 within Sweden I was astonished - the academic, if he invents anything, it’s his IP

263 because his skills, his network are absolutely critical in order to commercialise the project

261 there becomes less and less motivation to look at exploiting their intellectual property

265 (paraphrasing) you need to have a balanced and clear bargaining position, say 50/50 share right from the start

I’ve asserted here that the network is part of the synergy because they would form a part of the deal that make it all work. Apart from that, knowledge of his skills is also relevant

229 if you need certain expertise we can put 3 or 4 in front of you and then it comes down to personality

225 and that’s why we say to people that at the end of the day you’re not dealing with institutions or organisations, you’re dealing with people

226 and therefore you have to sit down and decide; do I trust this person, do I like this person

227 a lot of that comes down to gut instinct

In other words, facilitators use their own judgement to prevent inappropriate people engaging through subtle rejection.

Capacity/ Support: This is an general impression gained of competence and ability that creates the image of a ‘winning team’ – one that can offer you rewards by becoming involved.
98 we don’t get any operating grant whatsoever (apart from the original shareholding)
25 so while there was pressure there to have an incubator, whilst having this ‘very pure’ remit, then had to take a much more pragmatic view of it. 27 our board and our shareholders took the very pragmatic view that ‘we’ve not got any pot of money to dip into’ - ‘we’ve got to start generating money’. 23 fill the space - even if they’re non-techie, service oriented businesses.

29 we’re a small business ourselves - we only employ 6 people
30 we very much understand the stresses and the strains they have because we had them ourselves.
36 therefore some of the advice and assistance we’re giving is aligned very highly to what they’re capable of doing (as participants, not faces).
37 I think that’s quite important for the client to not be put in a position of having no one to do that inadequately.
38 a lot of the time they will have big consultants or banks or advertising agencies waxing lyrical to them and a lot of the time they’ll say ‘well what you have to do is resource-up for that’. 39 (and the client says) well that’s great, but what you’re suggesting I cannot do.

95 Strathclyde is very successful at getting money to fund its research.
34 we have got an extremely good research base.
55 I would also like to see the private sector take more than they put in.
56 they talk a very good game - about being interested in early-stage and pre-start-up companies - but they’re not.
57 (the business) angels were supposed to meet that gap (funding early stage ventures)
59 you’ve also got a number of angels who are not really angels - they’re people with money.
66 there are a lot of ‘bad angels’ around.
68 we don’t get any operating grant whatsoever (apart from the original shareholding)
25 so while there was pressure there to have an incubator, whilst having this ‘very pure’ remit, then had to take a much more pragmatic view of it. 27 our board and our shareholders took the very pragmatic view that ‘we’ve not got any pot of money to dip into’ - ‘we’ve got to start generating money’. 23 fill the space - even if they’re non-techie, service oriented businesses.

89 there’s a lot of misinformation even within the university and academics with regard to what is out there.
90 there are a lot of ‘bad angels’ around.
91 what we’re trying to do is educate the deans with regard to all the component parts of the commercialisation process.
92 we went to meet the principal and one of his vice-principals.
93 to join all the dots up and make it a fairly seamless process.
Since the university administration has the power, it is up to them to do it. See Sharon Bamford for a classic story.

100 and I would like to see teams picked more carefully.
101 people that are very serious about starting their own business.
102 if they’re put together within a team within the Hunter Centre, 100 and I would like to see teams picked more carefully.
130 in order to create a more balanced team.
140 funnily enough, we blast out 6000 questionnaires to alumni.
141 a lot of the requests that I get to be involved in the programme we from lawyers and accountants.
146 we got a huge amount of these - what we did not get was technologists.
By marketing I think simply promotion would be sufficient, and this only requires straight use of facilitator capacity.

This comment illustrates the importance of finding the right facilitators. Interestingly, the leadership of the Hunter Centre was hand picked by its sponsor - a millionaire retailer of tracksuits…so no surprises there.

There seems to be a paradox between ‘picking teams’ and forming a good team bond. I think the implication is that the facilitators should refuse unbalanced teams, but rather than ‘picking teams’ they simply need to make the requisite skills available. Interestingly, this reveals that synergies do not require the right skills being given enough enthusiasm, and that the value of synergy is largely human based - but a lack of activity would invalidate such feel good
now I know that in order for people to start up a venture they must truly believe in it therefore some people say 'well you've got to take the risk'
some of those kinds of things can be done that will allow people to say 'right, I will take the risk'
I would like to see people given the ability to take more risks without ruining their lives
maybe the university or government part-funding that salary - and the business part-funding it
within it's first year of failure they can be taken back into their position within the university
once the companies' a certain age, then it must stand on its own and the university can cut it's ties

never underestimate greed - 'greed is good' as researchers see the guy beside them making half a million by taking a stake in a business
you will also that as you change people's attitudes the learning occurs from understanding those within their own network. However, as other interviews showed, the people within RCS have something of an attitude problem, and aren't ready to listen.

these entrepreneurs are, by definition, very awkward individuals to deal with - they can make you tear your hair out
they will sit on your doorstep and hound you and hound you and hound you
but I think what RCS must get into their heads is these are the bright people - and unless we have these people, we're not going to have ideas
they've got to learn to deal with them, and deal with that awkwardness and irrational behaviour
they're not businesspeople, they don't know how the business world works, they are a bit irrational

they're not doing business with a bank, you're doing business with the guy sitting behind the desk who's talking to you
full information to him, keep him on side, keep him on your team, keep him aware of the progress and the problems
don't save your cash flow problem until the cheque gets bounced because that's just going to tick him off
if you're up front with as much advance notice as possible, people will appreciate that
therefore the relationship works better
and you'll find people will go the distance for you!
In other words, the synergy will persist (meaning people continue to contribute), and thus so does the project
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In other words, the synergy will persist (meaning people continue to contribute), and thus so does the project
153 on the same day we launched a website, a portal - which was highlighting university commercialisation opportunities in all 13 of the university. 148 last year for example we tied in with MIT and produced a bio-tech map (of bio-tech establishments in a number of regions).

Such a map is useful for participants and facilitators (who may also be participants)

**Known Capacity** is the total resources of the network known to exist via personal linkages. Management systems cannot substitute for personal relationships, then can however make the information easier to access (good for keeping fellow professionals ‘in the loop’), but (unlike a dating site) human linkages are still required to gain access to the resource.

They can also identify synergies without using resource. **Power** devoted to responsible facilitators. The transparency is laudable but probably not critical – as it is unproven, there may be no linkage. But, there could be for professional linkages.

247 his line was "I thought I was going to be an accountant, and then I discovered SEI - it's people rather than spreadsheets that I enjoy" 248 and so suddenly he's just completely changed career track to (because they can't find a job)

**Facilitator Engagement**

Facilitators can become more or less engaged, which then affects their interactions, and enthusiasm. (they part of the synergy too???)

264 and we feel it’s more credible that a student is driving the peer-to-peer stuff (rather) than I’m coming in like their mother

Remember: Network Extent is all about professional relationships for the purpose of expanding the network. Engagement is more about fostering personal r’ships – but of course both are hit by ‘interaction’

**Support** Requires knowledge, which is acquired through meeting people and participating in activities. **Capacity**: Without engagement (confidence) information will not be forthcoming

232 we have the student intern networking 238 the interns are charged with either coordinating, or linking in with existing, or starting - an entrepreneurship society 230 and again we can get ‘fed in’ to all of that 236 they are actually organizing regional networking "incredible" - they’re actually having different institutions getting together for networking events

203 there’s entrepreneurial push and pull 204 and it may be, as job market changes that they’re going to be pushed into entrepreneurship (because they can’t find a job)

207 it is likely that they’re going to go into self-employment or start something up, or have periods of self-employment or starting something up 206 particularly when you look at visual and performing arts

205 and at least they have the skill base to know where to start, or where to go and who to talk to

**Resource Accessibility**: Since this is from the perspective of individual participants, and they see everyone who can help as a resource, it is named as such. Includes geographic factors as well as communications and other factors such as onerous visa restrictions.

143 we appeared to be almost unmanageable and out of control because most people weren’t delivering at that speed 144 but we’re actually very tightly controlled as my staff will verify in that everybody has their own budget centres, own tasks lead-on projects 145 and that means we can multi-task and the next project comes along, and that next and the next and the next

134 absolutely, and we have our operational plan for next year - we run ourselves as an enterprise, as a business 135 we have strong targets, measurable targets, project plan deliverables that outline key tasks, when things are happening 140 and our whole community can see what we’re doing, when we’re doing it, how we’re going to measure it and who’s accountable and what the budget is

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223 because the barrier of what does it take to start a company when you haven’t studied business and it’s an alien concept

217 some of them might not be ready to share that info (about themselves) or have completely formulated (their plans for commercialising) 222 and they’re actually saying 'well why can’t I?' (just go and out of concert business and get funds to patent from you) 220 so we’re actually seeing more and more (people coming forward)

231 if you've got an idea or you think you might be the sort of person who is 'moving towards that', here are the opportunities, here is a network to plug into

230 and again we can get ‘fed in’ to all of that 236 they are actually organizing regional networking "incredible" - they’re actually having different institutions getting together for networking events
91 so we actually ask the students for their ideas about how we would communicate this message amongst their peers.
93 and they (the interns) are far more effective at communicating our materials.
97 that's been hugely effective - it's probably been the most effective thing we've actually done.
98 the energy, the vision being in touch with the market - it's all just totally there - so that's

183 Having said that, we ran our first international student enterprise conference this year. We had 620 - which was full capacity and 800 odd registered.
186 calibre of speakers, the fact that we paid for transport, so that was hugely successful and a lot of Scottish students came along to that and were inspired by that.

117 our activities feed right up to the minister and the Minister for Enterprise is familiar with what we're doing.
116 so my next meeting this morning will be with the government - the Scottish Executive will come in for briefings.

49 it could be educate through informal networking, it could be workshops, multi-media modules.
51 it could be educate through professional development through our own commercialisation people.

Resource Accessibility

49 Gained/Translation: Activity = enterprise conference. Synergy b/w students, speakers (require info) and facilitators (transport). Oversight by facilitators.

273 and we're hoping that the students will

114 and it also enabled us to build the network where we can gather the data about what is happening in the facilities.
115 and share the knowledge - so we have positioned ourselves as that 'front door' of authority on enterprise in the Higher Education sector.
118 we've proactively positioned ourselves as a leading authority.

This is interesting, it is substituting clarity and simplicity for penetration with a distracted student body, but it still counts as a resource informing personal interaction.

114 and we're hoping that the students will engage not once but at least twice.

128 but there is so much engagement that will occur and people will want to engage because we add value (even if our funding has been cut). We also need to become a membership organisation where we'll have 20 institutions as members.
129 and then locally they'll all continue the delivery that we (originally) pump-primed - not because they're compelled to report to us, because we fund them, but because there's value in it.

In this case, 'share the knowledge' relates to making it available for the purpose of synergies (rather than 'showing it off' directly), which impacts impression and then support - therefore power. This corroborates the impressive nature of synergies alone.

In this example, disengagement resulting from a project targeted project resulted in a lower capacity below what Network Diversity promised. In combination with previous experience allowed the facilitators to The new capacity informed the creation of Furthermore, design a better project, with the characteristics of UG students in mind.

Network Capacity: What resources are both available and known to be available. In thay way, Capacity includes knowledge of who participants are offering inherently. Thus, if resource is ill-defined, only that part that understood adds to capacity. Thus, capacity may only be increased if knowledge of those within the network is also increased.
and we have a weekend workshop where we have 100 students there - working together, running ideas off each other, from all the institutions.

That will encourage them next year to engage in some of the workshops and what-have-you so it's leading by experience and leading through giving confidence and knowledge.

Another initiative we started which was piloted in Edinburgh is a 'Building Business Teams Portal' anything from matchmaking for physics and marketing to real commercialisation opportunities.

MIT has a very good model where they have a filing cabinet (full of unused IP) and you can rustle through and just run with it.

305 another initiative we started which was piloted in Edinburgh is a 'Building Business Teams Portal' anything from matchmaking for physics and marketing to real commercialisation opportunities.
100 IT company on the premises has begun a ‘club’ where we donate space for the meetings, so things are changing.

87 We’ll recommend one or two of these three VC companies who have all said they want to work with Oxford. If you don’t get along with any of those, come back and we’ll try to think of some more for you.

94 The ones that work best is when I organise a lunch between half a dozen people that are working in the same area.

102 Until recently the IP at each Cambridge of each of the professors was owned by the professors.

104 The guys would not do anything with it, because they were too busy or they flog it off.

16 Could openly say that in his experience the office was extremely under-resourced and with more resources could do some very significant things.

60 Spin-out companies exist as an independent entity that is beholden to no one and makes decisions in the best interests of the company.

Network Information

Knowledge Gained/ Lost

Facilitatory Capacity

Synergy

Identification

Facilitator Specialisation

Activity Begun/ Ceased

Knowledge Transfer

Policy Support

Network Extent

Linkage Improved/ Degraded

Network Engagement

Support Gained/ Lost

Synergy

Facilitator Specialisation

Personal Interaction

Anecdotal Impression

116 [Head Facilitator] is extremely good at the detail of designing a company structure to keep it moving.

57 Simple monthly license agreements including flexible expansion (move out in a month’s notice).

55 Helped with the infrastructure for companies to grow.

74 Begbroke (strengths and weaknesses).

75 Very strong ties to the university.

76 Lots of space, old materials research facilities ready to be used.

78 Answer: if it’s something beneficial, lets go for it. Otherwise, why waste everybody’s time.

99 Computer (hardware) companies have only a slight competitive advantage that is difficult to protect with patents.

121 the investors involved with onion (an angel network) can bring their own problems, such as the desire to be involved on a day-to-day basis.

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Engagement: Facility providers are part of the network, and when they are more ‘engaged’ better synergies become possible.

Extent: Begbroke is more about the ties between facilitators, making available a large range of resources that otherwise wouldn’t be.

Capacity → Extent: Professionalism, judgement (the right ppl)

Capacity → Information: Intelligence, memory, comprehension

Specialisation → Information: Focus, expertise, depth

Specialisation → Interpersonal: Subject matter, respect, appreciation

Capacity → Specialisation: Manpower, ability

Re 94 & 100: ‘Organising a lunch’ is pointless unless you have already met the people and they like you, and respect the system (ref my CEISYS meetings) – then they decide to come. But the synergy remains between them.

However organizing is like structuring a business, an oversight.

Knowledge Transfer: Includes networking activities – projects!

KT → Impression: When in own project, impression gained only by your interaction with facilitators. Since assume facilitators making full use of time, more projects don’t lead to more interaction. In fact, the reverse may be true since projects take up time, but this may be compensated for by improved intensity due to greater relevance.

U3_1
ISIS has a very good reputation as a Technology transfer operation. The network has been going for a decade and is a catch22 where one has to develop a reputation for a successful network before one can be a successful network. ISIS has built up a reputation and a body of investors who are active and serious and interested in things that come out of Oxford and other universities. Success breeds success, where you have a reputation in the investor community for providing interesting, exciting (if not less risky) but more upside. When you make successful introductions and people invest, companies see the network as a place where they will meet people who will invest in them.

With Oxford being a prominent research university there is a lot of innovative entrepreneurial activity around here. Oxford Trust set up about 15 years ago by Sir Martin Wood is a charitable body set up to foster and improve charitable activities in and around Oxford.

Section 22 has tax implications on start-up companies. If you're a TTO that spins out one company every three years, the implications are much smaller than if you are an ISIS that spins out a company per month. ISIS has been harder hit by the new legislation.

The critical part of my job is deciding which propositions are put to the monthly meeting, and I get one proposition a day. Sorting through, commenting on the propositions, though not a business plan advisory service, though we will tweak parts of ones I like.

I understand that ISIS is very active within the different academic departments and faculties. They maintain a high profile in terms of making academics aware of opportunities to commercialise their research. It's fair to say that many academics are not commercially minded and are content to remain in the academic sphere without commercial pressures.

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33 ISIS has been harder hit by the new legislation.
37 The network has been going for a decade.
38 It's a catch22 where one has to develop a reputation for a successful network before one can be a successful network.
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Network Capacity
- Facilitative Capacity
- Network Engagement
- Collaborative Activity
- Commitment Gained/Lost
- Linkage Addition/Removal

Capability Gained/Lost

Network Diversity

Page 276
Anecdotal Impression
Facilitator Capability
Synergy Identification
Interpersonal Interaction
Network Engagement
Support Gained/Lost
Knowledge Transfer
Policy Support
Network Extent
Linkage Improved/Degraded
Activity Begun/Ceased
Facilitator Specialisation
Accumulated Familiarity
Specialisation → Capacity: Increases personal confidence in one's job. Specialisation → Synergy: unavoidable when specialisation reduces proportionately how much u know

7 I'm a biologist so the biologists got a lot more of my time than the mathematicians

20 we had DTI funding to work with each other
23 the partnership was very useful in getting to know the other TT officers

16 people like Malcolm were brought in as head of IP and it brought a much more professional, focussed service into being

51 it's very important to be known to the academics

41 we (the facilitators) get a certain amount of protection if we're going to speak to commercial people, and they do as well (since they can't be blamed for stealing)

58 we try to structure a deal that meets those expectations

81 the places where there were commonalities we found there were collaboration s anyway

44 academics know that when they have an idea (ding) they know to come and talk to Ali (myself as bioscience) or Graham the physical science

49 allows us to find out about the context of the idea, 'background and foreground potential'

80 not forgetting that academics are competing more often than not for a limited amount of money, so to a certain extent they are in competition

49 its part of the TT 'biz' that you will never know everything about who knows who

84 its part of the TT 'biz' that you've got to have a feel for how the academic might work alongside the project

53 (its important) for lots of reasons.
20 but its impossible to bring academics together that don't really want to work together, and I don't think its right anyway, quite frankly

24 swap best practice and get advice on where you might go with technologies
25 we had a few one-day meetings centred around things such as drug delivery or neuroscience

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16 people like Malcolm were brought in as head of IP and it brought a much more professional, focussed service into being
11 It's important to be structured and above-board but that mustn't be the driving force
13 There is sometimes a perception that the deal comes from the legal agreement rather than the 'entrepreneurial' deal
14 So often the legal people obstruct deals
15 Sometimes the solicitors obstruct for good reason, but sometimes it doesn't happen because they have obstructed the deal to death

Shows the facilitator has to keep various aspects his network in check, otherwise he loses the ability to influence the outcome.
Synergy Identification: Rather than a good synergy being transported to a project, it goes on constantly. Thus, the project is continually re-conceptualised based upon the quality of information available to the participants – which include facilitators who are essentially a participant as well as an ‘office advisor’. As such, facilitators represent a repository of knowledge to know what works and guide the design of new projects.
19 funding something within a university department is tricky. It is difficult to "ring fence" the funding for a particular project. 20 departments will claw back money if they can, and take 'overhead fees' from funded or an internal project. This displaces the facilitator and reduces their ability to guide the project. 21 the academic having control of the money they can become sidetracked. Little eureka moments can cause the academic to go off on tangents to the original idea. 22 the academic has a scientific perspective and the fund managers have a commercial perspective with knowledge of the market. 23 maintaining the motivation of the academics towards a commercial objective, since their primary focus is research, it can make for a difficult relationship. 24 if the company is seen as being external to the department, the overheads may increase, support from the department waver and the academics focus reduces their ability to guide the project. 25 spin out companies provide a much more focussed set up.

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36 they are cultural issues from the departmental managers as well. They have to see that commercialisation is a good thing rather than a drain. 37 the returns will come back to their institution and that ultimately it will be a good thing, rather than worrying about the RAE status through staff loss.

Here the department (and the RAE) has the power to stop contribution from the academics and is therefore too strong. By selecting appropriate projects, facilitators can show the benefit, but also avoid sapping staff.

46 the universities all do the groundwork in finding the opportunities and doing the groundwork, and questa came down and receive the presentations. 47 questa had to learn, and the universities had a lot to learn about the investment process.

48 bring in expertise and contacts for interim management and mentoring, work on legals of company set up and take shareholdings on behalf of seedcorn fund shows how control of projects allows for indirect control of capacity.

56 questa had a lot to learn, and the universities had a lot to learn about the investment process. 58 there is now a growing pool of individuals with direct commercialisation experience coming out of universities ready to work on successive projects. 68 serial entrepreneurs we call them, the sort of people who are interested in starting things, getting them off the ground, bringing in the money. 88 often suls funding goes to recruit an interim CEO who's task is to a) bring in the next round of funding and b) to recruit the board and the management. Consultancy indicates there is no shared purpose, and therefore that they are not part of the collaborative activity. Thus other flow-on effects are not triggered.
57 when the university challenge funds all around the country were first announced, and bath/bristol was only one, they had all different approaches.

58 some of the challenge funds spent all the money by giving it straight away to the influential academics without real conditions or selectivity.

60 I don't think it worked very well particularly because after they had spent out their $250k, they were sitting on an array of opportunities.

61 they hadn't spent the money out, teased out the best opportunities, by just going for the obvious key professors.

This approach does everything wrong. It doesn't seek out a diverse network, it doesn't ensure activities are truly collaborative, and the outcomes are just as poor as the model predicts.

57 Rallis took a kind of fairly conservative investment policy; slow to start for the first couple of years.

64 working out what kinds of models were going to work; talking to all the academics and HODs; making sure they understood what the fund was for.

65 telling the academics what was going to happen after they had gotten the money; in other words, there was going to be a commercial expectation.

67 every time you invest in something and it is successful (it gets a license or its gets other funds and gets its own legs) and word gets around.

66 our rate of investment increased as the culture changed.

105 because of growing awareness, track record and some successes we've been having.

106 they don't come along and say they want to invest in a specific thing, they say we've got this money and would like to invest in some of your research.

This is why Engagement (and the ensuing information) doesn't directly cause new linkages to be made – it is a general thing.

58 there were challenge funds that hardly spent any penny. That were so selective it was like oh my god we can't possibly spend any of this money.

Everything as a network capacity (money) and no Facilitatory capacity, no Diversity, no Engagement. This disabled all the feedback loops and kept the system static. Facilitatory capacity is a system capacity, and deciding to not allow the money to be spent essentially kept this at zero.

57 Sulis does pay for the service of two roving 'mentors' - one on the ICT side and one on healthcare. Each of the 3 universities is at liberty to include them on any project if they think they can bring value.

99 we bring them into the universities to work with the opportunities and the TT executive to help facilitate everything and take it forward.

This is like the definition of facilitative capacity, and these guys can be brought in where required.