Loughborough University

Building A Boundaryless Manufacturing Organisation through HITOP method.

by

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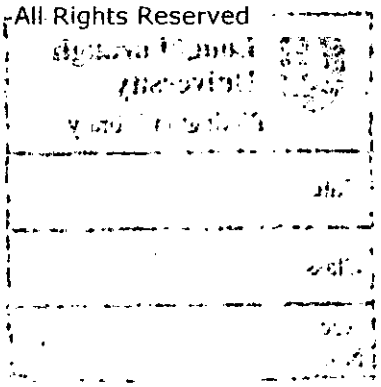

ABSTRACT

There is little empirical research to support the allegation that leagile manufacturing organisations thrive in hostile environments, nor has it been demonstrated that organisation processes (referred to as enablers) actually support leagile performance. This study tests the statistical significance of five selected HITOP (highly integrated technology, organisation and people) leagile enablers. This was accomplished by using a mail survey instrument to measure the presence of "leagile enablers" in a sample of companies taken from best factory award winners in UK, US and Japan. Companies were classified as successful or non successful on the basis of their financial performing using data envelopment analysis (DEA). Finally, logistic regression, and analysis of variance (ANOVA) tested the ability of each enabler to correctly classify the companies into their respective groups.

Research results indicate that leagile manufacturing organisations tend to survive in hostile business contest environment through highly integrated technology, organisation and people (HITOP) model. Its five HITOP enablers: organisational readiness for change (ORFC) and an assessment of the technology and identify its critical feature (AOT) and innovation and technology management analysis (IATA) and an assessment of the people's skill requirement to find new organisation structure (AOPS) and design organisation changes--HITOP model organisation application (DOC-HITOP) showed significance with its organisation performance on innovation and technology management. The results also show that lean organisations provide a perfect platform for agile and leagile organisations on innovation and technology management. A logistic regression model was developed in this study. It correctly classified 90% of all organisations as successful or non successful on the basis of survey responses for the leagile boundaryless manufacturing organisation question sets.

Acknowledgements

I would like to express my gratitude to the faculty and colleagues in Wolfson school of Mechanical & Manufacturing engineering who made it possible for me to accomplish my Mphil study. Each of you played a pivotal role that made it possible for me to arrive, successfully at this day. You, guided, contributed and, directed my efforts and, to each of you I will always be thankful.

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Finally, I want to say I am very proud of graduating from Loughborough University. Thanks.

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1	AOPS --- An assessment of the people's skill requirement	29
2	AOT --- An assessment of the technology	29
3	ASTs ---- Assets	173
4	AVE ----- Agile virtual enterprise	37
5	BOM ---- Bill of materials	55
6	BCC model--- The model introduced by Banker, Charnes and Cooper.	160
7	CAD ---- Computer aided design	141
8	CAM---- Computer aided manufacturing	141
9	CCT ---- Lean customer contact team	12
10	CGS ---- Cost of good sold	173
11	CIM ---- Computer integrated manufacturing	28
12	CNS ---- Central network server	141
13	CONWIP ---- Constant work-in-process system	54
14	CRS ---- Constant return to scale	160
15	CS&A --- General selling and administrative expense	173
16	DAI ----- Distributed artificial intelligence	121
17	DEA ---- Data envelopment analysis	159
18	DMU --- Decision-making unit	160
19	DOC-HITOP---- Design organisation changes—HITOP model organisation application in British NTBFs	29
20	ECM ---- Evolving cell model	121
21	EDI ----- Electronic data interchange	85
22	EE ------ Enterprise engineering	143
23	EI ------ Enterprise integration	14
24	EIMS----- European innovation monitor system	55
25	EKP----- Emergent knowledge processes	13
26	EMI ------ Enterprise modelling and integration technology	143
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29	GM ------ Gross margin	173
30	HITOP--Highly integrated technology, organisation, and people automated	12

31 HTSFs --- High-technology small firms 36

32 IATA ---- Innovation and technology management analysis 29

33 INV ------Inventory 173

34 JIT ----- Just in time 30

35 KBS ---- Knowledge-based system 121

36 Leagile---Lean and agile 12

37 MRP---- Material resource plan 55

38 MANOVA--- Multivariate Analysis of the Variance 155

39 MPIM model--- Manufacturing Paradigm Innovation Model 136

40 NDRTS---Non-decreasing returns to scale 162

41 NTBFs--- New technology-based firms 12

42 ORFC----Organisational readiness for change 29

43 Organocentric--- Technological innovation follows organisation adaption 23

44 OM ---- Operating margin 173

45 POA---- Percent over the group average 173

46 R&D --- Research and development 173

47 SLS -----Sales 173

48 STS -----Social technical systems 19

49 SVG ----Super value goods 173

50 TQM--- Total quality management 28

51 US SBIR/ STTR award---- US small business innovation research and small business technology transfer award 151

52 US ATP award ---- US national institute of standards and technology's advanced technology program 151

53 UK SMART award ----- UK department of trade (DTI) award for small business with innovation. 151

54 VC^3 team---- Virtual cross-value-chain collaborative creative teams 19

55 VRS model---Variable return to scale model 162

56 VE---Virtual enterprise 37

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Research Topic: Building A Boundaryless Manufacturing Organisation through HITOP method.

A solution by combining the merits of lean and agile and building a leagile boundaryless organisation in British new technology-based firms (NTBFs).

Mr YIYANG ZHANG

CHAPTER ONE: INTRODUCTION

In chapter one, Firstly I introduce why innovation and technology management is important for operation management, secondly I describe the aim of this research, thirdly, I synthesis the past research on lean and agile relationship and its impact on lean and agile organization, focus on innovation and technology management. Finally, I describe the overall thesis structure and the significance and limitations of this study.

1.1: PROBLEM CONTEXT

Increasing competitive pressures are forcing companies to increase their rates of innovation. Successful organisations treat innovation as the key competitive advantages (Pavitt 1987, Uttal1987, Storey 1994, Thomas 2001, George 2005, Davila 2006). However, global marketplace has resulted in an environment where technologies, competitive positions and customer demands can change almost overnight and lift-cycles of products and services are getting shorter.(Olshavsky 1980, Qualls 1981, Sanderson 1990, Clayton 1997, Nicholas 1999) This requires the firms to develop the ability to highly integrate their technology, organisation and people (HITOP) without limits to geographical or organisational boundaries. In such environment, lean customer contact team

(CCT) (Womack 2005) and Virtual Agility's Far-Flung team or VC^3 team (Virtual cross-value-chain collaborative creative teams) (Majchrzak 2004) are deployed for knowledge sharing and innovation creation. CCTs are defined as teams of frontline workers who meet with a customer's or supplier's front line workers. (Levinson 2002) Far-Flung teams are defined as virtual teams that are multi-unit/multi-organisational, multi-functional, globally dispersed and conduct their interdependent activities mainly through electronic media with minimal or no face-to-face interactions.

From the innovation management point of view, the merits of CCT teams are they can promote customer-supplier communications at the shop floor level and they rely on three characteristics. Firstly, they use the frontline manufacturing worker's knowledge, skill and experience. Secondly, they open short, direct communications between the people who make a product and the people who use it. Thirdly, they improve sensitivity toward customer concerns within the organisation. Meanwhile, the merits of Far Flung team or VC^3 team are they can create computer-supported inter-organisational virtual team for knowledge sharing and radical innovation using computer-mediated collaborative technology for emergent knowledge process design (EKP). (Majchrzak 2002)

However, innovation management is risky and expensive. In managing innovations organisations face a completely different control problem than in managing steady-state processes like production or logistics. The difference between controlling an innovation process and controlling a steady-state production process reveals itself with respect to:

The time dimension:

Like a production process, an innovation process has a beginning and an end, but the transitory nature of the innovation process makes it impossible to build in permanent facilities. Innovation processes ('the production of one new product') generally run much longer and are more stochastic than production processes ('the production of a known product');

The system boundaries:

In a production process, people work in groups whose composition rarely changes. In the case of innovation processes, however, system boundaries are continuously changing or blurring as the composition of the group of people working on the innovation projects or involved from the outside (customers,

suppliers) changes both during the process and from innovation to innovation as well;

The amount of routinization:

Contrary to the case in steady-state processes, the material and information flows in innovation processes are unique for each process. Routinization (or learning by doing) occurs when knowledge and skills learnt in a particular process are reapplied to the same process. This 'gliding down the learning curve' which occurs in steady-state processes is difficult to achieve in innovation processes, since such processes all differ from each other. In production processes, one learns from the process with the aim of mastering the same process more effectively, whereas in innovation processes one must learn from the process in order to master future, similar or related processes more effectively. In the later case, learning from experience occurs mainly in the course of different (innovation) processes and not within the same repeating process. This implies a different type of learning and routinization.

The amount of uncertainty:

The degree of freedom in an innovation process is usually much higher than in a production process, especially at the start, when there is often only a vague idea about the characteristics and appearance of the new product or simply a list of specifications. During the process, the degree of freedom will decrease. Among other things, this uncertainty about the final outcome implies that managers cannot always function on the basis of existing norms and values, because these very norms and values are themselves subject to change and may no longer meet the requirements.

Therefore, Modern companies are considering 'organisational solutions' to this new challenge: internal and external co-operation has increased and greater emphasis has been placed on interdisciplinary and holistic perspective. (Kanter 1989b, Docter 1989, Biemans 1992) In other words, the solution relies on manufacturing organisation integration (Lazonick 1998, Ghoshal 2002) and enterprise integration (EI). (Bernus 1996)

The value of lean and agile principles for innovation management has been under-researched (Yusuf 1999). Although studies exist on lean and agile practices (Robertson 1999, Evans 2000), these studies have not distinguished theoretically derived dimensions of lean and agile principles in innovation

management, or examined the relationship between the use of these lean and agile principles in those British new technology-based firms.

This research will focus on combining lean and agile principles to create a boundaryless leagile manufacturing organisation in British new technology-based firms through HITOP method.

In sum, my study seeks to answer the following research questions:

1. Lean and agile: which manufacturing organisation can create innovation more effectively?
2. How to combine lean and agile merits to create a boundaryless leagile manufacturing organisation in British new technology-based firms?

The rest of this chapter discusses each problem in more detail. The objective is to frame the problem in light of previous research, discuss the solution technique, and articulate why the problem is worth studying.

1.2: RESEARCH AIM AND OBJECTIVES

My overall aim is to extend the work on lean and agile manufacturing organizations currently in progress in British new technology-based firms. As part of this aim I will also investigate the applicability of the HITOP (define HITOP) methodology. The particular objectives of my research were as follows:

1: I will determine to find if lean and agile relationships provide a key way for modern manufacturing organizations to influence innovation and technology management.

2: I will determine if at the new technology-based firm level, this new leagile manufacturing system is a major contributor to the innovation and technology management by means of combining the merits of lean and agile manufacturing organizations.

3: I will investigate the applicability of the HITOP leagile model and its five enablers: organisational readiness for change (ORFC) and an assessment of the technology and identify its critical feature (AOT) and innovation and technology management analysis (LATA) and an assessment of the people's skill requirement to find new organisation structure (AOPS) and design organisation changes for HITOP model organisation application (DOC-HITOP)

1.3: SYNOPSIS OF PAST RESEARCH

OPTIMAL LEAN AND AGILE MANUFACTURING ORGANISATION FOR INNOVATION AND TECHNOLOGY MANAGEMENT

Past research brings many choices on lean and agile manufacturing organisation for innovation and technology management. For instance, Andy (2001) provides a reference model to research the relationship between business performance, innovation and the internal and external factors that can facilitate innovation within a company. In the framework he has included an intermediate block of variables, called "outcomes of innovation", which refers to the efficacy of innovation in getting, for example, lower costs and/or better service. In other words, the outcomes of innovation are the results of the exploitation of the different kind of innovation. (Figure1).

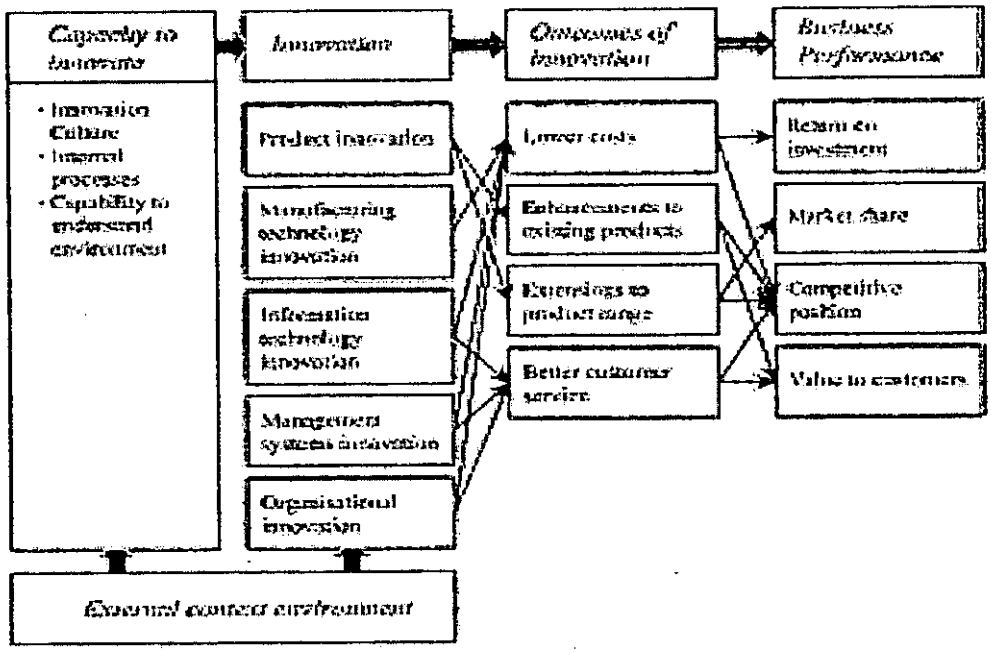


Figure 1: *Links between types of innovation and outcomes of innovation, and between outcomes of innovation and business performance.*

Source: Andy Neely (2001): A framework for analysing business performance, firm innovation and related contextual factors: perceptions of managers and policy makers in two European regions. Integrated manufacturing systems, Vol 12(2) 2001,pg 114-125.

Previous research on lean and agile innovation management brings more detail evidences. For instance, Riitta (1994) brings a generic framework to manage innovation change towards a lean enterprise. (Figure 2) His case study focus on Finland car industry flexible manufacturing system (FMS) development shows that internal "lean" change in manufacturing processes can trigger radical innovation towards lean enterprise structures. According to his generic framework, the vision, direction and the guidelines for change are the most important top-down managing tools. The individual change projects can and should unfold under this development umbrella, consciously managed as innovation processes that enable participation, bottom-up creativity and learning. Also this change management framework contains, as an important method, social simulation games. In the games, an effective "hologram" structure is created for innovation.

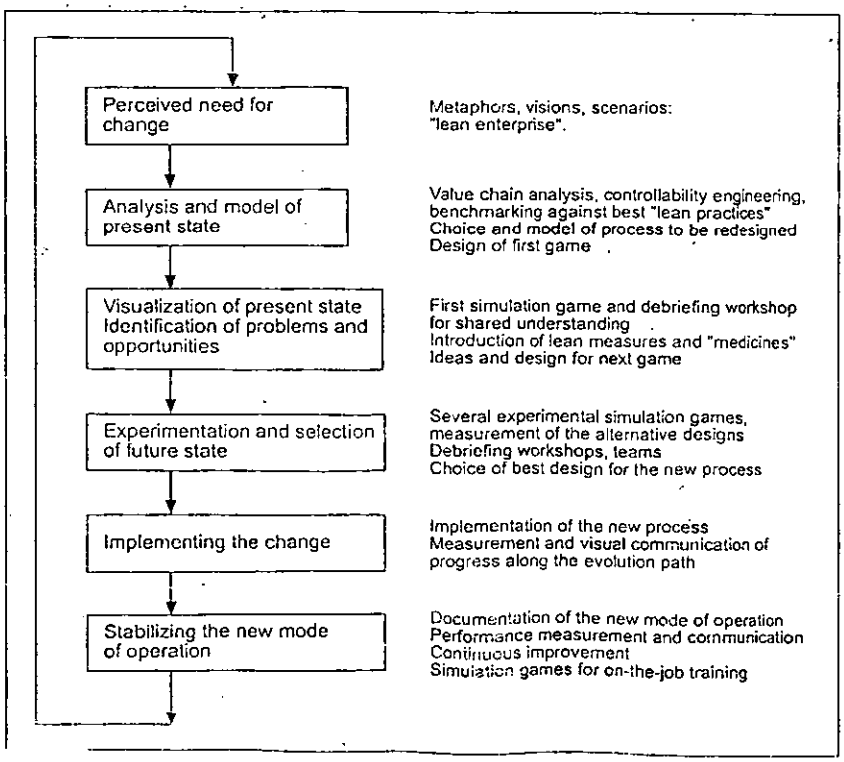


Figure 2: The Generic Framework for the management of change towards a lean enterprise.

Source: Riitta Smeds (1994): Managing change towards lean enterprises. International journal of Operations & Production management, Vol 14, No.3.1994.pp.66-82.

Meanwhile, Hauschildt (2000) brings two theoretical concepts "Gatekeeper concept" and the "Promotor model". Through empirical studies on innovation management in German agile practices, they state that the combination of these two concepts can create a powerful management concept for supporting agility in organisation.

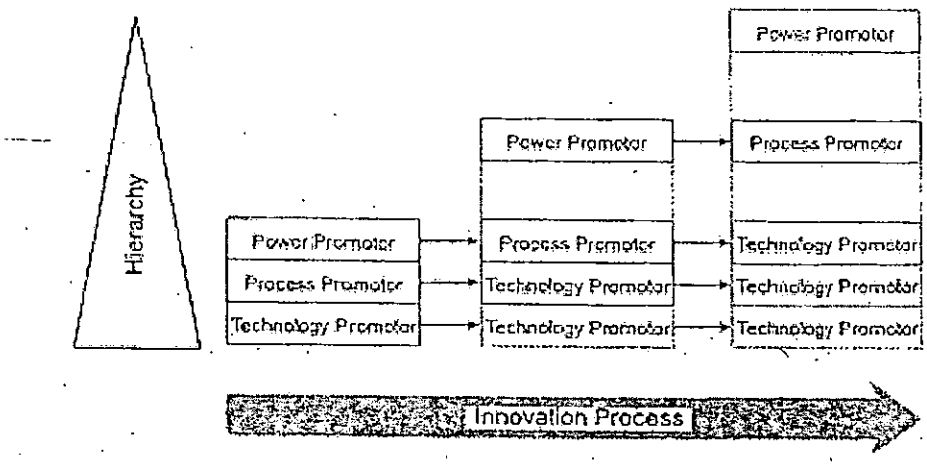


Figure 3: Change of the roles performed by key persons during the innovative process.

Source: Jurgen Hauschildt and Gerhard Schewe(2000): Gatekeeper and process promotor: key persons in agile and innovation organisations. International Journal of Agile Management systems 2/2 (2000) 96-103.

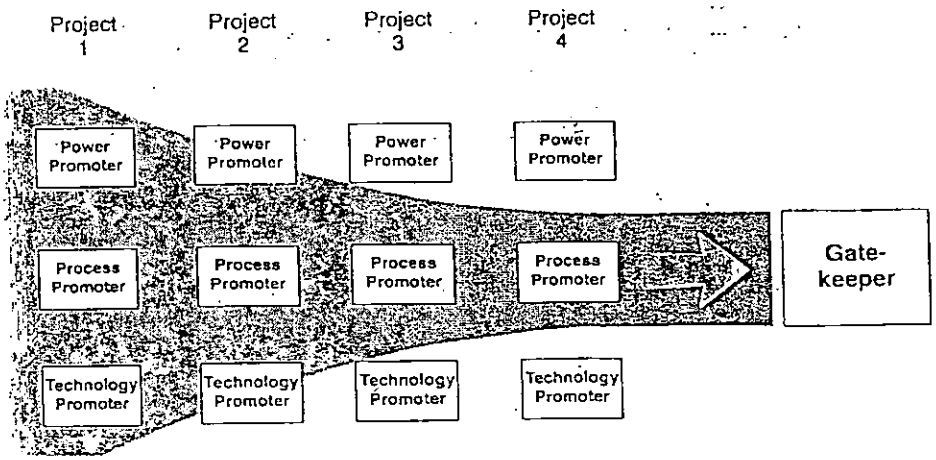


Figure 4: changes in the roles performed by key persons during a series of projects.

Source: Jurgen Hauschildt and Gerhard Schewe(2000): Gatekeeper and process promotor: key persons in agile and innovation organisations. International Journal of Agile Management systems 2/2 (2000) 96-103.

Therefore, in my research, the innovation management analysis strategy will follow the previous research on lean and agile innovation, but I will especially focus on leagile innovation management through combining the merits of lean and agile innovation.

OPTIMAL HITOP MODEL MANUFACTURING ORGANISATION FOR INNOVATION AND TECHNOLOGY MANAGEMENT

HITOP-A model (Highly Integrated Technology, Organisation, and People-Automated) was designed by Professor Ann Majchrzak from University of Southern California, which can facilitate interdisciplinary agile manufacturing systems design to support the agile virtual enterprises. Based on Chern's classic socio-technical systems (STS) theory, Majchrzak introduces a new midrange STS theory for agile systems that can support emergent knowledge processes. Also she believes that this new agile manufacturing organisation can create innovating virtual team, called Far-Flung team or VC^3 team (Virtual cross-value-chain collaborative creative teams) in those multi-functional global manufacturing organisation through 'Virtual workspace technology' (Majchrzak 2005).

However, the question as to whether the combined effect of more than one competency, such as technology or organisation competency, provides a better explanation for innovative success has so far remained unanswered in any academic books. Here is some debate on how to create optimal innovation management.

Kanter (1983) found that the entrepreneurial spirit which generates innovation is associated with an 'integrative' way of approaching problems: the willingness to move beyond received wisdom and to combine ideas from unrelated sources. In an integrative climate, problems are seen and treated as 'wholes', and as related to larger wholes (context). Such organisations reduce rancorous conflict and isolation between organisation units; create mechanisms for the exchange of information and ideas across organisation boundaries; and ensure that multiple perspectives will be taken into account in decision making. On the other hand, companies which have adopted the contrasting management style, referred to as 'segmentalism', find it difficult to innovate or handle change. The segmentalist management style (Kanter 1983) is concerned with compartmentalising actions,

events and problems and with keeping each piece isolated from the rest. Problems are seen as narrowly as possible, independently of their contexts and relationships to other problems.

However, Grant (1991) argues that, for most firms, the most important capabilities are likely to be those which arise from an integration of functional capabilities, such as the McDonald's management. McDonald's possesses outstanding functional capabilities in product development, market research, human resource management, financial control, and operations management. Critical to McDonald's success, however, is the integration these functional capabilities to create the concern's remarkable consistency of products and services in thousands of restaurants spread across most of the globe.

Meanwhile, Harvard business school scholar William Lazonick (1991) defines 'organisation integration' as it is a set of ongoing relationships that socialises participants in a complex division of labour to apply their skills and efforts to the achievement of common goals. The foundation of the socialisation process that achieves organisation integration is 'membership': the inclusion of the individual or group into the organisation with all the rights and responsibilities that membership entails. In a business organisation, a fundamental right of membership is employment security, and a fundamental responsibility is to ensure that the pursuit of one's individual interests is consistent with organisational goals.

Lazonick states that it should be emphasised that our use of the term 'organisation integration' focuses on the social process that achieves cooperation among individuals and groups of individuals, whether they are employed by the same firm or different firms. This usage differs from the common notion that terms such as 'vertical integration' or 'horizontal integration' apply only to individuals and groups employed by the same firm.

For the business enterprise engaged in competition for product markets. Organisational integration permits the specialised division of labour to generate higher quality and/or lower cost products than the enterprise had previously been capable of producing organisational integration provides the capability to learn as an enterprise and the potential to innovate in market competition.

At the same time, Lazonick states that organisation integration is a costly process. To build the relationships among the participants in the specialised

division of labour that are the social substance of organisational integration requires substantial commitments of resources over sustained periods of time. The high fixed costs of building these relationships will place the enterprise at a competitive disadvantage until such time that the learning process that these relationships generate yields returns. The prospects of returns, moreover, are always highly uncertain, in part because the expected learning may not occur and in part because even when it does occur this learning may not be sufficient to meet the challenge of more innovative competitors (Lazonick 1991). The building of the relationships that constitute organisational integration must therefore be strategic.

Lazonick(1993) states that American industrial corporation's strategic responses to Japanese competitive challenges can be categorised as either innovative or adaptive. An innovative strategy entails investments that enhance the productive capability of new combinations of inputs, thus making possible the generation of higher quality, lower cost outputs. Whether any particular innovative strategy succeeds depends on whether the upgrading and recombination of inputs yields sufficient increases in quality and decreases in cost to make the enterprise's products competitive. In contrast, an adaptive strategy does not attempt to upgrade and recombine the productive capabilities of the enterprise's accumulated assets and purchased inputs. The timing of an enterprise's strategic response to a competitive challenge is critical because of the need to augment the productive capabilities of the enterprise's resources.

It is useful, therefore, to distinguish the strategic responses of companies according to whether they are (i) innovative or adaptive, and (ii) prompt or delayed. In considering differences among companies in response to competitive challenges, we shall employ five categories of investment strategies: first mover (innovative), fast mover (innovative), slow mover (adaptive, but then innovative), no mover (adaptive) and remover (adaptive).

Lazonick (1993) states that to generate the higher quality, lower cost products that bring competitive advantage, and innovative enterprise must have an organisation structure to implement an innovative strategy to develop an utilize technology. To put this organisational structure in place and to sustain the learning process that this organisational structure must generate requires that strategic decision-makers have access to what we call 'financial commitment'.

Financial commitment represents the willingness of those who control financial resources to commit these resources to financing the high fixed costs of developmental investments that, because they entail innovation, promise uncertain returns. (Lazonick 1992, O'sullivan 1995)

Given the requisite financial commitment, a managerial organisation is required to plan a coordinate the development of the specialised division of labour and the integration of the specialised productive activities required for an innovation to emerge. Competitive advantage requires a learning process that results in the generation over time of higher quality and/or lower cost products. Lazonick (1993) summarises the general attributes of the learning process as concentrated, continuous, cumulative and collective. Concentrated learning ensures that one focuses on the objects of productive transformation to acquire best-practice skills. Continuous learning results in productivity enhancement in particular skills. Cumulative learning permits new skills to build on the foundation of previously acquired skills. Collective learning enables the planned coordination of specialized divisions of labour to develop complex technology and generate productivity. Management's role is to ensure the concentration continuity, cumulativity, and collectivity of the learning process.

For innovation to occur, the combination of financial commitment (strategy) and organisation integration (structure) must result in the development of technology that yields higher quality products and utilisation of technology that yields lower unit costs. The development of technology entails the combination of machines, materials and labour in the learning process. Labour is the most critical input into the innovation process because it is the input that can potentially learn, because of the concentrated continuous, cumulative and collective character of the learning process.

Also MIT Sloan school researchers Ghoshal Sumantra and Gratton Lynda (2002) spent five years researching 15 large, global companies in North America (Oracle, Goldman Sachs, Sun Microsystems), Western Europe (ABB, BT, Lufthansa, SKF, BP, LVMH), Asia (Sony, the LG Group, Standard Chartered Bank) and emerging markets such as Brazil (Natura) and India (Indian Infosys , Nicholas Piramal). Their research focus is not on integration, per se, but on management of change and performance-improvement processes. The issue of horizontal integration emerged from their research as one of the important means

many of these companies were adopting in order to improve their business performance. The authors have seen that it is possible to balance those tensions between submit autonomy and empowerment on the one hand and overall organisational integration and cohesion on the other successfully by implementing four kinds of horizontal integration for achieving cohesion without hierarchy. The four areas of action are:

(1) Operational integration through standardisation of the technological infrastructure.

(2) Intellectual integration through the development of a shared knowledge base.

(3) Social integration through collective bonds for performance.

(4) Emotional integration through the creation of shared identity and meaning.

In UK, The early pioneer researcher on joint technology and organisation design is Professor Joan Woodward (1965) together with other organisation theorists in the UK and USA, such as Burns and Stalker (1961), Thompson (1967), Lawrence and Lorsh (1967), and Perrow (1967), they can be credited with the foundation of the school known as the Contingency theory of organisation. The common theme underlying this theory is that if an organisation is to maintain good performance its structure in particular, must be designed to fit the situational demands which stem from the technology being used, its market position, its product diversity and rate of change, and its size. The common focus is that these contingent factors—technology, market situation, diversity, size generate varying degrees of uncertainty and complexity which have to be 'coped with' by the development of appropriate structures and the encouragement of appropriate behaviour and attitudes on the part of management and workers.

Also, Oxford University scholar Giovanni (1998), the editor of their pioneer Journal "Industry and corporate change" states that Organisation systems mediate the impact of technology on competitiveness. Absent robust and adaptable organisational systems in firms, among firms, and between firms and external institutions, the fruits of technology will become dissipated. Conversely, well-designed organisation structures and effective management are the handmaidens of competitive advantage, economic developments and growth.

Many scholars bring their unique opinions on how to joint technology and organisation design. For instance, Bessant and Haywood (1988) bring an 'organocentric' approach where technological innovation follows organisation

adaption. And Scarbrough and Lannon (1998) emphasise the usefulness of taking an 'organisational learning' approach to the management of technology.

Also Gregory (1990) points out the relationship between operations and technology should be decoupled. Successful operating strategies must be grounded in marketplace and competitive requirements. The combination of operational drivers and technological capabilities, tempered by real-world constrains, defines how well a company can deliver its service. This holistic approach ensures that customer needs are met, that internal competing factors are balance, and that technology is fully integrated into operations.

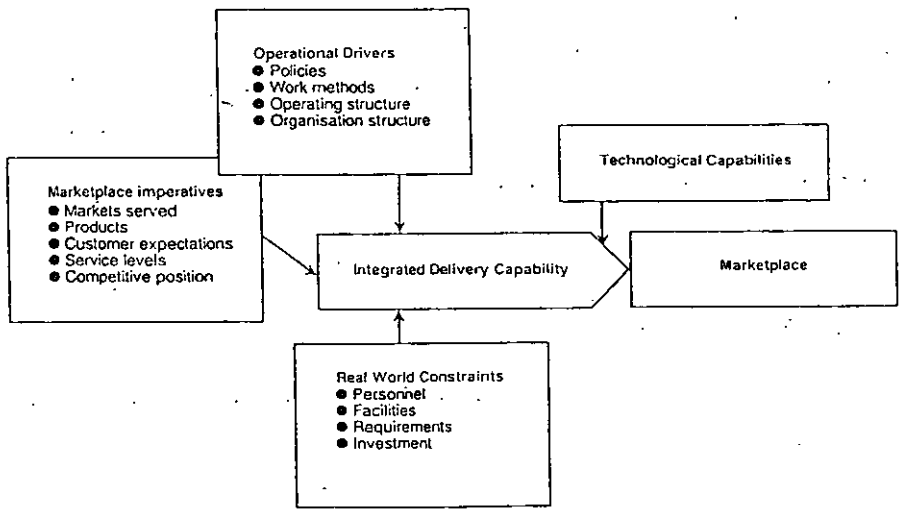


Figure 5: Integrated Operating Strategic Framework.

Source: Gregory R.Hackett(1990): Investment in technology—the service sector sinkhole./ Sloan management review winter 1990.

Dorothy Leonard-Barton (1987) points out technology and organisation should be implemented as mutual adaptation. He summaries three types of implementation misalignments:

(1): Technical: the technology with its original specifications or with the production process into which it is introduced.

(2): Delivery system: the technology with user organisation infrastructure (supporting hardware, software or educational program).

(3): Value: the technology with job performance criteria in the user organisation.

He also defines that the responses of those above adaptive misalignments are conceived as recursive cycle, because the process is one of circling back to revisit a decision point—reopening issues of technical design that the developers assumed were resolved, redesigning delivery systems in the user environment or 'unfreezing' organisational routine to re-examine the goals implied by current performance criteria. These adaptive cycles vary in magnitude, depending upon how fundamental is the change to be made. In the case of technology adaptation, a large cycle would mean that the developers return to the drawing boards, whereas a small cycle would entail a shift very low in the 'design hierarchy', that is , a minor adaptation such as a new module of software code or a different nose cone piece on an electronic pump (Figure 6,7,8).

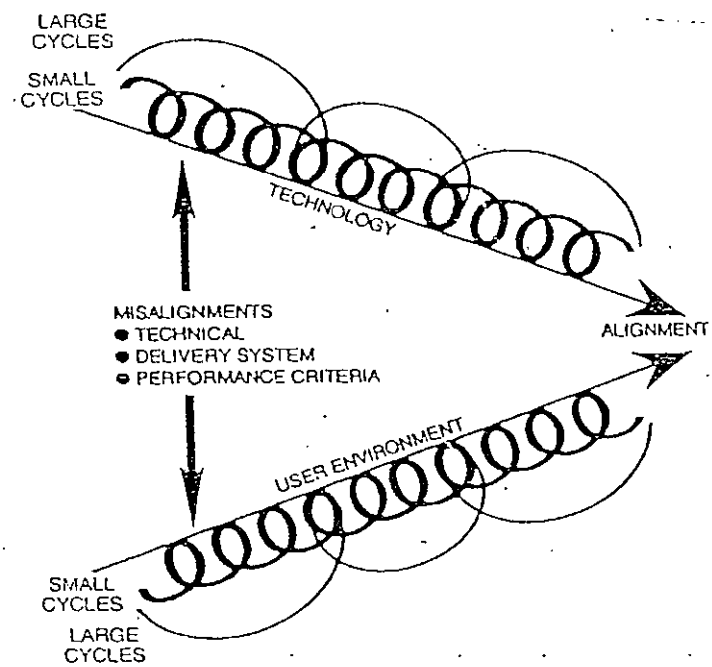


Figure 6: Mutual adaptation of technology and organisation

Source: Dorothy Leonard-Barton (1987): implementation as mutual adaptation of technology and organisation, Research Policy, Vol.17, 1988.

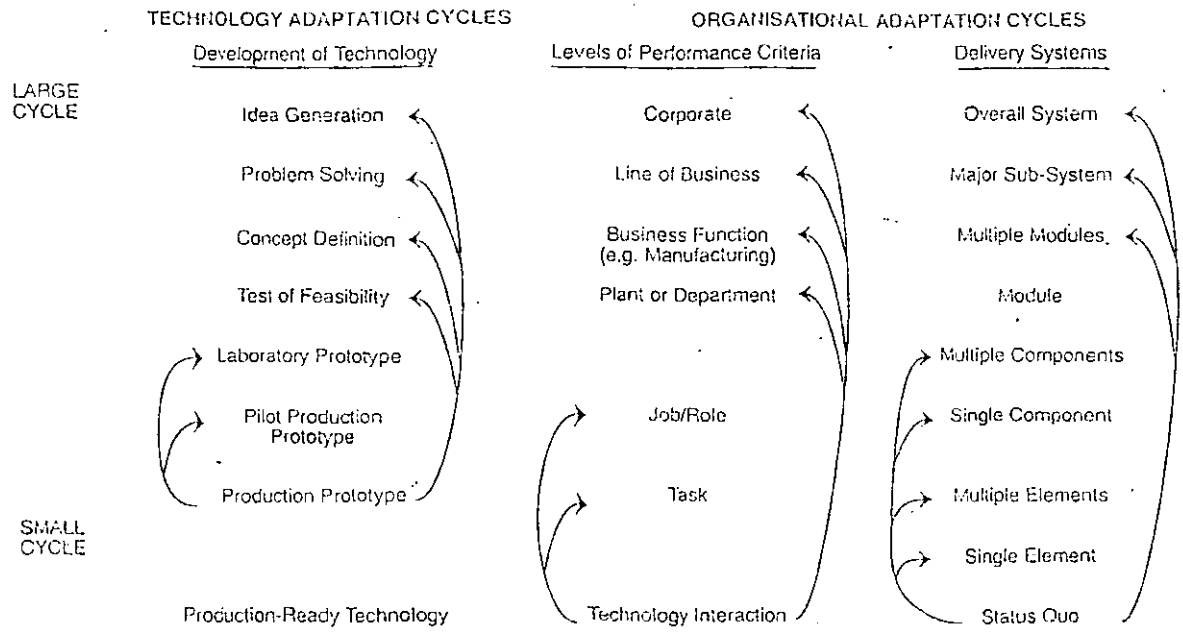


Figure 7: Large and small cycles of redefinition

Source: Dorothy Leonard-Barton (1988): implementation as mutual adaptation of technology and organisation./Research Policy, Vol.17, 1988.

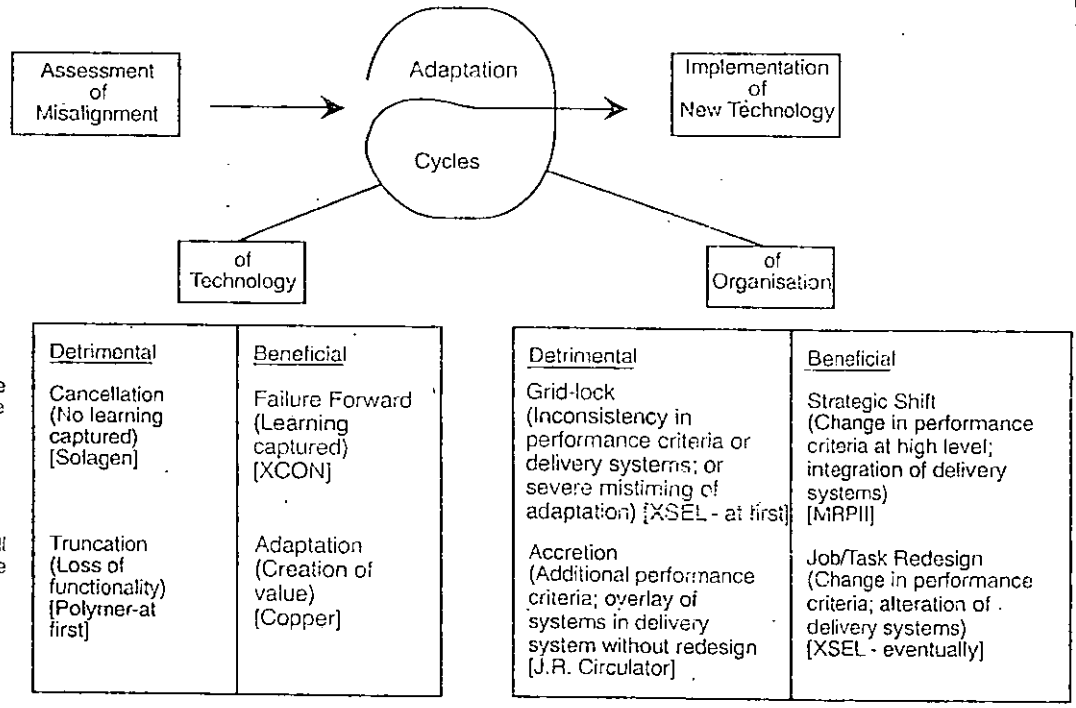


Figure 8: Forms of adaptation: beneficial and detrimental

Source: Dorothy Leonard-Barton (1988): implementation as mutual adaptation of technology and organisation./Research Policy, Vol.17, 1988.

Also Erkko (1995) addresses the development of new technology-based firms in innovation networks. He defines the new innovation system model or an innovation network.

Table1: Summary of qualitative differences in the business descriptions of science-based firms and engineering-based firms.

Science-based firms	Engineering-based firms
1. Product or service of the firm is described in terms of some natural phenomenon. 2. Product of service of the firm is described in terms of some theoretical construct. 3. Product or service of the firm is generic in nature. 4. The scope of application of the product or service is (relatively) broad. 5. (Generic) technical features of the product or service are emphasised in the business description. 6. The business description conveys the impression of a technology-push mode of technology transfer; exploitation of technological opportunities is emphasised.	1. Product or service of the firm is described in terms of some specific application. 2. Product or service of the firm is defined in terms of some customer need. 3. Product or service of the firm is application-specific in nature. 4. The scope of application of the product or service is (relatively) narrow. 5. Market needs and features of the market niche are emphasised in the business description. 6. The business description conveys the impression of a market-pull mode of technology transfer; exploitation of market opportunities is emphasised.

Source: Erkko Autio (1993): New technology-based firms in innovation networks.Technology in society, Vol.17, pp.365-84.

Therefore, in this section, I make two arguments: innovation management can be differentiated along lean and agile principles, and HITOP method is able to bridge the gap between lean and agile innovation management through joint technology and organisation design. This research will focus on HITOP method for optimal innovation management through finding the boundaries among those

lean and agile and total quality management (TQM) and computer integrated manufacturing (CIM) organisations.

1.4: SIGNIFICANCE OF THIS RESEARCH

This study provided several significant contributions to the body of knowledge. (1) It produces a HITOP leagile organisation framework based on the theory of joint technology and organisation design. Its organisation design theory is called "middle range socio-technical system" which evolves from traditional organisation theory because modern business contest force organisation seeking integration solution to highly integrated technology, organisation and people. Lean and agile organisation are born under this circumstance, the core concept of lean is relentless eliminating waste and agile is using virtual information system. They share the same organisation platform as socio-technical system, because they all rely on integrating technology, organisation and people to build a knowledge-based organisation.

(2) It demonstrates the existence of reciprocal relationships between lean and agile organisation, mainly focus on innovation and technology management. The reason I choose innovation and technology management is that it can create four modern success organisation factors: speed, flexibility, integrating and innovation. Also leagile boundaryless organisation can create new leadership to overcome four traditional organisation boundaries: horizontal, vertical, external and geographical boundaries. In my research, I find lean innovation is strongly connected with lean culture. Through its unique customer contact team, lean organisation will obtain optimal innovation and technology management under stable operation environment. However, agile innovation is strongly connected with virtual information system, called Far-flung team for radical innovation. Agile organisation will obtain optimal innovation and technology management under hostile business contest environment. But through comparing lean and agile innovation and technology management practices in British new technology-based firms, I find lean organization brings a perfect platform for agile and leagile organization practices. It is possible to combine the merits of lean and agile innovation and technology management to create a leagile organization based on existed data resource. However, more research need carry on cross different industry sectors to support this leagile organization concept in the future.

(3) It brings one of the optimal paths to transfer traditional JIT/ TQM/ CIM/ BPR organization to modern lean and agile organization through HITOP leagile organization model. Through comparing with other paths to transfer to modern lean and agile organization, I find HITOP leagile organization has its own unique merits, such as solid mid-range socio-technical organization theory with easy to follow organization design steps, also it is knowledge-based expert system through continue absorbing best lean and agile practices from those blue print company like Boeing and HP companies. It make senses that this HITOP leagile model is best fit the need from those new technology based firms, one the one hand, those NTBFs keep innovation and technology management as their unique competitive advantages, on the other hand, they urgently need mature organization structure to support its innovation and technology management with limited investment, this HITOP leagile model can satisfy their requirement with reasonable investment.

1.5: THESIS STRUCTURE

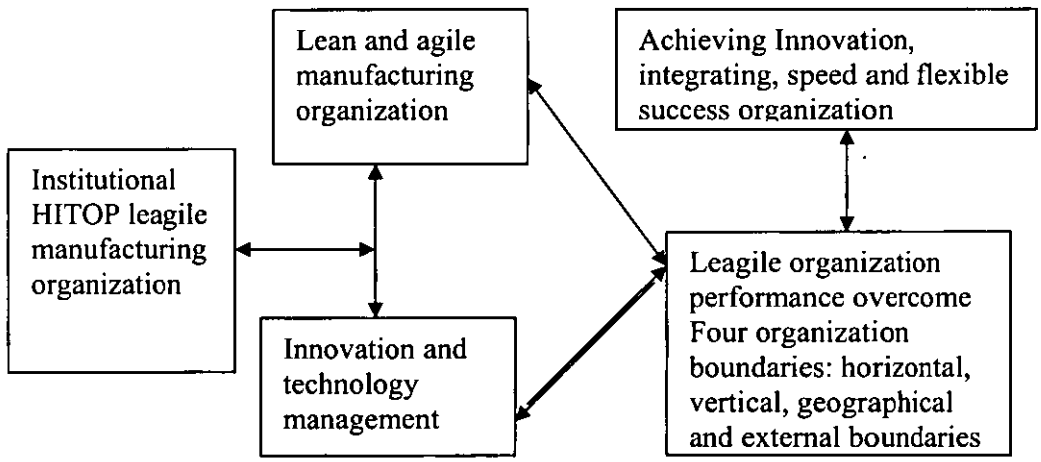


Figure 9: Overall framework for the Dissertation

This thesis is organized around three primary parts. Figure9 illustrates the overall structure of the dissertation. The underlying theme of the thesis is the relationship between lean and agile manufacturing organisation and innovation and technology management in British new technology based firms. The research aims to address the following three general questions? First, what is the

relationship between lean and agile manufacturing organisation? What are the underlying mechanisms that help to explain the relationship? Second, what role does the specific mechanism of HITOP method play in innovation and technology management and what organisation structures are needed to facilitate this HITOP method? Third, how do lean and agile manufacturing organization join together to create a new leagile manufacturing organisation? How might HITOP method influence this leagile manufacturing organisation?

The first part, chapter 2, starts at the most macro level, lean and agile and their relationships, focuses on the role of innovation and technology management. Despite past research explores the leagile organisation concepts, many questions remain regarding this leagile organisation structures, how HITOP method will influence this its innovation and technology management?

Using both quantitative and qualitative data, the second part, chapter 3, focus on testing five HITOP enablers through broad survey in those best factory award winners in Japan, UK and USA. Although this five HITOP enablers: organisational readiness for change (ORFC) and an assessment of the technology and identify its critical feature (AOT) and innovation and technology management analysis (LATA) and an assessment of the people's skill requirement to find new organisation structure (AOPS) and design organisation changes for HITOP model organisation application (DOC-HITOP) show significant connection with leagile organisation, there remains much to be understood about the complex relationship between leagile organisation structure and its influence on innovation and technology management.

The third part, chapter 4, moves to the highest level of analysis to look at the influence of HITOP leagile organisation on innovation and technology management. Through comparing with lean and agile organization performance, leagile organization explores the conditions under which combining lean and agile organizations can obtain optimal innovation and technology management.

1.6: LIMITATION OF THIS RESEARCH

The limitation of this research includes the following items:

1: In this research, I only focus on lean and agile relationship on innovation and technology management for those British new technology-based firms and design a HITOP leagile organization with five HITOP enablers. However, lean and agile

relationship is very comprehensive, the same as innovation and technology management research, maybe in the future, more advanced theories will replace current popular socio-technology system (STS) theory, then HITOP leagile organization will need more solid theoretical ground to support.

2: In this research, I only find limited lean and agile measure methods, one is Arizona University's multi-echelon inventory theory for lean system analysis, another one is Ted Goranson's agility measuring metric. However, in the future, more and more advanced lean and agile organization performance measure methods will be developed, maybe this five HITOP leagile enablers' test need redefined by new lean and agile measure methods.

3: In this research, I only focus on those British new technology-based firms, because I assume that innovation and technology management is the key for their future business contest, and they are new organization easy to adopt modern advanced lean and agile practices. However, many fortune 500 companies are also adopted lean and agile practices, maybe this five HITOP leagile enablers test will bring different results from those well-organized fortune 500 companies than those British new technology based firms. Actually, it is much better for HITOP leagile organization test through comparing those different test results, but due to the time limit, I have not yet started it.

4: In this research, I only choose DEA method to measure the lean, agile and leagile organisation performance, because DEA is current . most popular organisation efficiency measuring method and its malmquist index is suitable for the multi-input and multi-output data resource, such as innovation and technology management.

However, innovation and technology management has no standard measure method so far, the same as lean and agile and leagile organisation measuring method. Maybe in the future, more standard measure methods have been developed, HITOP leagile organisation performance will be measured more accurately.

1.7: Summary

In chapter one, I introduce the background of this research, innovation and technology management leads to new business competitive advantages for those new technology-based firms. In order to adopt modern advanced manufacturing

practices--lean and agile manufacturing practices, both academic and industries need investigate the relationship between lean and agile manufacturing. Through synthesis the past research literature on lean and agile relationship and its influence on innovation and technology management, this research finds the following literature gaps:

1: Both lean and agile manufacturing lead to innovation and technology management through the same theoretic platform—middle range socio-technical system (STS) theory, in other words, using manufacturing organization integration solution—highly integrated technology, organization and people. However, so far I have not yet found any leagile organization exists in either academic research paper or real world industry operation management model.

2: Both lean and agile manufacturing research has been carried on in parallel directions. Lean manufacturing has been successfully transferred from original lean thinking to lean enterprise and lean consumption on service management. The next step lean research will focus on lean design, lean and green, lean accounting and financial management, in other words, lean solution. However, agile manufacturing is original from US manufacturing strategy in 2020---creating more flexible and responsible manufacturing strategy for next generation business contest. It highlights using virtual information technology to create a virtual agile enterprise. In sum, the weakest link between lean and agile manufacturing is lack of standard measuring method. Although I find lean inventory planning model using Arizona university's multi-echelon inventory theory and Agile virtual enterprise reference model using Ted Goranson's agility measuring metrics, both of them are still exist on academic research level at present time.

3: Both lean and agile principles have been adopted in British industry, such as BT and Tesco, however, the problem is which model is optimal: lean, agile and leagile. How to measure the efficiency of their lean, agile or leagile organization performance?

Therefore, based on above literature gaps, the aim of this research includes:

1: Combining the merits of lean and agile principles through middle-range socio-technical system to create a new leagile manufacturing organization, in other words, using highly integrated technology, organization and people (HITOP) leagile manufacturing organization solution.

2: Testing HITOP leagile manufacturing organization five enablers for innovation and technology management in British new technology-based firms.

3: Comparing lean, agile and leagile manufacturing organization performance, focus on innovation and technology management using DEA method analysis the survey reply data from those best factory award winners in Japan, UK and USA.

In general, the research conclusion includes:

1: HITOP leagile manufacturing organization can satisfy the goal of combining the merits of lean and agile principles at both theoretical and real-world operation level.

2: HITOP leagile five enablers can create innovation and technology management business competitive advantages for British new technology-based firms.

3: Lean,agile and leagile manufacturing organization performance varies depends on different operation environment, hostile or stationary.

CHAPTER TWO: THE LITERATURE SURVEY---THE INFLUENCE OF LEAN AND AGILE PRINCIPLES UPON THE MANUFACTURING ORGANISATION.

INTRODUCTION:

In chapter two, I present a comprehensive review of the literature that supports the development of the research question. It begins with a review of the influence of lean and agile principles upon the manufacturing organisation. Part I: Optimal lean and agile manufacturing organisation for innovation and technology management and Part II: Optimal HITOP leagile model manufacturing organisation for innovation and technology management.

2.1: OPTIMAL LEAN AND AGILE MANUFACTURING ORGANISATION FOR INNOVATION MANAGEMENT

2.11: BACKGROUND

This research will look at determining optimal lean and agile manufacturing organisation for innovation management. The goal is to develop a simple but effective organisation model that operations managers from new technology based firms can use it for innovation management by combining the merits of both lean and agile principles. In other words, we try to build a boundaryless leagile organisation model for innovation management in NTBFs.

This chapter is structured as follows. Firstly, the influence of lean and agile principles on manufacturing organisation is described, and the relationship between lean and agile organisation is explained in depth. Secondly, the influence of lean and agile principles on innovation management is described, also I will explain the relationship between lean and agile innovation management in detail. Thirdly, I will bring some examples on lean and agile best practices in the UK, also I will explain lean and agile analysis method in detail. Finally, I will give general conclusions on optimal lean and agile organisation practices in innovation management in UK.

2.12: THE INFLUENCE OF LEAN AND AGILE PRINCIPLES ON MANUFACTURING ORGANISATION

I LEAN AND MEAN ORGANISATION

Lean manufacturing is based on reducing waste within the company and along its supply chain. It involves taking steps to reduce stocks, minimise defects and reducing excessive transportation costs and inefficient or inappropriate processes.

From production point of view, its five lean Principles include:

(1). Understand what the customer perceives as value.

(2). Identify all the steps within the value stream that deliver a product or service.

(3). Remove all the barriers and interruptions that restrict the flow of a product or service.

(4). Only supply a product or service when it is demanded or pulled by a customer.

(5). Continually work to remove waste and achieve perfection.

Also from service point of view, its five lean consumption principles include:

(1). Solve the customer's problem completely by insuring that all the goods and services work, and work together.

(2). Do not waste customer's time.

(3). Provide exactly what the customer wants.

(4). Provide what's wanted exactly where it is wanted.

(5). Provide what's wanted where it is wanted exactly when it is wanted.

Meanwhile, lean tools include 5S, error-proofing (Poka-Yoke), six sigma, continuous improvement (Kaizen), Just-in-time production control, Lean supply chain management, Kanban, Preventive maintenance, Group technology, Lean value stream mapping etc.

However, an international survey (Clegg 2002) of modern manufacturing practices shows that the UK lagged significantly behind Australian, Switzerland and Japan on the uptake of best practices and report less effectiveness with them. They also report less planned future investments in best practice. Survey evidence (EEF/NOP productivity survey 2001) shows that US and EU owned firms operating in the UK are more likely to adopt lean manufacturing methods than their UK peers. (Figure10)

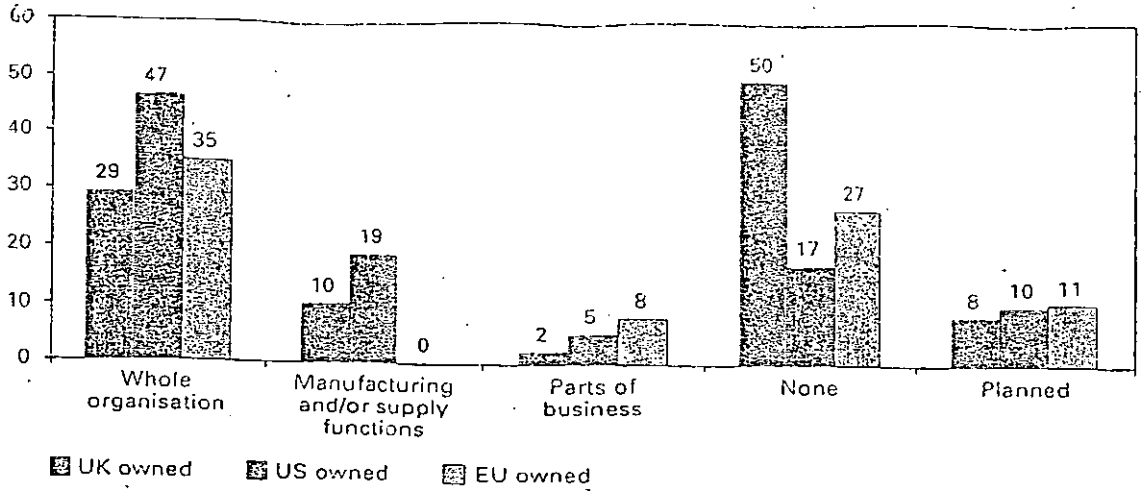


Figure10: Percentage of respondents undertaking/planning to undertake any form of lean manufacturing.

Source: EEF/NOP productivity survey 2001.

And US and EU firms are more likely to say that lean manufacturing methods are very successful –over a half of US owned firms believe that they make a tangible difference compared to around 20% of UK owned firms. (Figure10). Respondents cited attitudes to change, lack of understanding, cultural issues and a lack of management skills as the most significant barriers to implementing lean manufacturing (Figure11).

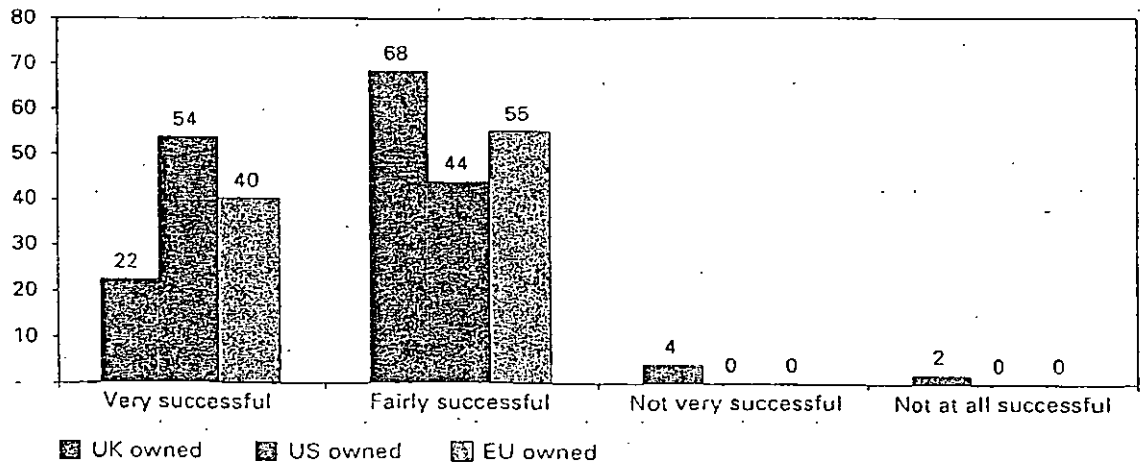


Figure11: percentage of firms undertaking lean manufacturing that say it has been...

Source: EEF/NOP productivity survey 2001.

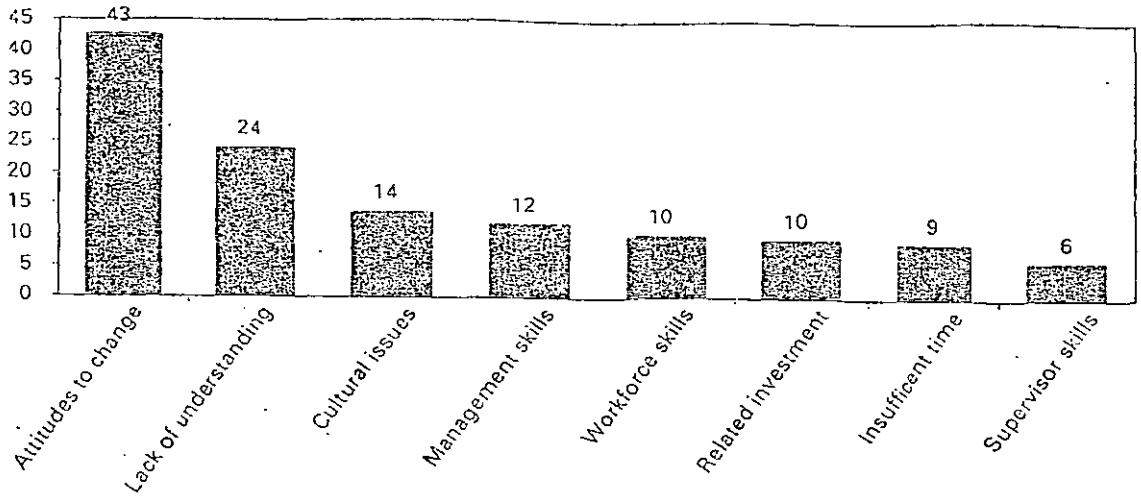


Figure 12: The barriers to lean manufacturing; percentage of firms already undertaking lean manufacturing.

Source: EEF/NOP productivity survey 2001.

A recent study suggests that UK companies are less likely to adopt modern management practices and, on average, compete less on unique value and innovation than their peers from other countries (Porter 2003). Another study (Clegg 2002) compared the uptake of modern management practices (e.g. Total Quality Management, supply chain partnering, integrating computer-based technology) across a total of 880 UK, Australian, Japanese and Swiss manufacturing companies produced similar results.

Meanwhile, the survey (Michael 2001) carried on by UK Warwick University on lean practices in European shows that In Europe, there has been a great deal of debate about how lean production principles will impact upon established production models , in particular those in Germany (Streeck 1992, Culpepper 1999) and Sweden (Sandberg 1995). From a critical perspective, its effects upon the workforce (it often requires de-unionisation or single union agreements) have been fiercely attacked (Williams 1992, Garrahan 1992) and more managerially, the demands placed upon workers by lean systems have been highlighted as a problem with respect to ongoing staff recruitment (Cusumano 1994).

Their survey results include:

(1) The case data confirm that becoming lean does not automatically result in improved financial performance, thus contradicting the first proposition. The critical issue appears to be the firm's ability to appropriate the value generated by

any savings the firm can make. In markets (like automotive, or supermarkets etc.) where key firms exercise dominant market power, the benefits of lean production can very easily flow to these powerful players, lean production does not automatically create these difficult conditions.

(2) The case material illustrates why it has proved so difficult to precisely define lean production. Despite apparent similarity on the initial questionnaire, closer examination revealed the variation inherent in each of the initiatives and highlighted how important the starting conditions were. This offers strong support for the proposition that each firm is likely to follow a more or less unique lean production trajectory.

(3) The single market context of the case studies prevented cross-sector comparisons from being drawn but the case material still provided strong support for the "context matters" proposition. It highlighted how some markets can render specific resources "strategic" (i.e. location) and how certain job markets (i.e. those with skill shortages) can leave managers in a lean production system with a radically altered power dynamic vis-a-vis their key staff.

(4) The final proposition suggested that firms would inevitably see a narrowing of innovative activity, as they became more "lean". Over time, this resource development process involved technology push, short-term cost penalties and deliberately generated system complexity. This contradiction with lean production principles suggests that the proposition needs to be reformulated around some form of trade-off between degree of lean production and innovation.

However, recently Harvard business review (2005) has published James Womack's paper "Lean consumption", he highlights Tesco, a UK based retailer, is the world leader in applying those lean consumption principles and is now approaching a level of service of more than 96%. Although that is not good enough to get all customers exactly what they want, but it is a big leap—and proof that lean production principles can support lean consumption.

Therefore, based on these previous different survey results on lean performance in UK, in this research, I will try to map out lean best practices in those new technology-based firms or High-technology small firms (HTSFs) in UK through broad survey on those British best factory award winning companies and lean practices companies.

II AGILE VIRTUAL ORGANISATION

Agility forum defines the twelve attributes of an agile organisation as

1. Rapidly bring products to market.
2. Customer-chosen options: Reconfigurable and Upgradeable.
3. Individualised goods and services.
4. Ever changing models, longer lived product families.
5. From Mass markets to Niche markets.
6. Customer-perceiver value.
7. Extending customer relationship by continually adding value.
8. Leveraging skills and knowledge of workforce.
9. Cooperating internally / externally (including with competitors).
10. Organisational structure that fits diverse production activities.
11. From centralised to decentralised decision-making.
12. Incorporating societal values into decision-making process.

Meanwhile, Goranson (1999) has defined four types of Virtual Enterprise(VE).

Type1: An aggregation formed in response to an opportunity. In its pure form, this is the prototypical (and most interesting) type where an entity identifies an opportunity (or recognises a change) which takes advantage of a core competency. Then the entity (normally the one that recognises the opportunity) acts as organiser to identify and creatively integrate partners with complementary, required core competencies.

Type2: A relatively permanent aggregation of core competencies that largely pre-exist, and which is seeking an opportunity. Generally, new members must be brought into the partnership in order to address the opportunity. Large corporations are often examples of this type when they have many perceived core competencies.

Type 3: A supplier chain which, while using relatively conventional business relationships, exhibits agility in responding to market needs. Electronic commerce also fits into this group when it employs traditional (albeit automated) business transactions.

Type 4: A bidding consortium, such a group relies on relatively conventional business relationships in its interactions. But it employs agile practices in

response to market needs, and it acts as a virtual enterprise in representing collective capabilities to a customer.

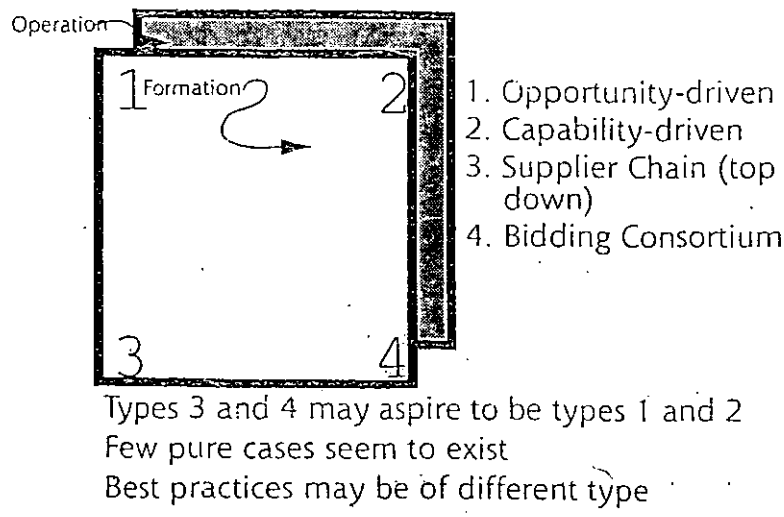


Figure 13: Four types of virtual enterprises.

Source: Ted Goranson (1999): The agile virtual enterprise: cases, metrics, tools.

In UK, BT (Robertson 1999) first adopts lean and agile principles in their customer services organisation in 1999. Lean production includes proactive maintenance. An automated system that carries out nightly checks of the condition of each line is being put in place nationally. This is able to give warning of potential faults before a customer has noticed anything wrong. The problem can be rectified without the customer inconvenience of service downtime, not only improving customer satisfaction (less faults) but also allowing maintenance to be time tabled rather than taking place reactively.

Also, agile service products, such as "Callminder", a network-based answering service, can be provided instantly on receipt of the customer's order, using automated software controlled systems, this would give customers the flexibility to change or upgrade their communications service without a visit from an engineer. In sum, BT lean and agile journey first begin from Mass customisation through BT's "Friends and Family" service.

Meanwhile, Tesco (Evans 2000) lean and agile journey focus on Synergistic Thinking from a pragmatic view of 'Lean' and 'Agile'. Base on the seven differences cited by Whitehead between agile and lean, they have categorised them into two groups, the first is synergy and the second is paradigm. Based on this expansive view of lean in Tesco, they substantiate the synergies under the

headings of standards, customer satisfaction and measurement and workflow, planning and stock reduction.

However, from the survey of Agile practices in UK manufacturing organisation (Zhang 2000), The survey covered 1,000 companies from three major industrial sectors, the Electrical and Electronic Manufacturing sector, the Aerospace Manufacturing sector, and the Vehicle Parts Manufacturing sector. The case studies covered 12 companies selected from the survey sample. While the details of the survey and case studies are reported in other publications (Zhang and Sharifi 1999a, 1999b), some of the important findings are summarised below:

I: Changes/pressures from business environment, i.e. the agility drivers, are strongly recognised by companies as the source of disturbances and problems in the battlefield of competition. And "change of customer requirements" is identified as the most important factor for all three sectors.

II: Companies in different sectors respond differently to changes by considering strategic capabilities, which suit them and correlate to their specific circumstances. Focusing on customers has, however, been emphasised by most respondents. A generic list of capabilities has been determined through the study. These may be divided into four major categories.

1: Responsiveness: This is the ability to identify changes, respond rapidly to changes either reactively or proactively, and recover from changes. This is itemised as:

(1) Sensing, perceiving and anticipating changes.

(2) Immediate reaction to changes.

(3) Recovering from changes.

2: Competency: This is an extensive list of abilities that provide a company with productivity, efficiency, and effectiveness in achieving its aims and goals. The following items form the major part of the list:

(1) Strategic vision.

(2) Appropriate technology, or sufficient technological capability.

(3) Products/service quality.

(4) Cost- effectiveness.

(5) High rate of new products introduction.

(6) Change management.

(7) Knowledgeable, competent, and empowered people.

(8) Operations efficiency and effectiveness (leanness).

(9) Co-operation (internal and external).

(10) Integration.

3: Flexibility: This is the ability to carry out different work and achieve different objectives with the same facilities. It consists of items such as:

(1) Product volume flexibility.

(2) Product model/configuration flexibility.

(3) Organisation and organisational issues flexibility.

(4) People flexibility.

4: Speed: This is the ability to carry out tasks and operations in the shortest possible time. Items include:

(1) Quickness in new products time-to-market.

(2) Quickness and timeliness in products and services delivery.

(3) Quickness in operations (short operational lead-times).

Among the four types of capabilities, responsiveness is the essential capability for any organisation which needs to be agile. The other three are the necessary elements in order to achieve responsiveness.

III: Utilisation of methods, tools and techniques to obtain the required capabilities is widely experienced or considered by respondents. Most of the proposed practices as appropriate tools for agile manufacturing including information system methods/tools/techniques are partially implemented in more than 60 per cent of companies. At the same time, despite the perceived impact and importance of these practices, the achievements resulting from them in responding to changes and taking competitive advantage have not gone far enough. This could be interpreted as being due to the lack of strategic intent and weakness of approaches to the adoption of practices. Practices regarding Organisation and People are found to be more effective and also more important for manufacturers. In contrast to the strong emphasis of agile manufacturing literature on the need for practices such as virtual organisation, mass-customisation, and utilising the Internet as an information tool, these practices were found to be implemented partially in only a small percentage of responding companies.

In European, the survey on Agile practice (Remko 2001) was based on Cranfield University's agile supply chain framework to design questionnaires. Its agile supply chain framework includes:

1. Customer sensitivity. Customer centred versus product centred logistics policies (ten questions): assumes that "agile" policies emphasise customers and markets, while "lean" policies focus on the elimination of waste in products and processes.
2. Virtual integration. Immediate conversion of demand information into new products using knowledge-based methods versus multi-stage, multi-function methods (three questions): assumes that agile policies focus on instantaneous demand capture, interpretation and response while lean policies emphasise stable production periods and protecting the "operations core".
3. Process integration. Self-management versus work standardisation (five questions): assumes that agile policies focus on operator self-management to maximise autonomy and immediate response, while lean policies emphasise work standardisation to ensure conformance to quality and productivity standards.
4. Network integration. Fluid clusters v. long term supply chain partnerships (six questions): assumes that "agile" policies emphasise fluid clusters of network associates, while lean policies focus on a more fixed set of long-term stable partnerships.
5. Measurement. Capabilities versus "world class" measures of performance (seven questions): assumes that agile policies are based on broad-based measures that underpin capabilities, while lean policies emphasise "hard" measures such as quality and productivity only.

This survey response rate was about 40 per cent, 35 respondents, 22 from the UK and 13 from the Benelux. The survey result includes:

1. A central point made by respondents is that introducing agility in the supply chain might raise customer sensitivity capabilities but might also call for project-like management approaches. When every customer requires his own supply chain and customised product/service offering this might not be a strange consideration at all.
2. Another central point made by respondents is that hard measures of quality and productivity are important but that winning the order comes first in today's dynamic market environment. As a result customer sensitivity counts first,

whereas "lean measures" are relevant, partly as a qualifier, partly as a second order consideration.

3. The issue that developing an infrastructure for virtual integration is one thing, but the actual use and leveraging of information might be another. Virtual integration, therefore, does not only represent technology but an important management challenge too. It was still unclear about how this could be used to cope with expected increases in demand uncertainty in future.
4. Most organisations surveyed considered that they had a low level of predictability of customer demand over the next six months. Such a description from a small batch/jobbing environment was reminiscent of Remmele Engineering, widely quoted by the Agility Forum as an exemplar of agility. Using such operational mechanisms as safety stocks, temporary employees and outsourcing for capacity reasons (all three mentioned multiple times) does not really reflect a proactive approach to mastering uncertainty. It rather reflects a reactive approach of coping with uncertainty, nor does it use uncertainty to proliferate agile capabilities and outperform less agile competitors.

   Finally, the "service edge" was seen by most of our surveyed companies as a key business imperative.

   Therefore, in this research, I will investigate the agile practices in British new technology-based firms, especially map out their agile organisation innovation management issue.

2.13: THE RELATIONSHIP BETWEEN LEAN AND AGILE ORGANISATION

Yusuf (2002) carries out a research by comparing lean and agile manufacturing practices in UK, his research concludes that market instability would intensify and become universal. UK Companies would therefore be compelled to look beyond their internal boundaries for enhanced competitive advantage. They would have to ensure the lean virtues of internal efficiency as well as the agile value of supply-chain based responsive adaptation.

Also he summarises the essential difference between lean and agile manufacturing in the following table 2.

Table2: The essential difference between lean and agile manufacturing

Factors	Lean	Agile
1.Market conditions	Fairly stable market, suitable for sequential customisation of product families.	Turbulent market, most suitable for parallel customisation as market demands very randomly.
2.Competitive objective	Productive efficiency through continuous improvements in resource and process usage.	Customer enrichment through timely mobilisation of enterprise-wide competencies.
3.Core capability	Multi-skilled workers, who constantly retool flexible machines for JIT deliveries.	Knowledge workers who manipulate intelligent machines to quickly replicate custom solutions.
4.Management style	Paternalistic management-longer time contractual obligations with stakeholders.	Laissez faire management of professional engaged in open sharing through virtual technology.
5.Operations control	JIT, TQM and TPM all focused on smooth and frugal process and resource flow.	Specific tools yet to emerge but there is increasing focus on virtual concurrent engineering.
6.IT architecture	EDI based technologies used widely to transmit operational and contractual data	Client server technologies employed for virtual design, engineering and manufacture.
7.Logistics	A hierarchy of distributors and	Virtual sharing of manufacturing

	suppliers put on master servant long-term contracts.	knowledge via ad hoc supplier, customer and competitor networks.
8.Work organisation	Process based work teams who meet frequently to discuss quality and efficiency.	Virtual work teams with boundary-spanning concept to cash.
9.Machine characteristics	Simply machines which are continually retooled by multi-skilled operatives.	Programmable machines which are continually reprogrammed by knowledge workers.
10.Nature of automation	Repetitive automation, applied to linear flow transfer batch processes.	Re-programmable automation applied to the manufacture of intelligent one-of-a kind products.
11.Core training requirements	Cross-training in preventative maintenance and operations before and after own station.	Specialist training in system monitoring/ analysis as well as applications software.
12.Overriding limitation	A fragile balance of inventories, capacity and relationships, not robust against shocks.	Inadequate attention to internal factors, and absence of implementation methodologies.

Source: Y.Y.Yusuf (2002): A comparative study of lean and agile manufacturing with a related survey of current practices in the UK.

Meanwhile, Goranson (1999) describes the relationship between lean and agility in depth. Firstly, lean focuses on profitability today, therefore, it works to lower costs, and possibly to reduce time of current product portfolios, improving quality does not appear to be an intrinsic result of lean, but a result of concurrent adoption of complementary quality initiatives. However, agile focuses on

profitability tomorrow, with the realisation tomorrow becomes today all too soon, so it focuses on the ability to change in order to improve cost, time, and quality. Secondly, lean is static, agility dynamic. Best agile practice study in Agile Virtual Enterprise Focus group from Agile Forum in USA discovered many cases where lean and agile decisions were contradictory. However, let's look at this more closely; a high value area might be the overlap between the two. Actually the real value of the agility metrics is in understanding the costs and benefits of agile decisions that are not freebies. This may in many instances involve making a business case for deviating from lean decisions in the direction of agile decisions. In making this analysis, they have used the following understanding of lean:

1. In the physical and workflow area (physical infrastructure), lean means JIT (just-in-time).
2. In the business practices area (Legal/Explicit infrastructure), lean means flat organisation.
3. In the cultural area (Cultural/Social Infrastructure), lean means empowered, motivated workforce.
4. In the information area (information infrastructure), lean means Client-server models and standard representations.

One difference between lean and agile is how they originated. Lean resulted from a focused survey of what was the apparent discriminator for extraordinarily successful enterprises (in the automobile sector). The term lean intuitively fits some of the practices (just-in-time workflows, flat organisations, and a decreased supplier base) and came to be applied to others as well (Total Quality Management, empowered workforce, and a focus on customer needs).

As result of this origin, lean practices do not derive from any underlying philosophy and they involve known methods and support technologies. Agility is quite different. It originated from an intensive, several-month workshop of business executives who were concerned with a specific need that they knew to be of immense importance to survival, for which they lacked existing methods and underlying technology. So, by definition, agility is an ideal that goes beyond current knowledge. And unlike lean, all agile methods result from a common underlying vision—namely, the ability to thrive when faced with change.

Certainly, a complex relationship exists between the two. A compelling argument can be made—and has been—that agile is a logical evolution of lean. Contrarily, it can be argued that, in many dimensions, lean and agile are contradictory; several clear examples are available. Yet a third proposal is that each is equally apt and modern, but they address quite different needs. This is probably the best approach. Lean optimises processes; agility optimises the ability to adapt processes to new conditions. This view emphasises the reinforcing similarities between the two.

Although, the concept of "leagile" supply chains has been promulgated (Van Hoek 2000, Mason-Jones 2000, Naylor 1999). "Leagile" takes the view that a combination of lean agile approaches be combined at a decoupling point for optimal supply chain management. Mason-Jones (2000) argues that agility will be used downstream and leanness upstream to form the decoupling point in the supply chain. Thus, leagile enables cost effectiveness of the upstream chain and high service levels in a volatile marketplace in the downstream chain. However, Van Hoek (2000) argues that although a leagile approach to supply chain management may work in an operational sense, it makes no sense to fundamentally challenge the concept of agility, as it has to fit with an agile approach to supply chain management in order to be applied properly.

Ultimately, this debate has no effect on this research. I believe all three views have some merits. Often, the difference goes to philosophical differences so deep they are called religious preferences, or, more reasonably, the strategic goals of the enterprise. Equally often, the views depend upon the communities of interest.

I have come to believe that manufacturing organisation research is understandably less concerned with lean and agile practices in NTBFs than other firms. This makes sense and is proper, because NTBFs are currently more unstable than others.

Based on the above research results, this research will focus on how to combine lean and agile merits in those new technology-based firms in the UK. It mainly focuses on how to ensure the lean virtues of internal efficiency as well as the agile value of supply-chain based responsive adaptation and survive under the unstable market environment.

2.14: THE INFLUENCE OF LEAN AND AGILE PRINCIPLES ON INNOVATION MANAGEMENT

I LEAN INNOVATION MANAGEMENT

Holbeche (1998) defines lean organisation as those organisation that trim their internal costs to produce the highest possible margins on whatever goods or services they are providing. In theory they enable an organisation to reap the benefits of flexibility and innovation which facilitating such useful practices as team working. In business process terms, the aim is to reduce the cost of supplying the input whilst at the same time maximizing the value of the output to the customer.

Table3: Summary of quantitative research on the relationship between lean organisation and innovation management.

Author	Background knowledge	Method	Finding
Holbeche (1998)	lean organisation innovation management guild	Framework guide for lean innovation organisation	Strategies for motivating and developing employees, from the high-flyer to super executive to Technical specialist.
Holbeche (1994)	lean organisation innovation through Human resource (HR) management	Interview in MSL international company	The ten 'Paradoxes of lean flatter structures'
Jon Kotter (1995)	lean organisation innovation through lean culture	Attitude survey in NHS and British Airway in the UK	The lean culture creating using Kurt Lewin (1958) model.
Roffey Park Management institute in	lean organisation innovation through teamwork	Consensus and interview with British firms	Broad consensus results on new leadership change in the new Milliennium.

UK	and leadership	leaders.	
Michel Syrett (Roffey Park Management institute)	Lean organisation innovation through cross-culture Experiences	Case study of General Electric in Hungary by comparing with Japanese lean solution.	1. Japanese solutions of lean organisation through comprehensive reorganisation schemes practice. 2. GE lean solution in Hungary through balance the twin philosophies of empowerment and continuous improvement.
Roffey Park Management institute	Lean organisation innovation through strategic approach	Survey UK and German company in the mid-1990s	New strategy changes bring many difficulties, such as Career development Pay Discipline.
Lathin and Mitchell (2001) from US Lean Enterprise Action Network LLC	Lean organisation innovation through STS system.		Socio-technical systems (STS) integration is a conceptual model that enables organisations to introduce the new processes and methods of lean manufacturing more effectively.
Terry Wallace. (2004)	Lean organisation innovation through hybridization.	Volvo Truck Company Lean innovation practice in Brazil	Hybrid lean organisations are able to "search out and mobilise untapped pockets of technology and market intelligence" to add significant value to their operations.

Source: Holbeche, L(1998): Motivating people in Lean Organisation. Butterworth-Heinemann.

II AGILE INNOVATION MANAGEMENT

It was the early Schumpeter (1912) who first describes the agility of innovative entrepreneurs. He states that the management of innovations is without doubt a cornerstone in securing the agility of enterprises. Meanwhile, modern agility innovation researchers (Nagel 1994, Voss 1994) state that agility not only means to react quickly to changing technology as well as changing market but also to be responsible for technological and market change. Also Kasarda (1998) describes that innovative infrastructure can create agile manufacturers after carefully analysis the performance of US firm Global Transpark's Global network business linkage among Asia and European and USA.

Recently, agile innovation management research focuses on how to create this agile innovation team. For instance, Majchrzak (2004) describes how to create this Far-Flung Virtual team or VC³ team for agile innovation management. (Figure 14)

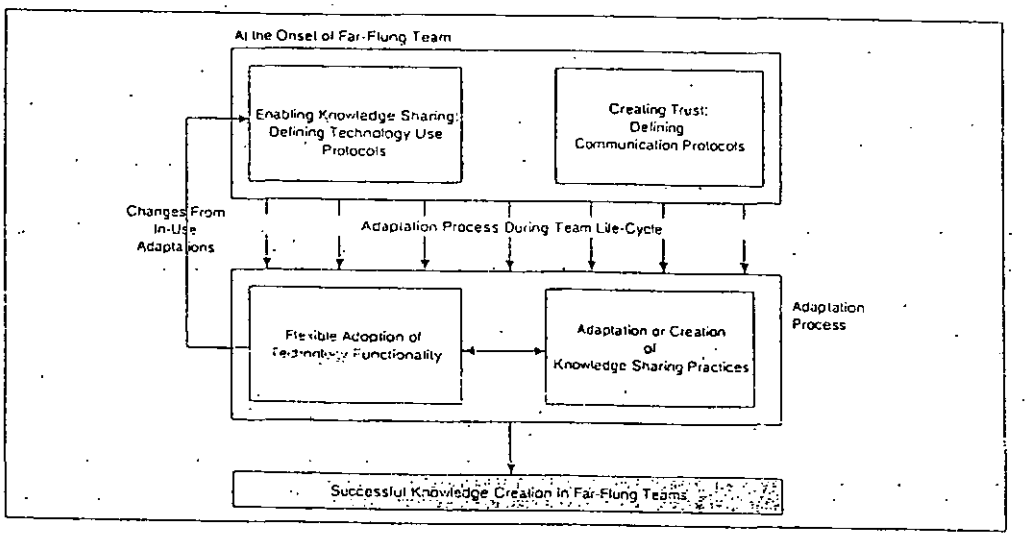


Figure14: Enabling successful Far-Flung teams.

Sorurce: Arvind Malhotra and Ann Majchrzak(2004): Journal of knowledge management. Vol 8, No4. 2004.pp75-88.

Table 4: Challenges of a VC³ team

Management Factors	In the case of virtual teams	In the case of Boeing Rocketdyne VC³ team
Objectives of the team	Clearly defined objectives and tasks (e.g. software development)	Emergent new design with ever changing tasks
Development of shared understanding	Members often bring shared understanding to the team through a common allegiance to a profession or organisation.	Shared understanding must be created since there are no common allegiances.
Frequent opportunities for interaction with team members.	...Opportunity for collection from time-to-time allows for spontaneous face-to-face interaction-Albeit minimal.	With members having primary obligation to their own company, collocation is infeasible; all interactions were through virtual media only.
Role definition	Roles can be well-defined at outset, aiding team success.	Roles must be flexible to respond to emerging task, problem, and solution.
Coordination norms	Communication protocols about what gets communicated to whom, when, and how, can be established at the outset and aid team success.	Communication protocols are difficult to define upfront since team needs change.

Sorurce: Arvind Malhotra and Ann Majchrzak(2004): Journal of knowledge management. Vol 8, No4. 2004.pp75-88.

Table5: Structuring core processes for VC³ team.

Core needs of creative teams	Practices of collocated creative teams	Practices adopted by VC³ teams
Development of shared understanding	Lead engineer is "spoke-in-the-wheel" for coordinating information and consolidating ideas into new design proposals, which constitute the shared understandings of the team.	From spoke-in-the-wheel coordination (with lead manager/engineer in centre) to democratic coordination. Encourage development and use of "common-language" metaphors.
Frequent opportunities for interaction with team members	Collocation allows for frequent and spontaneous interaction.	Coupling use of knowledge repository with synchronous and frequent teleconferences. Allowing for one-on-one discussions when need arises but documenting results for everyone.
Rapid creation and sharing of context specific transient information.	Most discussion verbal and undocumented, hard to capture the context.	Promote only minimal cataloguing of new information-even to the extent of restricting it to "touchstones" and "placeholders" Timely and frequent discussions of new entries in knowledge repository to enable members to learn the context.

Sorurce: Arvind Malhotra and Ann Majchrzak(2004): Journal of knowledge management. Vol 8, No4. 2004.pp75-88.

2.15: THE RELATIONSHIP BETWEEN LEAN AND AGILE INNOVATION MANAGEMENT

Ted Goranson (1999) defines four contexts of agility as:

Agility 1: The sum of internal agility of each of the components for mass customisation.

Agility 2: The agility of the VE as a whole. It is a logical evolution of lean for businesses whose change rate is high.

Agility 3: The ability of each component to quickly/cheaply aggregate. This is the most revolutionary agility. Through measuring agility using Ken Preiss's theories on dynamically coupled systems (Preiss 1996) and Rick Dove's early investigation (Dove 1995), Ted Goranson invented a VE agility analysis metrics.

Agility 4: The ability of each component to quickly/cheaply change the aggregation boundary.

In this research, I will focus on Agility 3, through comparing lean and agile organisation innovation performance, find out the new way to integrate technology, organisation and people.

2.16: CURRENT LEAN AND AGILE ANALYSIS DESCRIPTION

I LEAN ANALYSIS DESCRIPTION — Design and analysis of lean production systems using Arizona University's multi-echelon planning models based on multi-echelon inventory theory (2002).

Liker (1997) describes the five phases identified by Ford Motor Company for becoming lean.

1. Process stabilisation.

   We begin by improving the production environment. Processes must become predictable and reliable. The techniques of total productive maintenance, total quality control, Poka-yoke, setup time reduction, development of standard procedures, and organising/ cleaning of the workplace all contribute to this objective. Employees are trained in lean thinking and employee involvements are expectations in this phase.

2. Continuous flow.

   The second phase attempts to reduce WIP inventories and batch sizes. The mentality of running machines as fast as possible begins to fade. Parts flow in small or even single-unit quantities between adjacent workstations.

3. Synchronous Production.

   Weekly production schedules are now not only produced but followed. The former daily production meetings to review machine and material availability and revise the published schedule are no longer necessary and are eliminated. All processes are producing parts in concert whereby parts enter final assembly operations in the proper sequence. Likewise, suppliers have been integrated into lean behaviour with frequent deliveries of the appropriate quantity and type of parts to point-of-use workstations.

4. Pull authorisation.

   Production authorisation occurs by the pull of parts from successor workstations. Kanbans, either physical or electronic, dictate production.

5. Balanced (level) production.

   Finally, all processes produce at a constant level, continuous rate. Every part type is made daily, and parts flow through the system in a steady and continual manner---materials transform into products.

   However, recently research find that inventory control is crucial for successfully adopting lean and agile system in today's dynamic market environment. (Arnott 1996) Thus, here I focus on introducing advanced lean inventory control method.

   Askin and Goldberg (2002) develop multistage planning models for lean production system based on multi-echelon inventory theory. This Multistage model can be split into three major sections. First, they considered problems in which setup cost was not a factor. Here, linear programming was used to model a variety of system issues. Model solution can be done using standard mathematical programming software. Next, they considered problems in which setup was important and demand was stationary. They presented models and solution approaches that depend on the specific product structure. As the structure become more complex, and there are multiple paths from a stage to an end product, Heuristics must be used. For a variety of problems settings, recently research has improved upon these heuristics, and they now have excellent

performance guarantees. Finally, they considered problems where setup is important and demand varies with time. Here, they developed mathematical programming models and solution approaches. Similarly to the stationary demand case, more complex structures generally require heuristics or extensive computational network.

The reason I use this advanced multistage lean system planning models is that in order to strive for lean, I must balance push and pull production systems. Push system such as MRP control throughput but allow WIP and cycle time to vary. Kanban and CONWIP (constant work-in-process system) pull system control WIP at a level intended to produce the desired average throughput. Push system rely on accurate and timely demand forecast and shop execution data to coordinate workstation actions. Pull system simplify coordination through physical linkage.

From previous research, there are several differences between push and pull systems when striving for lean. For instance, pull systems can be modelled as closed queuing network, the amount of WIP is kept constant or at least bounded. Push system resemble open networks, arriving jobs are dispatched to the shop floor and proceed as fast as fast as possible through the system. Spearman (1992) used this representation to compare push and pull systems. The first observation is that pull systems with fixed levels of WIP require low average WIP (and hence cycle time) than push systems to achieve the same throughput. However, the above statement does not include the time jobs spend waiting to enter the shop. If the material supply process cannot be tied to the pull chain, and expensive parts must be queued outside the pull system waiting their turn to be released, then these advantages of the pull system are diminished. Nonetheless, the pull system would still require less space for accommodating fluctuations in WIP levels and exhibit less congestion.

The second observation is that pull systems are more robust to errors in setting operating parameters. In MRP push systems, one would typically freeze the short-term production schedule for a few weeks representing the cumulative lead time for producing end items from parts. Once items are released to the shop floor, the quantity and timing of open orders is fixed. The schedule may be firm for even longer periods of time to incorporate the ordering of raw materials and external parts. Frozen and firm schedules mandate the use of precise demand

forecasts or large end-item safety stocks. With shorter lead times and reliance on actual customer demands to set final assembly schedules, pull systems avoid the need to rely on precise forecasts. In stead, pull systems assume production will be relatively constant and utilize their innate robustness to minor variations. In addition, pull systems may have more shallow (fewer levels) in the bill of materials (BOM). The BOM for a push system will include a level for every production stage, potentially every operation in a process sequence, to accommodate detailed capacity requirements planning. The BOM for a pull system need only list the major control levels at which controlled shortages of items are kept. If a work cell is constructed to create a complete part (or product) with the part (product) flowing through multiple processing and assembly operations in the cell, there still only needs to be one level in the pull-system BOM for the cell.

A final observation relates to the simplicity of pull systems. Production workers are automatically empowered and do not need to wait to be told what to do. In addition, fewer workers are needed to create and monitor production plans.

Therefore, this advanced multistage lean system planning models can design and analysis lean planning system from practical and theoretical levels.

II AGILE ANALYSIS DESCRIPTION —MEASURING AGILITY THROUGH TED GORANSON'S AGILITY MEASURE METRICS (1999)

Table6: Major headings of the agile virtual enterprise reference model.

The vertical columns provide an important breakdown concerning the infrastructures of the VE, the major categories being physical, Social/Cultural, and Legal/ Explicit, the latter including business processes, workflow, and contracts/ Regulations. The row headings focus on decision points.

Infrastructure Breakdown / Decision Point breakdown	Social /Cultural: Human Dynamics	Social/Cultural: Community Cultures	Social/Cultural: Business Culture	Legal/ Explicit: Business Processes	Legal/ Explicit: Contracts/ Regulations	Legal/ Explicit: Workflow	Physical: Logistics/ Warehousing	Physical: Equipment	Physical: Laws of Physics
Opportunity ID Opportunity Strategy Opportunity exposure Targeted Marketing Search									
Partner ID Partner Qualification Partner performance history Partner search									
VE Formation Vision/ Strategy development Partner Criteria and selection Enterprise Metrics Capitalisation Product liabilities Risk/Reward strategy Operating strategy Dissolution plan									
VE Operation Performance Metrics Customer Relations Operating Practice									
Reconfiguration/Dissolution Identification of need Residual Liabilities Dissolution Plan									

Due to the space consideration, the infrastructure breakdown items have been replaced below:

Social/Cultural Infrastructure	Legal/Explicit Infrastructure	Physical Infrastructure
Social and Psychological Laws Community Cultures Business Culture	Business processes Strategy development Supervise Risk/Reward Process Supervise Engineering Quality Work Scheduling Depth of Customer Relations Legal/Regulatory Quality Assurance Agreements Risk/ Reward Contracts How the Virtual Enterprise is represented Assignment of New Technology Labour Agreements Work Flow (Business Plan) Planning work breakdown assignments Work breakdown Responsibilities Monitoring/ Adjusting the work breakdown structure Arbitration/ Adjudication	Warehousing and Logistics Virtual Enterprise Human Collaboration Virtual Enterprise Product Collaboration Customer's Pipeline,Product Customer's Pipeline, People Raw commodities Equipment How Modular How Reconfigurable How Scalable How Relocatable How Storable Physics Geographically Limited processes Scale Limited Processes Attention Limited Processes Time Limited Processes Accident Limited Processes.

Source: Ted Goranson (1999): The agile virtual enterprise: cases, metrics, tools. Quorum Books.

Table6: Twenty High Value Cells

	C. Legal/ Explicit Infrastructure a: Business Processes e: Depth of Customer Relations	C. Legal/ Explicit Infrastructure b: Legal/ Regulatory b: Risk/Reward Contracts	C. Legal/ Explicit Infrastructure c: Workflow c. Workflow Breakdown Structure	D: Physical Infrastructure a: Warehousing/ Logistics a: Human Collaboration
1.Opportunity ID 3.Targeted market				
2.Partner ID 3.Partner search				
3.VE Formation 6.Risk/Reward Strategies				
4.VE Operation 1.Performance Metrics				

Source: Ted Goranson (1999): The agile virtual enterprise: cases, metrics, tools. Quorum Books.

Goranson (1999) selected twenty that were likely to host an agility strategy from case studies in Consolidated Aircraft in USA, called twenty high value cells.

Meanwhile, Goranson (1999) describes the Agile Virtual Enterprise Reference Model's major life cycle categories.

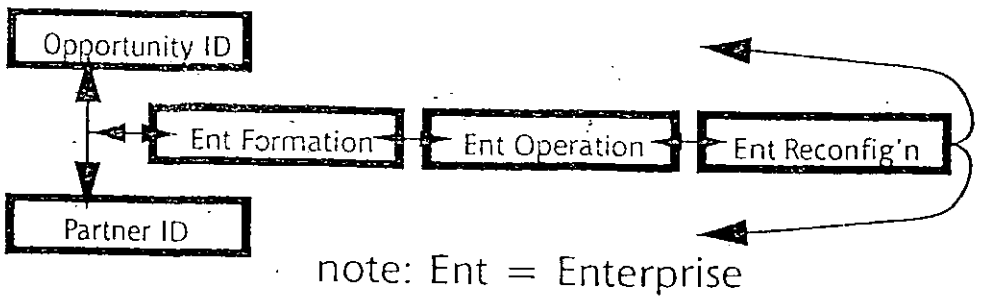


Figure 15: The Agile Virtual Enterprise Reference Model's major life cycle categories.

Source: Ted Goranson (1999): The agile virtual enterprise: cases, metrics, tools.

The merits of Goranson's agility measure metrics includes:

Firstly, Goranson's agility measuring metrics is different with other classic metrics that measures the cost, time, and quality/effectiveness of processes not associated with change. It only measures the time and cost of change and it will be combined with those base case better-faster-cheaper metrics to determine the total time and cost associated with the whole system under conditions of change.

Secondly, Goranson's agility measuring metrics is upstream metrics that based on the internal mechanics of the process. The reason agile virtual enterprise (AVE) needs upstream metrics rather than downstream metrics is that a downstream metrics is the conventional kind, related to benchmarking. It looks at a process and extracts some performance measure from it; for example, for monitoring the process. When the measures are compared to a large body of similar processes, one process can be benchmarked against the others, and management decisions made accordingly. But continuity in the context is

essential. Downstream metrics don't covey knowledge about the internal workings of the process, so they cannot tell one how to improve the process, only that the process needs to change somehow to improve the number. Moreover, since there is an assumption that the future will be extrapolated from the past, they tell us little about adaptability in a new context. However, upstream metrics is based on the understanding of the process and it can answer questions that a manager/planner may have about how to improve the process.

Meanwhile, agility upstream metrics as an upstream metrics are difficulty of benchmarking, because agility is defined as the potential to respond well to unexpected change. A downstream metric can do no better than measure how well a process responded to a specific change. So a downstream metric might have some utility for benchmarking a process against other instances of itself, but in order to be useful to another process in another organisation, a thorough normalisation must take place, making sure the process and the general context is similar between the two cases, including the specific unexpected change. Thus, agility is a paradigm that falls outside of the scope of those that can be addressed by conventional benchmarking. In particular, agility is the ability to react. Instead of conventional benchmarking, agility must look for a better way of accomplishing qualitative assessment, one that understands both the context and the effectiveness of the response.

Thirdly, Goranson's agility measuring metrics is dynamic, because it can project current capabilities in today's context into a new set of capabilities in another context. Also agility metrics are different than many other metrics in the manufacturing enterprise. Flexible, lean, and quality paradigms, for example, presume that there is always a better level of flexibility, leanness, or quality which would help the enterprise. The optimum level is a trade-off between better quality and its marginal cost. Agility follows this rule to a point. In ways that an enterprise needs agility, there is always a cost/benefit balance that metrics can inform. But there is another set of trade-off points, where further levels of agility are not good, and in fact might hurt an enterprise's strategy. Agility is insurance, and investment decisions need to be made accordingly.

Fourthly, Goranson's agility measuring metrics is a two-part metrics. The first part of will characterise the context in which the agility is posed. The second more simple part will characterise the response in cost and time. In other words,

agility is the ability or capability to change well (in terms of cost and time) in a given set of conditions; which means that the project must provide a measure of the response in the context of a measure of the stimulus. This will not only measure the effect (ability to change), but also indicate the specific behaviour that caused it.

Two of the underlying concepts of agility are scope and robustness. Scope refers to how large a domain is covered by the agile response system; in other words, how far from the expected set of events can one go and still have the system respond well. Robustness is a measure of how well the system responds, given a specific scope. These two together are naturally. They can be envisioned as a three-dimensional bump on a plane. The plane represents the universe in which the system operates. The height of the bump is the robustness of the system. (Figure 16)

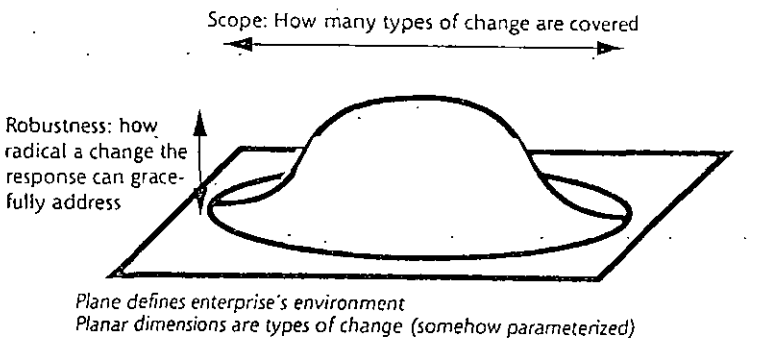


Figure16: The parameterised agility of an Enterprise can be seen as a curve over a plane.

Source: Ted Goranson (1999): The agile virtual enterprise: cases, metrics, tools.

Fifthly, Goranson's agility measuring metrics is quantitatively scalable metrics. First, the metrics of interest are not process-dependent, nor linked to any specific granularity of processes. In other words, it should not matter whether the metric is applied at the level of an individual process (fine granularity) or at a coarser level, such as a cell or line. Second, the metrics also scale horizontally across functions. It is useful that an enterprise component can be evaluated by the same metrics regardless of whether it is a shop-floor process or an administrative service. And third, the metric is internally linear, without discontinuous thresholds. Thus Goranson uses a scenario-based conversation breakdown to

capture two elements of agility for a process in each reference model's cell: the intrinsic agility of the process and the agility contribution to the system.

Goranson describes the procedures of using his VE analysis metrics:

1: Building a cell of VE reference model.

Building a managed supply chain with a specific type and extent of agility, presumably know the general type of change and have a general strategy for response that leverages corporate strengths.

2: Draw the Dooley Graph.

Step 1: Draw the states using Winograd and Flores' model (1988).

Step 2: Draw the Dooley Graph.

A Dooley Graph combines the qualities of states and utterances into one representation, showing both the efforts to support or move the conversation (the utterance component) and the effort effected by the conversation (the state component). It is a simple node diagram, consisting of nodes, or circles and links or arrows.

3: Dooley Graph Calculator.

Dooley Graph calculator is pomegranate. The purpose of pomegranate is to provide a means to capture a conversation as defined by its utterances and participants, evaluate the conversation using the Dooley Graph algorithm, and then ultimately to provide a mechanism to compare Dooley Graphs. The goal is to provide a framework to measure the agility of a conversation. Here is how it works.

Step1: Project window:

Step 2: Conversation editor.

Step 3: Utterance editor.

Step 4: Dooley Graph window.

Step5: Tailoring the Dooley Graph engine.

4: Calculating the metrics

Goranson's VE agility analysis metrics including distance and time-delay metrics, the resulting two numbers are simply added to give a raw metrics of the process's agility, the higher the number, the less the agility.

Also typology match these two metrics would be used in comparing the agility of process, such as moveability, importance and frequency.

Moveability: this metric is a typology match between the two graphs and measures the structural difference of the support for communication. It is calculated as the ratio of nodes that match to baseline nodes. It is a crude measure of the typology match but very effective, a greater number indicates a greater match and a lowered time and cost to adjust.

Importance: this metrics is the ratio of nodes to the total number of nodes (weighted sum) in the contracts sub-infrastructure for the entire virtual enterprise.

Frequency: Calculated in the same way as importance except using weighed loops. The greater this number the greater the time and cost of change.

In sum, Agility Forum describes Goranson's agility measure metrics from MIT agile practices as:

Calibrate the raw agility numbers to time and cost numbers in specific sectors. This will allow managers to register agility with other cost/benefit calculations in a balanced strategy.

Extrapolate numbers into functions. This will allow managers to follow process design guidelines in engineering the ideal agility into processes again following a balanced strategy.

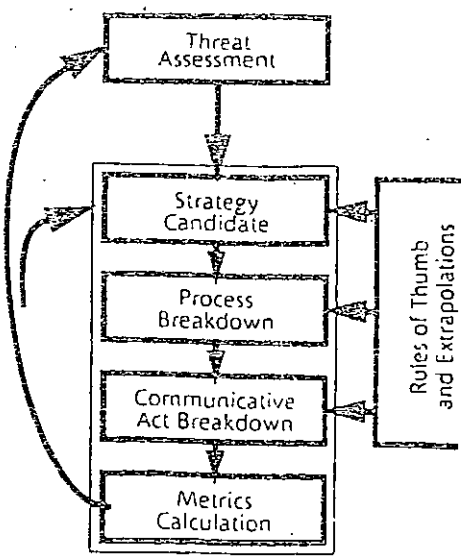


Figure 17: Rules of Thumb of application of Ted Goranson's agility metrics.
Source: Ted Goranson (1999): The agile virtual enterprise: cases, metrics, tools.

UK LEAN MANUFACTURING PRACTICE EXAMPLES

lean manufacturing practice in Scotland: • Scottish engineering –Lean sigma club. www.scottishengineering.org.uk • Centre for strategic Manufacturing. www.dmem.strath.ac.uk/csm	lean manufacturing practice in North Ireland: • Invest Northern Ireland—Process excellence. www.investni.com. • Manufacturing technology partnership—lean manufacturing. www.mtpltd.com • Queen's university Belfast—Product & Process development.www.qub.ac.uk • Centre for competitiveness—Capability &Skills development (Six Sigma). www.cforc.org.
lean manufacturing practice in North East. • MAS north east. www.rcme-ne.co.uk • North East Productivity Alliance (NEPA) & Accelerate North East. www.nepa-info.co.uk • Business links. www.businesslink.gov.uk. • Agility Group. www.dur.ac.uk/agility. • Institute of Automotive and manufacturing practice. www.amap.sunderland.ac.uk • Productivity North East(PNE) www.productivitynortheast.co.uk	lean manufacturing practice in North West: • MAS north west.www.mas-nw.co.uk • NWDA supply chain management programme. www.nwda.co.uk. • Lancashire West partnership—productivity centre. www.productivitycentre.org.uk • Greater Merseyside Enterprise—growing business Merseyside—Operations management.www.gme.org.uk • Liverpool John Moores university—automotive college.www.livjm.ac.uk • EEF north west—Lean training. www.eefnorthwest.org.

	• Chester, Ellesmere Port& North wales Chamber of commerce. www.cepnchamber.org.uk • Manufacturing institute—Accelerated Route to lean &Lean on-line. www.manu-online. • Merseyside Automotive Group – business improvement programmes. www.magroup.org.uk • Partnership for learning—business performance programmes. www.pfl.org.uk
lean manufacturing practice in Yorkshire & Humber. • MAS—Yorkshire & Humber www.mas-yh.co.uk. • Advanced Engineering & Manufacturing Cluster skills Brokerage www.aemcsb.com • Yorkshire Enterprise www.yorkshirecompanyservices.co.uk • Keyworth institute www.keyworth.leeds.ac.uk • West Yorkshire Manufacturing Excellence club www.wymec.com • South Yorkshire Manufacturing Alliance www.symanet.org.uk	lean manufacturing practice in West midlands. • MAS west midlands www.mas-wm.co.uk • AWM—supplying advantage www.advantagewm.co.uk • Advanced engineering cluster www.ae-cluster.co.uk • Accelerate www.accelerate-programme.co.uk • Lift-off www.mas-wm.co.uk • Innovative product development centre (IPDC) www.wlv.ac.uk • University of centre England—lean manufacturing www.uce.ac.uk

• Wakefield & District Manufacturing alliance www.wdma.co.uk • Hull engineering Alliance www.hullengineeringalliance • Yorkshire productivity www.yorkshireproductivity.co.uk • Leeds Manufacturing www.leedsinitiative.org • Calderdale Manufacturing alliance www.mas-yh.co.uk • Kirklees Manufacturing alliance www.mas-yh.co.uk • Airedale & Bradford Manufacturing alliance. www.mas-yh.co.uk • Rotherham Manufacturers group www.mas-yh.co.uk	• Warwick manufacturing Group—part time courses in lean supply chain Management. www.wmg.warwick.ac.co.uk • West Midlands Technology network www.wm-technet.co.uk • Inside manufacturing enterprise www.ime-wm.co.uk • Coventry University-lean manufacturing & Engineering management. www.coventry.ac.uk • EEF—west midlands www.eef.co.uk/westmid • Automotive Academy www.automotiveacademy.co.uk • SMMT industry Forum www.industryforum.co.uk • Association of Manufacturing Excellence. www.mynott.com/ame-uk • Skills4Auto www.skills4auto.org.uk • Centre of Engineering excellence www.cenengex.co.uk • Wolverhampton & Black countryN4C Lean programme - www.blackcountryforum.co.uk
lean manufacturing practice in East midlands. • MAS-East midlands	lean manufacturing practice in East of England. • MAS East

www.mas-em.org.uk • Lift off East midlands—Aerospace Production improvement programme. www.mas-em.org.uk/lift-off. • De Montford University—Lean engineering www.dmu.ac.uk • EEF East midlands—Manufacturing support service (MSS) www.eef.co.uk	www.mas-east.co.uk • Cranfield University-Fellowship in lean. www.cranfield.ac.uk • Cambridge university—institute for manufacturing www.ifm.eng.cam.ac.uk • Advancement of manufacturing & Technology Centre www.amtcentre.co.uk • Manufacturing excellence clubs www.mas-east.co.uk
lean manufacturing practice in South East. • MAS South East & MAS London www.mas-se.co.uk www.mas-london.co.uk • SEEDA—Lean manufacturing Programme www.seeda.co.uk • EEF south—lean training www.eef-south.org.uk • Farnborough Aerospace Consortium—lean manufacturing www.fac.org.uk • Centre of Engineering and manufacturing excellence www.ceme.co.uk • Thames Valley Technology—Supply chain network www.tvt.co.uk	lean manufacturing practice in South West • MAS—South west www.swmas.co.uk • Exeter Manufacturing Enterprise centre www.ex.ac.uk • EEF training—lean manufacturing www.eeftraining.org.uk • West of England Aerospace Forum www.weaf.co.uk • Marine south west—lean manufacturing www.marine-south-west.org.uk
lean manufacturing practice in	lean manufacturing Best practice

Wales	Case studies
• WDA—source wale www.wda.co.uk • MAS Cymru www.mascymru.org.uk • Accelerate Wales www.acceleratewales.org • Lean enterprise research centre www.leanenterprise.org.uk • Lean enterprise academy www.leanuk.org • Mid Wales Manufacturing group www.mwmg.org.uk	• Anson Packaging Ltd http://www.avroind.com/anson • Burbidge & Son Ltd http://www.burbidge.co.uk marketing@burbidge.co.uk • Garrett Thermal Systems Ltd http://www.egarrett.com • Hawke International http://www.ehawke.com meriol.folkard@ehawke.com • Ilford Imaging Ltd http://www.ilford.com • Oxford Engineering Ltd http://www.oxeng.co.uk • Perkin Elmer http://www.perkinelmer.com • Portmeirion Potteries http://www.portmeirion.co.uk • R Platnauer Ltd • Satchwell Control Systems Ltd http://www.satchwell.com • The Nuaire Group http://www.nuaire.co.uk • Waterfields (Leigh) Ltd http://www.waterfields-bakers.co.uk Wolstenholme International Ltd http://www.wolstenholme-int.com

Source: Manufacturing Foundation/ 3 Priestley Wharf/ Holt Street/ Birmingham/ B7 4BN. http://www.manufacturingfoundation.org.uk

UK AGILE PRACTICE EXAMPLES

Virtual Manufacturing Resources Case Study	E-manufacturing Case Examples
Kidd (2001): E-business Strategy: Case Studies, Benefits and Implementation, 1. **J. Sainsbury — The Internet in Food Retailing** — learn about J. Sainsbury's e-business strategy and how it is using the Internet to work with suppliers and manage its supply chains. 2. **Styles Precision Components — the Internet Enabling Virtual Manufacturing Resources** — learn how a small manufacturing company used the Internet to create new business for itself.	1. Clyde Blowers ***Application:*** Clyde Blowers, an British engineering company, manufactures products such as the tools used to clean the insides of coal-fired power station boilers. It has manufacturing plants in Europe, the US, China and India. The company has been using the Internet for a number of purposes. Document exchange and e-mail are used based on Lotus Notes (a widely used group working software tool) and video conferencing software is used to enable face to face meetings, thus helping to reduce travel costs. Also, the firm uses Lotus Notes to track customer enquires, so that firms throughout the group can see what is going on thus helping to avoid the situation where firms within the group are competing with each other for the same business. ***Illustrates:*** The use of the Internet to improve communications between geographically distributed parts of the firm and to increase co-ordination of activities 2. GKN

	Application: GKN, a British engineering company that manufactures among other things automotive components, is using its Intranet as a knowledge management tool. The objective is to enable knowledge about manufacturing techniques, normally communicated within a single plant, to be made available throughout the group, thus reducing duplication of problem solving and also unnecessary capital expenditure on eliminating problems that may have a simpler solution discovered elsewhere but not communicated company wide. In addition to sharing explicit knowledge such new ideas generated at each of its plants, GKN is also expecting that tacit knowledge will be shared. ***Illustrates:*** Knowledge sharing between geographically separated parts of a large firm using the Internet as the prime means of communication.
<u>European Projects</u> 1: Eureak Project 1173 - HITOP Development **Objectives:** HITOP is a systematic method that is an up-front investment in the management of technical change. It allows	Best agile practice examples from Ted Goranson's US agility focus group case studies : 1: FlexCell Flex cell is a collecting of small business, banded together for collective business development.

companies to design their organization and human resources, taking into account the needs of the technology (the term HITOP is an acronym which stands for High Integration of Technology, Organization and People). HITOP has been used successfully by both large and small companies to shorten the time that is necessary for making and balancing changes within the complex and inter-related domains of technology, organization and people. HITOP has also helped companies master the cascading effects of change by involving people within different functions in the change process. The project aims to improve the existing version of HITOP by making the method more user-friendly for non-experts working in small-to-medium sized enterprises (SMEs). Specific objectives are to: 1: make the method more user friendly and suitable for non-experts so that it can be easily used by SMEs; 2: develop analysis and design tools to support HITOP; 3: strengthen various aspects of the	Their business is focused on small lots of machined/ manufactured parts and associated services. They are a Type 4 AVE, using conventional practices for most of the reference base subcategories with the following exception. The key best practice is the assignment of a full-time person whose goal is to build and maintain that trust over several years. The link is exclusively within the social/cultural infrastructure. This practice leverages local, agriculturally-based values of honesty and constancy. It also appears to depend on a rare, high energy individual. There does not appear to be an indication for a metric. The metric is binary: if you compromise the trust factor incubated by the group, you are likely to be shunned. 2: Sikorsky Sikorsky Aircraft, a $2.3 B corporation, manufactures both commercial and military helicopters. The VE effort surveyed here examines how a permanent Type 1 VE, still in creation, is leveraging a specific, valuable best practice. The best practice here was assigned to Partner Qualification, but could be spread over at least a couple reference

HITOP method; 4: extend the applicability of HITOP. **Partners:** Cheshire Henbury (UK) Centre CIM de Suisse Occidental (CH) Trial User Sites Swissmetal Boillat (CH) GEC Alsthom T&D (CH) Fabrique de Tabac Reunies, Philip Morris (CH)	base subcategories. (1)Operation structure covers the processes of harmonising cultures, integrating processes, and establishing what in this case is the supervisory role of the prime contractor over quality. The best practice is in making those three elements explicit and portable before entering into the confusing period of actually establishing the VE. (2) Partner qualification. This case adds something to the Focus Group's understanding of this subcategory. In this case, the partners are selected for reasons that are not primarily based on capability. Thus, Sikorsky assumes some responsibility to make the partners qualified. The greater Sikorsky's ability to insert technology into partners, the greater the pool of potential partners and therefore the larger the number of countries that can be addressed. 3. Westinghouse This case involves a division of Westinghouse (since sold to Northrop Grumman) that supplies complex electronic products. The dominant customer is the U.S. government. As with many producers of complex good with a large supplier base, Westinghouse has begun to reduce

	and prequalify its supplier base. The firm is probably in the world-class category in how they mange this process, independent of agilityThe best practice of interest to the VE is related to how they take advantage of their supplier base. The sector in which Westinghouse competes is characterised by many bidding situations coupled with a remarkable need for keeping up advanced product and process technologies. In conventional supplier relationships, technology and bidding strategies trickle down to the suppliers, having been determined at the top. Westinghouse, however, has well-developed mechanisms to involve their suppliers as partners in both strategic technology planning and competitive bid development. As the supplier base has narrowed, supplier liaison personnel have increased their scope to include the entire product development cycle. Suppliers are continually surveyed for potentially advantageous new skills and processes which might add to the overall competitiveness of the Type 3 VE. Once an opportunity to bid has been identified, the portfolio of new processes is surveyed for advantage. Therefore, when the bid is developed, the supplies become involved in a

	more peer-to-peer way than their competition. The ability to supplier to collaborate with Westinghouse in this closer manner is one of the criteria used in searching, evaluating, and pre-qualifying partners. 4. Taligent Taligent is a joint Venture, a Type 1 VE, whose charter is to provide a radical improvement in the ability to develop and use software in enterprise. The company is developing a next generation object-oriented (OO) application system that is portable across all major desktop hardware and operation system environments. It was originally formed by IBM and Apple nearly three years ago. The focus of this case is how Taligent has been ale to listen to and respond to their customers, the three investors, as partners and outside customers, while juggling the realities of competitive versus precompetitive issues. Three internal policies contribute to this ability. Taligent's investors and partners must cultivate a trust relationship with Taligent while they also compete with each other. Taligent's workforce needs to collaborate closely with a respective

	partner in either the shared domain or various proprietary domains. For Talignet to proceed, it must scrupulously maintain the confidentiality of the information shared by its partners. No single set of procedures could cover all the conditions which arise in unexpected ways. The VE's solution is to provide leadership by example from above. A strong, ethical tone is set by the senior management and permeates the corporate culture, which is unique.

Source: UK Cheshire Henbury consultant group/ US agile focus group.

2.17: CASE STUDIES ON UK LEAN AND AGILE BEST PRACTICES

Through case studies about lean and agile practices in UK, US and European, I try to map out the best British lean and agile practices in details, especially the detail procedures on how to adopt lean and agile system.

CASE STUDIES ON PREVIOUS LEAN AND AGILE BEST PRACTICES IN EUROPEAN, UK AND US FROM EXISTED LITERATURE OR PUBLISHED SURVEY RESULTS.

CASE STUDY 1: LEAN AND AGILE PRACTICES IN BT

Source: Application of lean production and agile manufacturing concepts in a telecommunications environment, Michael Robertson, Carole Jones. International journal of agile management systems. Bradford: 1999. Vol.1, Iss.1; pg 14.

Michael Robertson: BT Laboratories, Martlesham Heath, Ipswich, UK

Carole Jones: BT Laboratories, Martlesham Heath, Ipswich, UK

INTRODUCTION

The expectations of customers and the increasing globalisation of markets are forcing industry to rethink business strategies. Information technologies and better communications create opportunities for companies in all market sectors to operate in new and different ways.

Agile manufacturing is a strategy that can create flexible or virtual organisations to meet increasing customer expectations. It has developed from the concept of lean production currently being employed increasingly in manufacturing industry. Whereas lean methods offer customers good quality products at low price by removing inventory and waste from manufacturing, agile manufacturing is a strategy for entering niche markets rapidly and being able to cater for the specific needs of ever more demanding customers on an individual basis.

This paper discusses some ideas for applying agile manufacturing concepts to telecommunications and in particular to British Telecommunications PLC (BT).

LEAN PRODUCTION

Lean production systems have been used in manufacturing industries for many years, and have recently begun to be adopted by service industries. Lean systems are characterised by five key principles:

(1) Value: "Precisely specify value by specific product" - redefine the whole product through the eyes of the customer.

(2) Value stream: "Identify the value stream for each product" - this is the entire set of actions required to bring a product from its raw materials to the customer.

(3) Flow: "Make value flow without interruptions" - eliminate departmentalisation and batch processing so that the process can flow, leading to a short lead-time, high quality and low cost.

(4) Pull: "Let the customer pull value from the producer" - if lead-times are reduced, then a producer can design, schedule and make exactly what the customer wants, when he wants it, rather than relying on a sales forecast. In practice, pull is usually achieved using the system known as "just-in-time". (JIT is a system whereby an upstream process does not produce parts until requested to do so by a downstream process.)

(5) Perfection: "Pursue perfection" - Do not attempt to be slightly better than your competitors, but rather strive for perfection through the use of continuous improvement.

Close co-operation with suppliers and empowerment of the workforce are also key characteristics of the lean organisation.

AGILE MANUFACTURING

Agile manufacturing is based on lean production, although there may be some apparent contradictions between the stability required for low cost and the flexibility required for agility. Agile manufacturing comprises the characteristics of lean production, extended to encompass the following four basic principles (Goldman, 1994):

(1) Products are solutions to customers' individual problems.

(2) Virtual organisations are formed where products are brought to market in minimum time through internal and external co-operation.

(3) Entrepreneurial approaches are adopted so that organisations thrive on change and uncertainty.

(4) Knowledge-based organisations are formed which focus on distributed authority supported by information technology.

As this suggests, agile manufacturing is a business strategy aimed at providing a company with the capabilities for success in the twenty-first century. Emphasis is on the design of a complete enterprise that is flexible, adaptable, and has the ability to thrive in a continuously changing business environment where markets consist of rapidly changing "niches" serving increasingly sophisticated customer demand. Mass customisation, that is the ability to tailor every product to the precise requirements of each customer, is an attempt to achieve this, although generally limited in scope to assembly-based variety. True agility means extending this flexibility back to product design and new product introduction through such techniques as rapid prototyping.

APPLICATION TO TELECOMMUNICATIONS

The principles above are written with reference to manufacturing industry, but are also highly relevant to service industries (Hooper1998). However, there are a number of significant differences between manufacturing industries and

telecommunications, which must be taken into account when applying these ideas.

A telecommunications product can be considered to consist of two parts, a physical network connection and a service over that connection. These two parts can be very different in the way that they are handled in terms of lean production and agile manufacturing.

The network connection (with the exception of mobile networks discussed later) is expensive to install, requiring civil engineering, e.g. digging up roads or pavements to install cable in duct or digging up gardens to bury cable. Where already installed, upgrades to higher bandwidth will still require physical work at the customer's premises. The nature of the connection should therefore be designed to be fully upgradable to avoid future expense. It should also offer transparency to different services, i.e. it should not require customisation for different services. These requirements lend themselves to a lean engineering approach.

The range of services offered, by contrast, over the network connection are largely software-based (probably running over the physical connection in a packet-based format (e.g. Internet Protocol), and can be customised for the individual customer requirement at short notice. This lends itself to an agile manufacturing approach.

Other differences that should be noted are:

1: The very nature of communications products means that the product itself is distributed over a vast geographic area, and it is therefore not possible to collocate all of the functions needed to produce that product. Some of the principles of continuous flow production cannot therefore be directly applied. The key principles here are to reduce delays and multiple-handling and to eliminate functional barriers.

2: The concept of "takt" time is a necessary, but not a sufficient, metric for matching supply with demand, since it is necessary to know, not only the volume of demand, but also where that demand will arise ("takt" time is the rate at which products are sold to customers. Lean producers strive to match their rate of production to this rate of sales).

3: Fixed network connection

Lean production espouses the virtues of low inventory and pulling flow based on customer value. In a telecommunications network, inventory in the form of switching capacity and physical cabling infrastructure cannot be provided in a pull system because of the sheer geographical complexity. It is perhaps fairer to consider the network infrastructure as analogous to the manufacturer's factory, and the network inventory level as being analogous to having a factory of adequate capacity. The preceding discussion demonstrates that it is difficult to relate some of the terminology of lean production to telecommunications, and it is important to appreciate that it is not possible to define a simple one-to-one correspondence between manufacturing and telecommunications terminology. Rather, when seeking to apply lean principles, one should keep sight of the generic principles of reducing waste at all levels and focusing on the delivery of the product to the customer.

4: Mobile networks

The problems of infrastructure cost and build delay of fixed network connections can be removed by the use of mobile network technologies. Mobile telephony is becoming ubiquitous, and it is anticipated that the next generation of mobile networks will lead to vastly more data being transmitted via this medium. Service can be pulled by the customer simply buying a mobile handset and requesting service, which can be set up in minutes. This is a lean process, and begs the question: why have a fixed network at all? Unfortunately, mobile spectrum and bandwidth are limited, and as increasing demands are made for higher and higher bandwidth services, the only solution would be smaller and smaller cell sizes to allow greater reuse of spectrum. Smaller cell sizes lead to increased costs and environmental issues as the number of base stations multiply and ultimately overtake the costs of a fixed network.

LEAN AND AGILE INITIATIVES IN BT

Recent changes in the organisation of the customer services part of BT apply some of the principles of lean and agile manufacturing. Responsibility for the entire telephony and provision service for residential and small business customers, from call centre reception of orders/faults through to the field engineering workforce are now in a new customer services division. This allows a focus on optimisation of the whole process, not sub-optimisation of individual

functions such as sales or operations. Process thinking leads to the breakdown of departmental barriers and allows process measures to be reviewed from a customer perspective.

Coupled with this change, the field engineering workforce is being given local autonomy through the formation of customer service teams, which will allow more focus on issues of a local geographic nature. On the training and development front, it has been the policy to increase the level of multi-skill in the field workforce through training for some time. This offers greater personal job satisfaction to the engineers and enhanced effectiveness through greater flexibility in job assignment and less need for follow-up visits.

Another enabler of lean production, proactive maintenance, is being pursued currently. An automated system that carries out nightly checks of the condition of each line is being put in place nationally. This is able to give warning of potential faults before a customer has noticed anything wrong. The problem can be rectified without the customer inconvenience of service downtime, not only improving customer satisfaction (less faults) but also allowing maintenance to be timetabled rather than taking place reactively.

The need for higher bandwidths for new services is being handled in a number ways. For customers with more than five lines, the installation of optical fibre is cost-effective and offers the perfect solution for upgradability. For customers requiring fewer than five lines, BT is successfully experimenting with digital subscriber line (DSL) technologies. These retain the existing copper pair connection (thus saving civil engineering costs) but increase the effective bandwidth of the connection by a factor of [similar]100 by electronic coding at both ends of the link.

With a reliable and upgradable infrastructure in place, agile service products, such as "Callminder", a network-based answering service, can be provided instantly on receipt of the customer's order, using automated software controlled systems. BT is also conducting research into providing customer premises equipment that is truly "Plug and Play", regardless of the bandwidth and service for which it is used. This would give customers the flexibility to change or upgrade their communications service without a visit from an engineer.

Finally, mass customisation is already a reality for BT customers. Customisation of billing is available through BT's "Friends and Family" service, where

customers can choose ten frequently called numbers, and receive a discount on all calls to those numbers. These numbers can be changed whenever the customer wishes, either through a simple telephone call or by accessing a World Wide Web site. It is anticipated that, over the next few years, many more applications will emerge which enable the customer to configure service to their own unique requirements.

CONCLUSIONS

An outline of lean production and agile manufacturing has been given in the context of telecommunications. Some examples of recent changes to successfully implement such techniques in BT have been described. These changes are a start, but there is still much to do on the lean and agile journey.

CASE STUDY 2: UK ALPHA ELECTRONICS LTD AGILE PRACTICES

Source: costing customer value: an approach for the agile enterprise Mark J Hooper, Derek Steeple, Clive N Winters. International Journal of operations production management. Bradford: 2001, Vol.21, Iss. 5/6; pg.630, 15 pgs.

INTRODUCTION:

In making the transition from a mass/lean production enterprise to agility a four-step methodology has been proposed by Maskell (1998) (Table 7). Within this outline methodology lean manufacturing principles form the basis for achieving the transition to agile manufacturing.

Hill (1995) concludes that in any manufacturing system a balance occurs in the trade off between flexibility and total product cost. The challenge for all enterprises is to achieve the transition from mass/lean production to agile manufacturing without incurring substantial long-term cost increases and reducing the ability of the enterprise to compete in the marketplace.

Table7: Costing customer value—an outline methodology for agile manufacturing.

Traditional manufacturing	Gaining control	World class manufacturing	Agile manufacturing
Complex systems	ERP or MRPII	Lean manufacturing	Enriching the customer
Departmentalise	Better customer service	Just in time	Competitiveness through co-operation
EOQ	Reduced inventory (10%-25)	Total quality management	Organising for change and uncertainty
No employee involvement	Lower production cost	Much less costly	People and information
Financial secrecy	Greater flexibility	More responsive	High customer flexibility
High inventory	Better control	Long-term profitability	Integrated flexibility
Inspection	Planned operations	Lead time improvement	Technology
Lack of strategy	Better communications	Productivity improvement	High educated and trained workforce
Late delivery		Time to market	Flexible management structure
Long cycle times Politics Record inaccuracy shortages/ expedite month-end push		Zero defects Inventory turns	Virtual corporations

Source: Maskell, B. (1998), *The Four Steps to Agile Manufacturing*, Brian Maskell Associates Inc., Cherry Hill, NJ.,

UK ALPHA ELECTRONICS LTD

Alpha Electronics is a small- to medium-sized enterprise employing 38 people with an annual turnover of 1.8 million. Based in the industrial centre of Coventry, it manufactures printed circuit boards (PCB) for a broad base of end customers in the aerospace, automotive, telecommunication and research industries in the UK. In an increasingly competitive global environment, the UK has seen a significant reduction in its PCB industry resulting from low-cost/ high-volume manufacturers in the Far East importing into the UK marketplace. Alpha Electronics by virtue of its size, and most importantly, its focus on delivering total solution products to customers, has established itself as a leading provider of prototype and low volume circuits with a reputation for delivering reliability, responsiveness and expertise. This focus is the key to its future survival and competitiveness. As an integral part of this, Alpha Electronics was keen to determine the cost of its solution provision. To achieve this required mirroring the operational environment, strategy and cost profile of the extended enterprise in the development of the Alpha Electronics costing system.

ALPHA ELECTRONICS: OPERATIONAL ENVIRONMENT

Alpha Electronics manufactures three types of PCB to customer order. These are single-sided, double-sided (plated through hole) and the more complex multilayer boards up to 24 layers. All products are commonly available for fast track (three to six days) and normal (20-day) delivery. It is the provision of a fast-track delivery capability that provides the current competitive edge for Alpha Electronics in the marketplace. The provision of normal delivery is most under threat from increased global competition. The enterprise does not have the capability to service the needs of high-volume business and is finding it increasingly difficult to obtain normal delivery work of a prototype nature. This market is increasingly being serviced by other manufacturers adopting a loss-leader approach to obtaining high-volume work.

Table 8: Comparison of cost control and costing techniques with agile costing systems characteristics

Throughput accounting	Standard Costing	Activity-based costing
Control Focused on price, Volume and material cost (no focus on overhead costs).	Control Provides a breakdown of standard labour and materials usage by activity. Can be used for variance analysis.	Control Provides identification and qualification of value adding and non-value adding activities.
Forward looking Allows for judgement to be made on the provision of future manufacturing resources.	Forward looking Allows judgement to be made based on historical performance.	Forward looking Allows for comparison regarding the cost of internal and external activities, together with the costs of servicing current and new future markets.
Outward looking Internally focused on manufacturing performance relative to product profitability	Outward looking Provides an internal focus on resource consumption. Minimal provision of value for making product/market decisions to be made.	Outward looking Internally focused on activity and resource costs. Can be adapted to understand the costs of the extended enterprise and supply chain.
Dynamic Focused on current manufacturing processes and methods. Supports the development and use of knowledge to reduce lead-time	Dynamic Based on set procedures and policies. Externally audible.	Dynamic Enablesevaluation/projection of future resources consumption against activity usage.

Source: costing customer value: an approach for the agile enterprise Mark J Hooper, Derek Steeple, Clive N Winters. International Journal of operations production management. Bradford: 2001, Vol.21, Iss. 5/6; pg.630, 15 pgs.

In delivering its total solution provision to customers Alpha Electronics utilises the skills and resources of its inter- and intra-enterprise that include:

1. Use of electronic data interchange (EDI) and e-mail to receive customer artwork, in addition to the production and examination of artwork by staff at Alpha Electronics.
2. Transfer of design data to CNC drilling and routing machines and for automated inspection.
3. Established relationships in the extended enterprise for the production of artwork, circuit testing and certification, tooling and gold plating to customer order for both fast track and normal delivery orders.
4. Development, exploitation and adaptation of technological solutions for meeting the current and future needs of the marketplace.
5. Management of knowledge throughout the enterprise, allowing changes in product specification, methods of manufacture and the introduction of IT solutions to be efficiently and effectively accommodated.
6. Minimal reporting structure in the enterprise, allowing for rapid decision making and ownership in all operations.

Alpha Electronics is indicative of many enterprises in this situation. While fast-track orders are most profitable, it requires a competitive normal delivery element to its business to sustain a marketplace presence and provide the added security of contribution to overhead costs.

The primary issue is one that will affect all agile and potentially agile enterprises. How can an enterprise develop and enhance its total solution provision in order to improve its order winning capability while maintaining its cost and pricing profile in line with order qualifying criteria? This situation has been faced by several organisations including Remmele Engineering (Harrison 1997) whose management stance is to "offer value, but not at the cheapest price". The issue within Alpha Electronics is that all orders require differing elements from the total solution portfolio dependent on the customer specification, and that there is insufficient detail within the current costing system to develop costs for this operational environment.

ALPHA ELECTRONICS: COSTING SYSTEM DEVELOPMENT

The implementation of a costing system for Alpha Electronics follows a simple generic method (Winters 1996). The issue in this case is not the method of implementation, but how the operational environment outlined earlier will be mirrored in the development of the costing system.

Identification of the problem situation within the enterprise by the organisational managers initiates the generic implementation method. In analysing the operational environment it is essential to determine the product/ total solution mix and to analyse the value and volume of each customer order. Within Alpha Electronics the solution portfolio is constructed as shown in Table 9.

Table 9: Solution portfolio

	N0. Of orders	Percentage	Values (£S)	Percentage
Single-sided PCB	30	9	5,333	3
Double-sided PCB	220	67	99,732	62
Multilayer PCB	80	24	56,168	35

Analysis of manufacturing and support activities reveals the resource requirements for each type of product solution. Activities used within Alpha Electronics include:

1. Sales order administration;
2. Design data preparation;
3. Diazo development;
4. Blank cutting;
5. Drilling (and set-up);
6. laminating and exposing;
7. Etching;
8. Development of artwork (external);
9. Gold plating (external);
10. Purchasing;
11. Hot air solder levelling;

12. Inspection;
13. Packing and despatch;
14. Automatic inspection (and set-up);
15. Routing (and set-up);
16. Electroplating;
17. Application of solder resist;
18. Circuit testing (external);
19. Tin plating;
20. Finance.

Each type of product solution requires a particular set of operational activities to be performed. The key in this stage is to identify the range of activities utilised by a product solution, quantify their use and compare this operational activity with the current costing system adopted by the enterprise. In the case of Alpha Electronics it became clear that multilayer printed circuit boards were not priced to reflect their complexity and their demand on inter- and intra enterprise resources.

Evaluation of solutions from the data presented in the operational analysis phase revealed that a redefined direct labour-based system would remain inadequate for the total solution product environment of Alpha Electronics. The variations in activity profile led to the conclusion that the activity centre approach of activity based cost management would prove beneficial in quantifying the value provided by each activity for each generic solution type. In reaching this conclusion, it was recognised internally within Alpha Electronics that a more concerted effort to cost management needed to be adopted to ensure that the value received by customers was adequately reflected in product pricing and that a simple activity-based approach would meet this objective.

In the first phase a simple spreadsheet solution was developed. The initial focus at this stage was to gain ownership of the process within the enterprise and focus attention on the resultant data. In the long term an industry specific business control system was to be implemented that would allow for integral accounting, sales order management, material optimisation and production management. The emphasis was firmly placed on establishing the costing rules and principles "offline" of the business control system to enable them to be appraised and

understood within the enterprise and then integrated into the business control system at a later stage.

In developing the spreadsheet solution the activities in the enterprise were aggregated in-line with the detail emerging from the cost information. This was taken from the profit and loss account, invoice data for raw and in-process materials, wages book and depreciation data and analysed over the most recent six-monthly period. Each cost item was assigned wherever possible to an activity centre. Those costs incurred and labelled general overhead (accounting for 25 per cent of total costs) were grouped by cost type (e.g. facility overheads, general production overheads) and allocated to activity centres using resource drivers (e.g. square footage, number of personnel hours, number of direct-- labour hours) applicable to the defined cost type. The activities in the enterprise were aggregated to provide 16 main activity centres, the resultant costs of which were to be allocated to the generic groups of total solution products through six cost drivers (e.g. number of orders, set-up time, product area). Additionally, activities utilised in the extended enterprise (e.g. bare board testing, jig construction, laser plotting, electroless nickel immersion gold plating, distribution) were assigned cost driver rates to enable the total solution provision of Alpha Electronics and its extended enterprise to be accurately reflected in cost information.

ALPHA ELECTRONICS: A POST COSTING SYSTEM IMPLEMENTATION RESPONSE

The response to the updated cost information has been an immediate focus on reducing process waste internally within the enterprise. Concurrently, an evaluation of process methods adopted in the PCB industry has been under-taken with an aim of reconfiguring the operational environment to provide greater support to the high-cost internal processes and a long-term reduction in the cost of total solution products, thus enabling the conundrum of providing total solution products as an order winner while remaining competitive on cost for order qualification to be reconciled. In relation to the product portfolio, it has been recognised that significant costs are expended in obtaining and servicing orders for multilayer printed circuit boards in comparison to the conventional single-sided and double-sided (plated through hole) circuit boards, and this has been reflected in undertaking the process evaluation.

CONCLUDING REMARKS AND FUTURE DIRECTIONS

This research paper has identified that agile enterprises require unique management approaches in addition to enhanced manufacturing capabilities. The future of agile manufacturing is based on the ability of an enterprise to make the transition from mass/lean production in an efficient, effective and profitable manner.

The adoption of activity based costing in Alpha Electronics has enabled it to become customer centric. In parallel, its use has identified the long-term resource implications of adopting agility, enhancing the development of knowledge and skills. Additionally, the approach has focused attention on the intra- and inter-enterprise cost structure, allowing the identification and elimination of waste. As a method activity-based costing is compatible with agility, but the change management process has required modification. The strategic approach outlined in this paper and undertaken by Alpha Electronics provides a low cost/no-cost approach for adopting agility.

The successful implementation of activity based costing in Alpha Electronics reveals that agility can be achieved from a lean manufacturing environment. The current adoption and use of agility is limited in both scale and scope by the ability of organisations to implement all the four key tenants identified by Nagel et al. (Goldman et al., 1995). In order to extend its application the relationship of Putticks future enterprise model (Eureka project, 1995) with the four prime tenants should be investigated and further researched to generate methods of implementation.

The key for the agile enterprise is to ensure that it can compete effectively with competitors against order qualifiers (including cost) and enhance its provision of total solution products in line with order winners. This work has shown that the flexibility/cost conundrum facing agile and potentially agile enterprises can be overcome.

The results provide a framework that will enable practitioners to anticipate and therefore plan for the likely consequences of adapting to an agile environment, where the distinction between service and manufacturing orientation is unclear. In particular, the ability to identify the cost, value and profit implications of delivering total solution products to a variety of customer bases is required to ensure long-term competitive advantage. This framework allows the dynamic

formation of networks or fractal organisations within the value chain to be assessed and optimised to deliver innovative products and solutions to customers' needs.

This paper provides a basis for academics to understand the inherent complexities of adapting organisations to agility. Agile manufacturing forms the basis of a series of management solutions dependent on the external and internal conditions faced by organisations. Rather than one holistic solution to the generic problems faced by organisations, a variety of models are being created, each taking elements of modern manufacturing management practice and synthesising them to form unique total solutions to customer specific requirements and demands. This paper illustrates how the theory and practice of activity based costing can be adapted to fit a particular management solution. The future development of agile manufacturing will require academics to evaluate modern manufacturing management solutions and consider their adoption for agility.

CASE STUDY 3: LEAN PRACTICES IN AEROSPACE—AIRBUS AND BOEING COMPANY.

Source: agile manufacturing in the aerospace industry: an industrial viewpoint Mark Philips. International journal of agile management systems, Bradford: 1999.Vol.1, Iss 1: pg17.

INTRODUCTIONS:

Lean manufacturing - can it be applied to the aerospace industry?

Order-winning criteria

Lean manufacturing is a system based on the philosophy of waste elimination, the removal of all non-value added activity from the process of delivering a customer's requirement in a manner that delights the customer and ensures they return with repeat orders. Most customers use the metrics of price, quality, on-time delivery, and availability of required quantity with which to measure the performance of a supplier. Lean manufacturing systems operate on a continuous improvement philosophy based on the removal of waste from the system in order to maximise the potential of these four order-winning criteria (Hill 1993). This philosophy is supported by the reduction of set-up times to allow the economic production of small quantities (Booth 1996).

Lean production is not about volume or mass production. It is more about delivering goods with the maximum indices achievable for the four order-winning criteria of price, quality, on-time delivery, and availability in the required quantities as measured by the customer. These indices can only be continuously improved by the constant removal of waste in the system that delivers the customers' ever-increasing expectations.

Both the automobile and aerospace industries deliver goods in volume to the respective markets they serve. Both industries have employed batch or mass production systems to deliver goods. During the 1980s the Western car industry faced stiff competition from Japanese producers employing the lean manufacturing system that concentrated on the continuous improvement of all four order-winning criteria. This was in contrast to Western companies whose systems were only capable of achieving these order-winning criteria separately and very rarely combining any two at one point in time (Hill 1993). The lean manufacturing system was developed in and evolved from a company whose output was less than 2,685 units over a 13-year period. The total output of the high volume aerospace industry is approximately 1,400 units per year.

The early 1980s saw a massive over-capacity in the worldwide automotive industry; this over-capacity became evident at the same time as competition from the lean producers was intensifying. Some of the more astute Western companies responded by adopting the best practices of their competition; that best practice predominately existed in the form of the lean manufacturing system developed by Toyota of Japan. The adoption of this new manufacturing system was achieved quite successfully by some Western companies.

Force for change

It is now evident that the aerospace industry is entering a down phase of the business cycle. Boeing has indicated that this down phase is being further impacted by the ongoing Asian crisis and as a result of this has announced world-wide layoffs of 40,000. However, it should be noted that not all analysts of the current situation are putting the blame for Boeing's current troubles on the downturn. Some recent reports have suggested that Boeing's antiquated manufacturing system could not cope with the demands placed on it. A recent article in the Financial Times (Skapinker 1998) observed that Boeing had not

faced the pressures to modernise from lean well-organised companies, unlike the Western automotive industry of the 1980s.

Airbus Industries, whilst agreeing that the industry is entering a down phase of the business cycle, will not be exposed to the Asian crisis as much as Boeing. In addition to this Airbus Industries points to the launch of the A318, A340-500/600 and future A3XX as products whose demand in the marketplace will help offset any slowdown. Boeing and Airbus Industries both agree that the market is now entering a period of slowdown in the current rate of orders. To offset this Boeing and Airbus Industries are about to launch (or have already done so) new products that will help maintain the market share. Speed to market for this new product is vital to gain competitive advantage and therefore market share.

Two further points should be taken into account when assessing the impact of the slowdown and the Asian crisis. The first point is that Boeing has recently purchased McDonnell-Douglas and some of the layoffs could be attributed to rationalisation. Another point is the approach to manufacturing adopted by Airbus Industries. They have adopted a capital intensive approach to manufacturing that requires less manpower.

LEAN MANUFACTURING DEPLOYMENT

The only proven manufacturing model to have constantly reduced the lead time for new products is lean manufacturing as practised in the automotive industry. Airbus Industries is well placed to take advantage of lean manufacturing with the introduction of the A318, A340-500/600 and the future A3XX. Boeing meanwhile appears to have recognised the weakness of its old manufacturing systems and during 1997 was halfway through the modernisation of its manufacturing, design and inventory management systems (Skapinker 1998).

There is fragmented evidence throughout the aerospace industry that companies are now adopting the lean production philosophy and system. This is particularly true of companies that have strong ties with the automotive industry, Lucas Aerospace of the Lucas Varity group being a prime example. To support this evidence some research into the applicability of lean manufacturing and its deployment within the aerospace industry has been performed. James-Moore and Gibbons (1997) cover this field of research to some detail in the paper titled, "Is lean manufacturing universally relevant?-An investigative methodology".

In the above-mentioned paper not only did the authors set out to establish the applicability of lean manufacturing to what they termed super value goods (SVG), in this case aircraft, but they also analysed the deployment of such systems. For the investigation they defined a typical case model representative of a lean automotive producer. From this model six core processes were identified (James-Moore1997). These core processes being:

1. New product introduction,
2. Manufacturing,
3. Logistics, including purchasing,
4. Sales and marketing,
5. Product support,
6. People management.

From this process model five key characteristics were established with which a lean producer would improve its business (James-Moore 1997). These characteristics being:

1. Flexibility,
2. Waste elimination,
3. Optimisation,
4. Process control,
5. People utilisation.

Against each characteristic the team then listed applicable lean practices that would be used. In total 68 lean practices and tools were listed and recognised as being likely to be used in a lean manufacturing company. These practices and tools were then used as a core against which the UK aerospace industry could be surveyed. The results of this survey found that 40 of the 68 practices had been deployed in over 50 per cent of the companies surveyed. This can be seen in Figure 2 (James-Moore 1997). This survey was conducted with over 100 senior and middle-ranking executives supported by employees at shop-floor level.

Upon analysis and further investigation of the survey results, James-Moore (1997) found that of the practices with a low adoption rate a majority of these practices were connected to customer interface areas, in particular sales and marketing including service and product improvement. This indicated little use or relevance of these lean practices within the aerospace industry. The paper suggests that this may be attributable to the relatively small customer base, only

approximately 500 customers world-wide and the long product life of over 15 years that requires technical support throughout the life cycle. This is in sharp contrast to the automotive industry whose products have short life cycles of as little as two years and whose customer base is counted in the millions.

CONCLUSION

The aerospace industry is currently facing market conditions similar to that of the automotive industry of the early 1980s. That is to say markets are in decline, the industry is entering the down phase of its natural business cycle and the Asian crisis is threatening to exaggerate the magnitude of this phase in the business cycle.

In order for the two major manufacturers to manage the slowdown two approaches have been adopted. Boeing is shedding labour, although not all of the layoffs can be attributed to the slowdown taking into account their recent purchase of McDonnell-Douglas. Airbus Industries intend to launch new products for which they have identified a market demand; this in turn will cushion any foreseen slowdown.

Boeing and Airbus Industries are now well placed to adopt the lean manufacturing practices of the automotive industry. The adoption of such practices will ensure the most efficient delivery of new products to market for Airbus Industries. In addition to this they will also reap the benefits during the ramp up in production to fulfil the record-breaking orders of 1998. Meanwhile at Boeing they have already started to modernise and are adopting lean manufacturing (Norris1998).

But what of the obvious differences that exist between the two industrial sectors of aerospace and automotive manufacturing? The answer is, it does not matter. Lean manufacturing is all about the elimination of waste from the value chain (Womack 1996). This system has already been proven to delight customers, the metrics of the customer being their own order-winning criteria of price, quality, on-time delivery and availability.

Market forces for both automotive and aerospace industries are identical albeit the phase shifts of their relevant cycles are time lapsed because of the difference in manufacturing times. Both industries have volume producers relevant to their markets and just like the automotive industry of the 1980s, costs need to be

driven down and quality continuously improved whilst ensuring availability of products on time if market share is to be increased and maintained. When the automotive industry faced the same dilemma its salvation came in the form of the lean manufacturing system from Japan.

As for relevance in the aerospace industry, it has already been stated that lean manufacturing is about the systematic elimination of waste. It is already being adopted by some forward-thinking aerospace suppliers. This is supported by investigations and resulting analysis of findings by some academics (James-Moore and Gibbons, 1997). In addition to this research Womack and Jones (1997) cover extensively the transition of a traditional manufacture to that of a lean manufacture in their detailed case study of Pratt and Whitney.

To conclude, both the academic and incidental evidence, by way of observations throughout the industry, lends itself to the fact that lean manufacturing is applicable to the aerospace industry. Indeed not only is it applicable but essential if many of the companies are to survive and the "Big Two" maintain their market share.

CASE STUDY 4: SURVEY ON LEAN PRACTICES IN EUROPEAN

Source: lean production and sustainable competitive advantage. Michael A.lewis international journal of operations & production management, Bradford: 2000. Vol.20, Iss.8; pg 959.

INTRODUCTION

In Europe, there has been a great deal of debate about how lean production principles will impact upon established production models, in particular those in Germany (Streeck 1992, Culpepper 1999) and Sweden (Sandberg 1995). From a critical perspective, its effects upon the workforce (it often requires de-unionisation or single union agreements) have been fiercely attacked (Williams 1992, Garrahan 1992) and more managerially, the demands placed upon workers by lean systems have been highlighted as a problem with respect to ongoing staff recruitment (Cusumano 1994).

RESEARCH PROPOSITION

P1: If a firm has increased its overall effectiveness in converting resource inputs into outputs (measured against criteria, including in-progress and finished goods inventory, delivery and quality performance, employee numbers, floor space etc.) this lowering of relative costs should result in improved overall business performance (measured by profitability or market share etc) .

P2: Each firm will follow its own unique lean production development trajectory. This can be defined by its starting conditions and the specific implementation path followed (which techniques applied in which order etc.) to achieve the lean production outcome (compare with P1).

P3: The success of lean production in delivering sustainable competitive advantage will be contingent upon the external context of the firm. Contextual factors might include: type of market (competitor activity, different demand profiles); dominant technology in sector; supply chain structure etc.

P4: The more successfully any firm applies lean production principles, the less it will engage in general innovative activity. The firms will focus instead upon continuously improving existing processes and adopting incremental changes.

SURVEY RESULTS

(1) The case data confirm that becoming lean does not automatically result in improved financial performance, thus contradicting the first proposition. The critical issue appears to be the firm's ability to appropriate the value generated by any savings the firm can make. In markets (like automotive, or supermarkets etc.) where key firms exercise dominant market power, the benefits of lean production can very easily flow to these powerful players, although as case C illustrates, lean production does not automatically create these difficult conditions.

(2) The case material illustrates why it has proved so difficult to precisely define lean production. Despite apparent similarity on the initial questionnaire, closer examination revealed the variation inherent in each of the initiatives and highlighted how important the starting conditions were. This offers strong support for the proposition that each firm is likely to follow a more or less unique lean production trajectory.

(3) The single market context of the case studies prevented cross-sector comparisons from being drawn but the case material still provided strong support

for the "context matters" proposition. It highlighted how some markets can render specific resources "strategic" (i.e. location) and how certain job markets (i.e. those with skill shortages) can leave managers in a lean production system with a radically altered power dynamic to their key staff.

(4) The final proposition suggested that firms would inevitably see a narrowing of innovative activity, as they became more "lean". Although cases A and B provide some evidence to support this proposition, the relative performance advantage of case C appears to be based upon innovation. Over time, this resource development process involved technology push, short-term cost penalties and deliberately generated system complexity. This contradiction with lean production principles suggests that the proposition needs to be reformulated around some form of trade-off between degree of lean production and innovation.

CASE STUDY 5: SURVEY ON AGILE PRACTICE IN EUROPEAN

Source: Measuring agile capabilities in the supply chain. Remko I. van Hoek, Alan Harrison, Martin Christopher. International journal of operation & production management. Bradford: 2001.Vol, Iss ½; pg.126.

INTRODUCTION

Agility is increasingly mentioned as one of the coming challenges to the international business world, given volatile markets and increasingly dynamic performance requirements. Existing literature, however, mainly presents agility as a general management or a strongly manufacturing biased concept, but does not explicitly relate the concept to the supply chain as a whole. Research also shows a bias towards the USA. This paper presents an attempt to establish an audit of agility in the supply chain. The audit is used in an empirical investigation of agile capabilities in Europe. Using existing streams of supply chain research as building blocks, a preliminary framework is introduced for creating an agile supply chain. Based on a survey of agile efforts in the UK and the Benelux the agile capabilities of companies are assessed and approaches to outscore the benchmark are suggested.

THE OPERRATING ENVIRONMENT OF AGILITY

Fisher (1997) suggests two specific operating environments. Functional products with predictable demand benefit most from "physically efficient" supply chain operating structures; innovative products demand "market responsive" supply chain processes that are focused on speed and flexibility rather than on cost. Figure 3A shows Fisher's supply chain matrix: efficiency has been defined in "lean" terms of productivity and quality. A different approach to production scheduling called accurate response (Fisher et al., 1994) is proposed to distinguish stable demand items from unpredictable items. The latter are treated separately by assessing early market signals using a risk-based sequencing that demands highly responsive production facilities and supply chains.

In addition to the two dimensions used by Fisher, in this comparative positioning of operating environments a further dimension can be introduced, that of economic trade-offs. Economic trade-offs based on physical assets, labor, capital and land are most relevant in the functional, lean, environment that is focused on eliminating waste in operational processes. Trade-offs based on time, information and knowledge are more relevant in the innovative, agile, environment. Recall that leveraging information and knowledge is one of the primary dimensions of the agility concept.

Note that this representation, again, does not suggest that agility is intended to replace all "lean thinking". Economic trade-offs relevant in functional, lean environments, in the sphere of physical assets, land, labor and capital can also be relevant in the innovative, agile environment

Three case studies about agile practices in UK: Vanguard Medica and Britvic Soft Drinks and Remmele Engineering.

ELEMENTS OF THE AGILE SUPPLY CHAIN FRAMEWORK

1. Customer sensitivity. Customer centred versus product centred logistics policies (ten questions): assumes that "agile" policies emphasise customers and markets, while "lean" policies focus on the elimination of waste in products and processes.
2. Virtual integration. Immediate conversion of demand information into new products using knowledge-based methods versus multi-stage, multi-function methods (three questions): assumes that agile policies focus on instantaneous

demand capture, interpretation and response while lean policies emphasise stable production periods and protecting the "operations core".

3. Process integration. Self management versus work standardisation (five questions): assumes that agile policies focus on operator self-management to maximise autonomy and immediate response, while lean policies emphasise work standardisation to ensure conformance to quality and productivity standards.
4. Network integration. Fluid clusters v. long term supply chain partnerships (six questions): assumes that "agile" policies emphasise fluid clusters of network associates, while lean policies focus on a more fixed set of long-term stable partnerships.
5. Measurement. Capabilities versus "world class" measures of performance (seven questions): assumes that agile policies are based on broad-based measures that underpin capabilities, while lean policies emphasise "hard" measures such as quality and productivity only.

SURVEY RESULTS: THE AGILE PERFORMANCE ACHIEVEMENTS

1. A central point made by respondents is that introducing agility in the supply chain might raise customer sensitivity capabilities but might also call for project-like management approaches. When every customer requires his own supply chain and customised product/service offering this might not be a strange consideration at all.
2. Another central point made by respondents is that hard measures of quality and productivity are important but that winning the order comes first in today's dynamic market environment. As a result customer sensitivity counts first, whereas "lean measures" are relevant, partly as a qualifier, partly as a second order consideration.
3. The issue that developing an infrastructure for virtual integration is one thing, but the actual use and leveraging of information might be another. Virtual integration, therefore, does not only represent technology but an important management challenge too. It was still unclear about how this could be used to cope with expected increases in demand uncertainty in future.
4. Most organisations surveyed considered that they had a low level of predictability of customer demand over the next six months. Such a description

from a small batch/jobbing environment was reminiscent of Remmele Engineering, widely quoted by the Agility Forum as an exemplar of agility (Arnott 1996). Using such operational mechanisms as safety stocks, temporary employees and outsourcing for capacity reasons (all three mentioned multiple times) does not really reflect a proactive approach to mastering uncertainty. It rather reflects a reactive approach of coping with uncertainty, nor does it use uncertainty to proliferate agile capabilities and outperform less agile competitors.

5. Finally, the "service edge" was seen by most of our surveyed companies as a key business imperative.

CASE STUDY 6: SURVEY ON AGILE PRACTICES IN UK MANUFACTURING ORGANISATION

Source: A methodology for achieving agility in manufacturing organisations. Z.Zhang and H.Sharifi. International journal of operations & production management. Bradford:2000.Vol.20,Iss.4;pg.496.

INTRODUCTION:

A recent empirical study carried out by the authors has investigated six UK manufacturers operating successfully in a turbulent market environment. The results from the study suggest:

1. Agility can be achieved in a manufacturing organisation through the strategic integration and utilisation of available managerial and manufacturing methods and tools (Sharifi and Zhang, 1998; 1999), including those already developed and used in other paradigms and those recently developed for agile manufacturing. Recently developed "agility practices" need to be fully integrated with existing ones in order to achieve the expected results and the way for such integration is often organisation-specific.
2. Different organisations experience different sets of changes and different levels of pressures resulting from the changes, and therefore would require different combinations of practices and tools to cope with the changes.

THE CONCEPTUAL MODEL FOR IMPLEMENTING AGILITY:

It has three constituting blocks. The first is concerned with "agility drivers", which are the changes/pressures from the business environment that necessitate a

company to search for new ways of running its business in order to maintain its competitive advantages. The second is concerned with "agility capabilities", which are the essential capabilities that the company needs in order to positively respond to and take advantage of the changes. The third is concerned with "agility providers" that are the means by which the so-called capabilities could be obtained. These providers are to be sought from four major areas of the manufacturing environment, i.e. organisation, people, technology, and innovation. It is also suggested that the providers need to be fully integrated with the support of information systems/technology.

A METHODOLOGY FOR ACHIEVING AGILITY

Based on the conceptual model described above, a methodology has been developed to help manufacturing companies formulate strategic policies in their pursuit of agile manufacturing. It consists of three major stages: the determination of a company's agility needs and its current agility level; the determination of agility capabilities required for the company to become agile; and the identification of business practices and tools which could bring about the recognised capabilities for the company.

First, the business environment as the source of turbulence and changes imposes pressures on the business activities of a company (Preiss 1997). These uncertainties, changes, and pressures, i.e. the so-called agility drivers, urge the company to search for appropriate ways to maintain their competitive advantages. The drivers could vary from one company to another and from one situation to another, and therefore the way they affect a company could vary as well. This necessitates a method to detect and recognise the changes in the business environment.

As changes and pressures faced by companies may be different, the degrees of agility required by individual companies will be different (James-Moore 1996). This degree is defined as the "agility need level", which is a function of various factors such as the degree of turbulence of the business environment, the characteristics of the environment in which the company competes, and the characteristics of the company itself. Once the agility need level is determined for a company, the next step is to assess the current agility level of the company, i.e. how agile the company is now. The difference between the level of agility

required and that which the company already has may then be analysed to provide a basis for further decision making. In this work, the outputs from the analysis are broadly classified into four categories:

(1) The company does not need to be agile.

(2) The company is agile enough to respond to changes it might face in the future.

(3) The company needs to take actions to become agile but not as an urgent agenda.

(4) The company needs to be agile strongly and urgently.

The next stage following the analysis of agility needs is to determine the required agility capabilities in order to become agile. This would require the detection, recognition and classification of changes faced by the company, as well as the analysis of the impact individual changes will bring to the company. The agility capabilities required may then be determined from the changes.

The final stage in the methodology involves identifying agility providers that could bring about the required capabilities, implementing the identified providers, determining the level of agility achieved (through performance measurement), and formulating corrective measures to further improve the performance. A number of tools are being developed to assist manufacturing enterprises to carry out the above processes, which are discussed below.

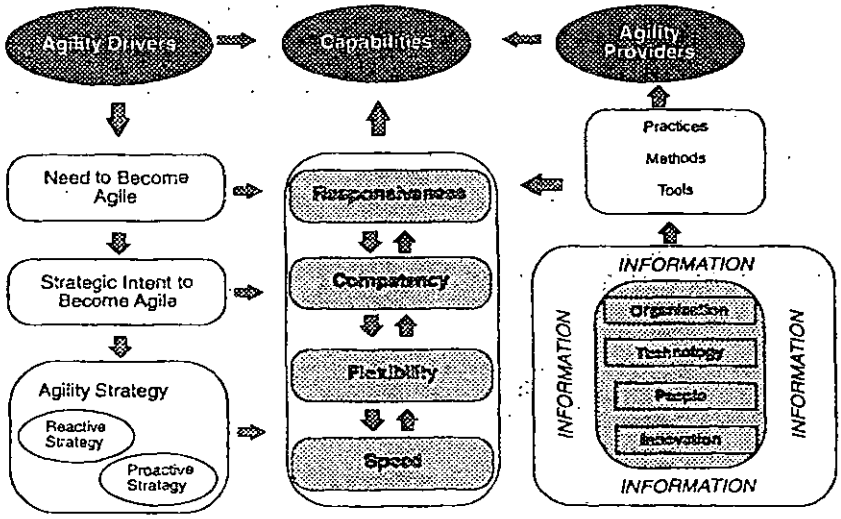


Figure18: The conceptual model for implementing agility

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20.Issue 4, pg 496.

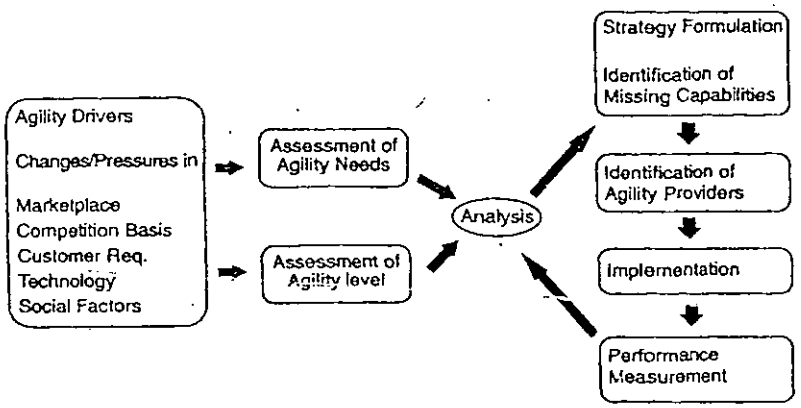


Figure19: The proposed methodology to achieve agility

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20.Issue 4, pg 496.

AGILITY ASSESSMENT TOOLS

An assessment model includes two assessment tools, one assessing the company's business environment and operational/internal conditions, and the other evaluating the current level of agility of the company. Following the assessments, two types of analysis are carried out. The first is a gap analysis in which a speculative interpretation is made to specify the point where the company is located on a continuum that starts from "no need for agility at all" to "high level of agility needed very urgently". The other is a direct analysis of the results from the second assessment to show the weak points of the company, considering the situation in the business environment and the available ability of the company in coping with the situation.

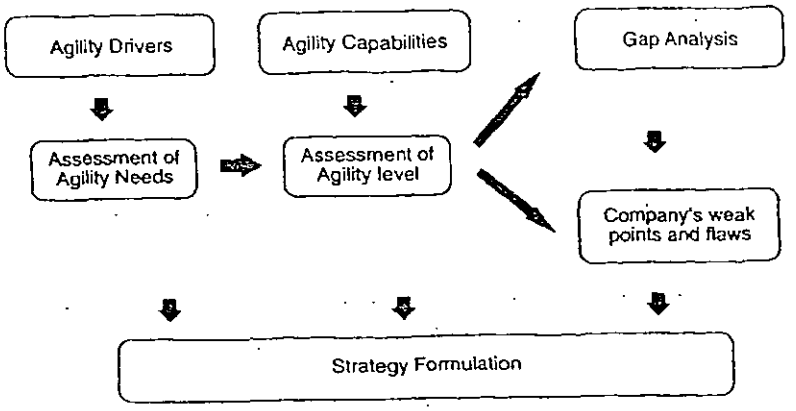


Figure20: The assessment model for agility

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20. Issue 4, pg 496.

PRACTICAL STUDY TO IMPLEMENT AND VALIDATE THE METHODOLOGY

An industrial questionnaire survey and a number of in-depth case studies have been conducted to investigate the practical aspects of the proposed methodology. The survey and case studies were designed to carry out a general study of agility drivers, the strategies and capabilities adopted by manufacturing companies in response to the drivers, and the agility providers deployed to achieve the capabilities, and to establish a preliminary correlation between the drivers, capabilities, and providers. The survey covered 1,000 companies from three major industrial sectors, the Electrical and Electronic Manufacturing sector, the Aerospace Manufacturing sector, and the Vehicle Parts Manufacturing sector. The case studies covered 12 companies selected from the survey sample. While the details of the survey and case studies are reported in other publications (Zhang 1999), some of the important findings are summarised below:

1. Changes/pressures from business environment, i.e. the agility drivers, are strongly recognised by companies as the source of disturbances and problems in the battlefield of competition. These changes/pressures vary from sector to sector and from company to company. However, "change of customer requirements" is identified as the most important factor for all three sectors. Although the number,

types, specifications or characteristics of changes could not be easily determined (different companies with different characteristics and in different circumstances experience different sets of changes that are specific and perhaps unique to their situations), changes occurring in companies from different sectors do share common characteristics. Some common areas where typical manufacturing companies may face change and the corresponding changes, which may occur in those areas, were established during the research. These are shown in Table 10. The changes were ranked by each participating company for their respective degrees of impact on the companies' business, as shown in Table 10.

Table 10: Changes as agility drivers

Changes	Impact	Changes	Impact
1. Changes in *market*		4. Changes in *technology*	
Growth of niche market	M	Introduction of faster and more	L/M
National and international political changes	L/M	efficient/economic production	
Increasing rate of change in product models	M/H	facility	
Product lifetime shrinkage	L/M		
		Introduction of new soft	M/H
2. Changes in *competition* criteria		technologies (software and methods)	
Rapidly changing market	M		
Increasing pressure on cost	H	Inclusion of information	L/M
Increasing rate of innovation	L/M	technology in (new) hard	
Increasing pressure of global competition	M/H	technologies	
Decreasing new products time-to-market	M/H		
Responsiveness of competitors to changes	L/M	5. Change in *social factors*	
		Environmental pressures	M/H
3. Changes in *customer requirements*		Workforce/workplace	L/M
Demand for individualised products/services	L/M	expectations	
Quicker delivery time and time-to-market	M/H	Legal/political pressures	L/M
Quality expectation increasing	M/H	Cultural problems	L
Sudden changes in order quantity specification	L/M		
Notes: L = Low; M = Medium; H = High			

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20. Issue 4, pg 496.

2. Companies in different sectors respond differently to changes by considering strategic capabilities, which suit them and correlate to their specific circumstances. Focusing on customers has, however, been emphasised by most respondents. A generic list of capabilities has been determined through the study. These may be divided into four major categories.

I: Responsiveness: This is the ability to identify changes, respond rapidly to changes either reactively or proactively, and recover from changes. This is itemised as:

(1) Sensing, perceiving and anticipating changes.

(2) Immediate reaction to changes.

(3) Recovering from changes.

II: Competency: This is an extensive list of abilities that provide a company with productivity, efficiency, and effectiveness in achieving its aims and goals. The following items form the major part of the list:

(1) Strategic vision.

(2) Appropriate technology, or sufficient technological capability.

(3) Products/service quality.

(4) Cost- effectiveness.

(5) High rate of new products introduction.

(6) Change management.

(7) Knowledgeable, competent, and empowered people.

(8) Operations efficiency and effectiveness (leanness).

(9) Co-operation (internal and external).

(10) Integration.

III: Flexibility: This is the ability to carry out different work and achieve different objectives with the same facilities. It consists of items such as:

(1) Product volume flexibility.

(2) Product model/configuration flexibility.

(3) Organisation and organisational issues flexibility.

(4) People flexibility.

IV: Speed: This is the ability to carry out tasks and operations in the shortest possible time.

Items include:

(1) Quickness in new products time-to-market.

(2) Quickness and timeliness in products and services delivery.

(3) Quickness in operations (short operational lead-times).

Among the four types of capabilities, responsiveness is the essential capability for any organisation which needs to be agile. The other three are the necessary elements in order to achieve responsiveness.

3. Utilisation of methods, tools and techniques to obtain the required capabilities is widely experienced or considered by respondents. Most of the proposed practices as appropriate tools for agile manufacturing including information

system methods/tools/techniques are partially implemented in more than 60 per cent of companies. At the same time, despite the perceived impact and importance of these practices, the achievements resulting from them in responding to changes and taking competitive advantage have not gone far enough. This could be interpreted as being due to the lack of strategic intent and weakness of approaches to the adoption of practices. Practices regarding Organisation and People are found to be more effective and also more important for manufacturers. In contrast to the strong emphasis of agile manufacturing literature on the need for practices such as virtual organisation, mass-customisation, and utilising the Internet as an information tool, these practices were found to be implemented partially in only a small percentage of responding companies. A generalised list of practices, which could be associated with the identified agility capabilities, is produced as the result of the research.

SUMMARY OF FINDINGS:

1. IMPLEMENTATION OF THE METHODOLOGY

Step1: Analysing the need for agility.

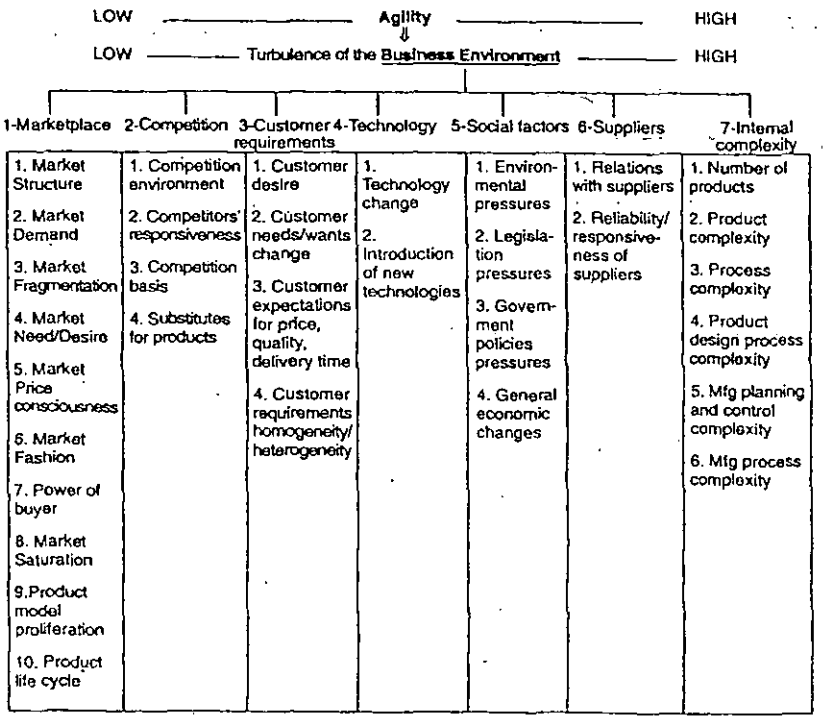


Figure21: Analysing the need of a company to be agile.

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20. Issue 4, pg 496.

Step2: Determination of ability capabilities

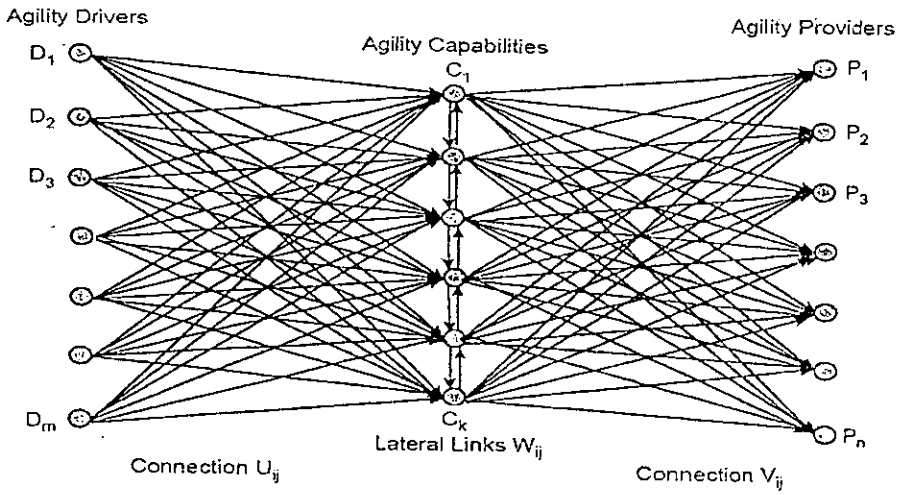


Figure22: Network to determine the required agility capability and providers

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20. Issue 4, pg 496.

Table11: Relationship between drivers and capabilities

General business practices	Information systems	Tech/tools
Establishing partnership with suppliers and/or customers	Establishment of an information management plan or model	JIT/Kanban
Close relationship with suppliers/customers, and involving them in co.'s planning and product development process	Strategic use of information system through the company's information management plan	CIM
Establishing virtual organisation	Using Internet and related information tools as a means of communication with outside	TQM
Adoption of advanced technology	Using an internal information network, that makes information available company-wide	Concurrent engineering
Mass-customisation through utilising adequate technology integration of inter-organisational systems, modules and the manufacturing system	Using integrated computer-based product development process	Flexible mfg system (FMS)
Flexible, responsive to changes, flat, and learning organisation	Using computerised manufacturing information system	Lean mfg
Continuous reengineering of the organisation and business processes based on benchmarking	Using computerised manufacturing information system, compatible with international standards of data exchange and transfer such as STEP	CAD/CAM/CAE
Informal, coaching, and encouraging management style	Information system interface with suppliers	Robot technology
Structured and flexible manufacturing processes	Information system interface with customer	Joint venturing
Concurrent and team working methods/models		Rapid prototyping
Continuous training and education of all people		

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20. Issue 4, pg 496.

Step3: Identification of ability providers

Table12: A list of agility providers

Increasing pressure on cost Capabilities	Wts	Dec. new prod. time-to-market Capabilities	Wts
Cost-effectiveness (competency)	4.1	Quick new products time-to-market (speed)	4.3
Appropriate technology/sufficient technological ability (competency)	3.9	High rate of new products introduction (competency)	3.7
Strategic vision	3.4	Knowledgeable, competent, and empowered people (competency)	3.7
Products/services quality (competency)	3.4	Co-operation (internal/external, competency)	3.7
Operations efficiency and effectiveness-leanness (competency)	3.4	Strategic vision (responsiveness)	3.6
Sensing, perceiving and anticipating changes (responsiveness)	3.4	People flexibility (flexibility)	3.6
Change management (competency)	3.3	Integration (competency)	3.6
People flexibility (flexibility)	3.3	Appropriate technology/sufficient technological ability (competence)	3.4
Immediate reaction to change by effecting them into system (responsive)	3.1	Products and services delivery quickness and timeliness (speed)	3.4
Co-operation (internal/external, competency)	3.1	Fast operations time (speed)	3.4
Organisation and organisational issues flexibility (flexibility)	3.1	Sensing, perceiving and anticipating changes (responsiveness)	3.3
Fast operations time (speed)	3.0	Immediate reaction to change by effecting them into system (responsiveness)	3.3
Recovery from change (responsiveness)	2.9	Products/services quality (competency)	3.3
Product volume flexibility (flexibility)	2.9	Change management (competency)	3.3
Products and services delivery quickness and timeliness (speed)	2.9	Operations efficiency and effectiveness-leanness (competency)	3.3
High rate of new products introduction (competency)	2.7	Product model/configuration flexibility (flexibility)	3.3
Integration (competency)	2.7	Cost-effectiveness	3.0
Product model/configuration flexibility (flexibility)	2.7	Product volume flexibility	3.0
Knowledgeable, competent and empowered people (competency)	2.6	Organisation and organisational issues flexibility	3.0
Quick new products time to market (speed)	2.4	Recovery from change	2.9

Source: Zhang.Z (2000): A methodology for achieving agility in manufacturing organisations. International journal of operations & production management, Bradford: 2000. Vol.20. Issue 4, pg 496.

CASE STUDY 7: THE MODEL AGILE PRACTICE--REMMELE ENGINEERING INCORPORATE

AN INTRODUCTION TO AGILE FORUM'S INTEGRATED VIRTUAL ENTERPRISE REFERENCE MODEL

Sponsored by the Agility Forum, this 1996 reference model project had two principal goals:

(1) Design a reference model structure that effectively captures and displays the essence of enterprise-wide competency at both proactive and reactive change.
(2) Validate the design with a rich, comprehensive example that provides an instructive reference case for an entire enterprise.

The purpose is to provide a defining profile with examples for business managers and executives responsible for strategic planning, operational management, and reengineering.

The reference model spans 24 interrelated critical business practices in 6 categories:

I: Strategic planning (3),

II: Business case justification (3),

III: Organizational relationship management (7),

IV: Knowledge management (4),

V: Innovation management (4),

VI: Performance metrics (3).

The seven organizational relationships focus on business units, employees, partners, suppliers, customers, information systems, and production systems. Each of the 24 practices is presented in a 3–5 page structure that provides: a generic definition, the framework and modules of a case-study practice that fits that definition, a set of generic proactive and reactive change issues, case-study responses for each issue, and finally, a change proficiency maturity synopsis that evaluates and displays the competency of the case example using the recently developed Change proficiency maturity model.

CHANGE PROFICIENCY MATURITY MODEL

A five-stage maturity model framework was recently developed as a tool to assess existing corporate competency at change proficiency, as well as to prioritize and guide an Agility transformation or improvement strategy.

The five stages of maturity provide a metric for measuring a company's proficiency on the two axes of interest: proactive and reactive change proficiency. The key change issues for each critical business practice are developed using response ability analysis, which refers to a collection of analytical methods based on eight change domains, four in the proactive realm and four in the reactive realm.

Table 13: Change proficiency Maturity Framework

	Stage	Knowledge	Metric focus	Change proficiency	
				proactive	reactive
Pre-Aware	Accidental	examples	Pass/Fail	incompetent	incompetent
Required	Repeatable	Concepts	Time	creation	correction
	Defined	Metrics	cost	improvement	variation
Advanced	Managed	Rules	Robustness	migration	Expansion
	mastered	Principles	scope	Modification	Reconfiguration

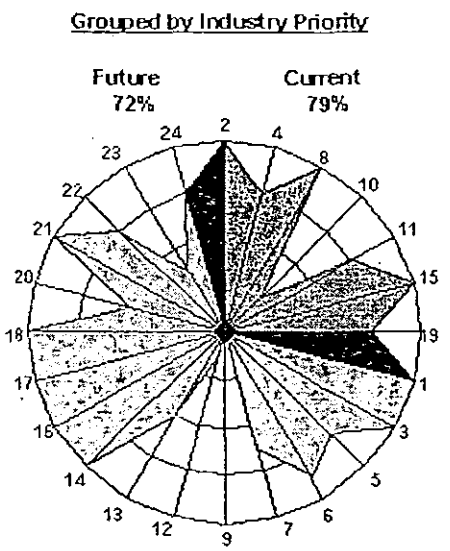
Note:

1. These metrics are associated with the change process itself and refer to the *time* to affect a change, the *cost* of making a change, the quality (*robustness*) of the change process, and the breadth (*scope*) of the change capability.
2. The *Accidental Stage* is characterized by the lack of any change-process recognition, yet change manages to occur. The actual process is ad hoc: typically exhibiting false starts and retries, unpredictable completion dates and costs, surprising results and side effects, and undesirable reactions from, and effects on, the personnel involved. On the obvious bad side are: grueling overtime, downsizing, multiple reengineering attempts, management fad-of-the-day, fire-fighting, and expediting.
3. The *Repeatable Stage* is typically based on anecdotal "lessons learned" from past change activities. Specialists and talented SWAT teams are recognized for prior successes and abilities to repeat these in relatively quick time frames.
4. The *Defined Stage* begins to recognize formal change processes with documented procedures. The base of potentially successful practitioners is broadened as process rather than intuitive talent becomes appreciated. Metrics for the change process are identified and predictability becomes an elusive desire. Typically procedures at this stage are rigid and based on studied experience and analysis.

5. The *Managed Stage* is characterized by the appointment of change managers (business engineers) with established responsibilities, though they may neither be called such nor recognized as such. An evolving knowledge base of change process fundamentals begins to emerge, appreciation for and participation in the corporate change process is widespread, rigid procedures are loosened, and predictability is the norm.
6. The *Mastered Stage* is characterized by a principle-based, deep appreciation of adaptability; an understanding that process alone is not sufficient; and a conscious engineering and manipulation of the structures of business practices and organizational infrastructures. Like a flock of birds swooping and turning as a unit, corporate change loses its event status and takes on a constant fluid motion.
7. To assess the maturity of a practice one identifies the knowledge base employed in decision support, the metric focus on active strategies, and the exhibited competencies in both proactive and reactive change—all relative to a previously determined set of change issues.

CASE STUDY RESULT---REMMELE ENGINEERING INCORPORATE AGILE PRACTICE

Industry Priority			
Future	Current		Critical Business Practice
4.00		1	Strategic Plan Vision
	4.00	2	Strategic Plan Dissemination
4.00		3	Strategic Plan Buy-In
	3.00	4	Capital Investment Justification
3.00		5	Infrastructure Investment Just.
3.50		6	Business Eng. Investment Just.
2.50		7	Business Unit Relationships
	4.00	8	Employee Relationships
0.00		9	Partner Relationships
	1.00	10	Supplier Relationships
	3.00	11	Customer Relationships
0.50		12	Information Sys. Unit Relationships
2.00		13	Production Unit Relationships
4.00		14	Product Innovation Management
	4.00	15	Process Innovation Management
4.00		16	Procedure Innovation Mgt.
4.00		17	Strategy Innovation Mgt.
4.00		18	Knowledge Portfolio Strategy
	3.00	19	Knowledge Generation
2.00		20	Knowledge Capture
4.00		21	Knowledge Mobilization
3.00		22	Leading Indicator Metrics
1.50		23	Operating Metrics
3.00		24	Valuation Metrics



Remmele Change Proficiency Maturity

TWENTY-FOUR CRITICAL BUSINESS PRACTICES---THE REFERENCE MODEL ARMATURE

Critical business Practices Framework	
1.0 strategic planning 1.1 strategic plan vision 1.2 strategic plan dissemination 1.3 strategic plan buy-in	4.0 innovation management 4.1 product innovation management 4.2 process innovation management 4.3 practice/ procedure innovation management 4.4 strategy innovation management
2.0 business case justification 2.1 capital investment justification 2.2 infrastructure investment justification 2.3 business Eng. Investment justification	5.0 knowledge management 5.1 knowledge-portofolio strategy 5.2 knowledge Generation 5.3 Knowledge capture 5.4 Knowledge mobilization
3.0 organisational relationship Management 3.1 business unit relationships 3.2 employee relationships 3.3 partner relationships 3.4 supplier relationships 3.5 customer relationships 3.6 information system unit relationships 3.7 production unit relationships	6.0 Performance Metrics 6.1 leading indicate metrics 6.2 Operation metrics 6.3 Valuation metrics

CASE STUDY 8: AGILE MANUFACTURING PRACTICES IN THE SPECIALTY CHEMICAL INDUSTRY IN USA

Source: Agile manufacturing practices in the specialty chemical industry: An overview of the trends and results of a specific case study. A Guisinger, B Ghorashi. International journal of operations & production management. Bradford: 2004, Vol.24, Issue. 5/6; pg.625.

INTRODUCTION:

The objective of this study was to examine the trends in the specialty chemical industry that have led to the rising number of agile practices and "virtual" organizations. An agile company can be defined as an enterprise that is capable of operating profitably in a competitive environment of continually, and unpredictably, changing customer opportunities.

RESULTS:

The five most prevalent agile practices in the specialty chemical industry can be summarized as, entering niche markets through customer chemicals manufacturing, improving relationships with suppliers (also, a lean manufacturing practice), formation of strategic partnerships, adaptation of advanced technology/research, and the emergence of "virtual" firms.

2.18: GENERAL CONCLUSIONS—RESEARCH NEED

From existed literature, we can see there are two biggest research centres carry on lean and agile practice research in UK.

(1). Daniel.T.Jones is the chairman of the lean enterprise academy (www.leanuk.org) in Herefordshire, England, UK.

(2). Paul.T.Kidd is the chairman of the agile enterprise consultant (www.cheshirehenbury.com) in Macclesfield, England, UK.

Also Many UK universities begin to carry out leagile supply chain management research, for instance, Loughborough University Manufacturing organisation's Postpone management strategy for leagile supply chain management.

However, lean and agile research is just beginning in UK, so far, still no standard lean and agile measuring method in academic environment, although many lean and agile models have been developed. Many British companies still

rely on world-class manufacturing company, such as Ford, as benchmarking model for lean adopting. From my survey result, many new technology-base firms in UK/US urgently need some easy adopted leagile organisation models to assist their future operation management.

Therefore, in this research, I will try to fill in this gap through carrying on a broad survey in new technology-based firms (NTBFs) in UK, USA and Japan. We try to map out the best lean and agile practice in UK, US and Japan, especially the detailed procedures on how to adopt this lean and agile system.

2.2: OPTIMAL HITOP MODEL MANUFACTUIRNG ORGANISATION FOR INNOVATION MANAGEMENT

2.21: BACKGROUND

This research will look at determining optimal HITOP manufacturing organisation for innovation management. The goal is to develop an optimal leagile boundaryless organisation model that operations managers from NTBFs can use it as innovation management tools by combining lean and agile merits.

The paper is structured as follows. Firstly, HITOP manufacturing organisation model will be described, then I will explain the HITOP organisation model analysis strategy in detail. Secondly, the research hypotheses will be described, then, I will explain the research design in detail. Thirdly, I will bring our survey data and case studies on lean and agile best practices in UK, then I will explain how to analysis lean and agile policy using DEA method in detail. Finally, I will give general conclusions on optimal HITOP organisation practices in UK innovation management, in other words, the justification of HITOP manufacturing organisation model.

2.22: OVERVIEW OF HITOP-A

HITOP-A (Highly Integrated Technology, Organisation, and People-Automated) is an automated knowledge-based design, decision support, and simulation package, to be used by people involved in the design and planning of new computer-based manufacturing systems. HITOP-A can be used during the preparation of capital investment proposals to identify hidden costs and benefits associated with the planned technological change, as well as during the implementation process to identify critical success factors.

HITOP-A incorporates specific decision rules and heuristics, drawn from subject matter experts, the current theoretical literature, current best-practice approaches, and our own formal analyses. These predict in detail, for a wide range of contexts, technologies, and management values, the future human infrastructure needed to support a proposed technological change. HITOP-A also performs a diagnosis of the readiness of the current organisation to implement the needed human infrastructure. Figure23 shows a schematic representation of the conceptual and implementation structure of HITOP-A.

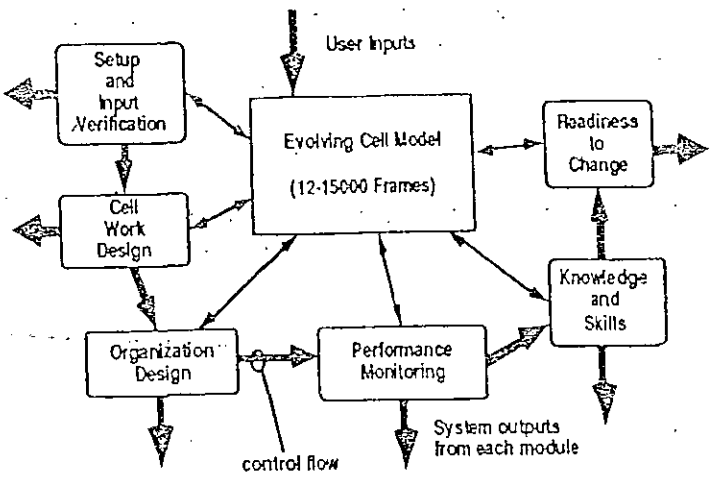


Figure 23: The structure of HITOP-A.

Source: Ann Majchrzak and Les Gasser (1992): HITOP-A: A tool to facilitate interdisciplinary manufacturing systems design. International Journal of Human Factors in manufacturing, Vol.2(3), 255-276(1992).

The HITOP-A domain knowledge represents greater clarity for the theory of technological change, as well as providing the first attempt to integrate a wide body of disparate research finding on effective organisational support of technological change. In addition, HITOP-A is intended as a methodological tool for use by technology-change researchers by providing a test-bed to explore how changes in technology and organisational goals affect human infrastructure. HITOP-A provides a level of control that has never been achieved in this field of study, and thus is a tool for careful theory development.

HITOP-A research involves the simultaneous development of an integrated and semantically well-formed body of domain knowledge, including an ontology of

manufacturing tasks, goals, practices, and relationships, and the actual construction of HITOP-A as a knowledge-based system (KBS). HITOP-A generates its human infrastructure model using the following information about the organisation, its planned technology, and its environment: production variances, strategic business goals, management values, hardware and software features of the planned technology, individual capabilities, motivational needs of the workforce, environment constraints, and organisational readiness to change.

In order to face the challenge in the domain knowledge development, for instance, identifying the complete conceptual model, the formal semantic structure, and the heuristic decision rules for specifying the human infrastructure of a manufacturing system. HITOP-A is first developing a comprehensive domain knowledge model and ontology which defines all necessary components of the human infrastructure, critical predictor variables, and relationships between predictors and human infrastructure components. This is represented in a formalised semantic structure, called the "Evolving Cell Model" (ECM). Through time, the ECM represents an increasingly elaborated representation of the target FMS cell. HITOP-A group critical definitional and heuristic knowledge with which to generate human infrastructure requirements into functional categories called " Work design", "Organisational structure", "Performance Management", "Skills", and "Readiness-to-change". Each becomes an operational knowledge module that, when integrated into an overall control structure and representational scheme, elaborates the core of the ECM. For each category, HITOP-A has identified the relationships of the inputs to particular infrastructure features, using a series of meta-analyses and delphis with subject matter experts. Each of the functional categories is implemented as one KBS module that semi-autonomously elaborates the ECM with its particular sort of knowledge.

Overall, HITOP-A is a "cooperating expert systems" architecture, one form of Distributed Artificial Intelligence (DAI). (Bond1988) By testing the model on example cases, logical gaps and model inconsistencies are identified and clarified.

HITOP-A METHOD BEST PRACTICES: BOEING ROCKETDYNE CASE STUDY

Majchrzak (2001) presents a case study at Boeing-Rocketdyne, entitled "Radical innovation without Collocation". She describes how a unique type of virtual team, deploying a computer-mediated collaborative technology, developed a radically new product. The uniqueness of the team—what we call VC^3 team, for virtual Cross-value-chain, Creative Collaborative Teams—stemmed from the fact that it was inter-organisational and virtual, and had to compete for the attention of team members who also belong to collocated teams within their own organisations. Using the case of Boeing-Rocketdyne, she describes the behaviour of members of a VC^3 team to derive implications for research on virtual team, especially for studying teams within emerging context. This case study has also been published in Harvard business review (Majchrzak 2004). Majchrzak states that HITOP method enable knowledge creation and sharing in Far-flung teams more effectively through virtual workspace technologies (Majchrzak 2005).

THE LIMITATIONS OF HITOP-A METHOD

Yusuf (2002) carry out a research by comparing lean and agile manufacturing practices in UK, his research concludes that market instability would intensify and become universal. UK Companies would therefore be compelled to look beyond their internal boundaries for enhanced competitive advantage. They would have to ensure the lean virtues of internal efficiency as well as the agile value of supply-chain based responsive adaptation.

From Yusuf's research, I can see the weakest link of HITOP-A method can be compensated by Lean method to enhance their internal efficiency. For instance, many scholars bring leagile supply chains concepts (Van Hoek 2000, Mason-Jones 2000, Naylor 1999). However, leagile supply chain concepts are still under tested. Meanwhile, there are no cases that some virtual enterprise was wholly agile (Goranson 1999). Therefore, in my research, I try to find some basic ideas on how to build this HITOP leagile enterprise by combining lean and agile principles in British new technology-based firms.

HITOP LEAGILE MANUFACTURING ORGANISATION DESIGN THEORY AND ITS TOP-MODELER STIMULUS TOOLS

Based on Chern's classic socio-technical systems (STS) theory, Majchrzak (2001) introduces a new midrange STS theory for agile systems that can support emergent knowledge processes (EKP) using TOP-Modeler stimulus tools.

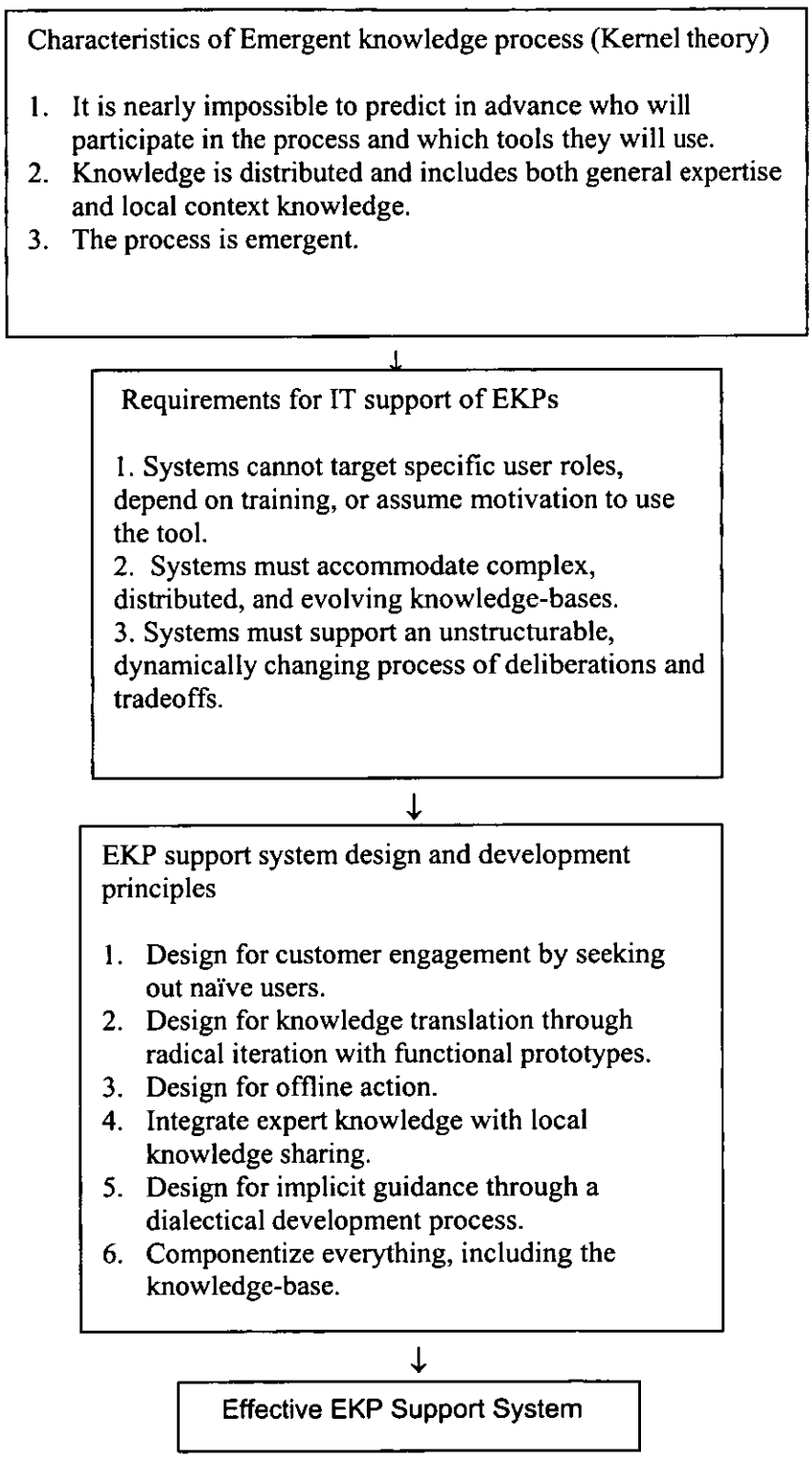
Table 14: The characteristic of this new midrange STS theory

Midrange STS theory	Elements of a midrange STS theory	Definition
Business strategies	Continuous improvement objectives	Continuous improvement objectives that drive the organization's design.
	Process variance control strategies	Technical variations (planned or unplanned) in the production workflow that create uncertainty in the processing of materials.
Organizational design or Organization's AS-IS state	Organizational values	Preferences of management about how employees (management included) should behave.
	Skills	Skills held by a majority of the employees in the unit.
	Reporting structure	Characteristics of the organization that describe if jobs are organized as teams, the number of jobs, and the reporting levels in the organization.
	Norms	Types of behaviours that are expected of the employees.
	Activities	Sets of activities that a unit must be responsible for if the unit is achieve its business objectives.

	General technology	General technical system characteristics as related to manufacturing processing equipment or systems.
	Performance Measures and Rewards	Attributes of the system which measures how employees and the organization perform the work and that provides the incentives to encourage employees or groups of employees to work towards organizational goals.
	Information resources	Types of dynamically changing data that is relevant to the manufacturing process.
	Production process	Aspects of the production process that make it more or less complex to manage and improve, such as knowledge depth needed, number of work-in-process queues, or variations in tools, batch sizes, and materials.
	Empowerment	Factors over which employees are encouraged to make decisions.
	Employee values	Values held and demonstrated by employees with regards to work.
	Customer involvement	Aspects of the organization's business in which the customers are actively encouraged to participate.

Source: Majchrzak Ann and Bryan Borys (2001): Generating testable socio-technical systems theory. Journal of Engineering and Technology management, 18(2001), 219-240.

Table 15:Markus (2002) summaries the contributions of EKP design theory as:



Source: M.Lynne Markus and Les Gasser (2002): A design theory for systems that support emergent knowledge processes. MIS Quarterly,Vol.26 No.3,pp.199-225. September 2002.

Also EKP design theory can be stimulus using Top Modeler. TOP stands for "Technology, Organisation, and People" integration. The system called Top modeler was developed to support the process of organisation design in manufacturing organisation. Top modeler was funded with a $3Million grant from the National Centre for Manufacturing Sciences in USA and included the active involvement of four companies: Hewlett-Packard, General Motors, Digital Equipment Corporation, and Texas instruments. The detail of this TOP modeler is from Top integration, Inc.(www.topintegration.com).

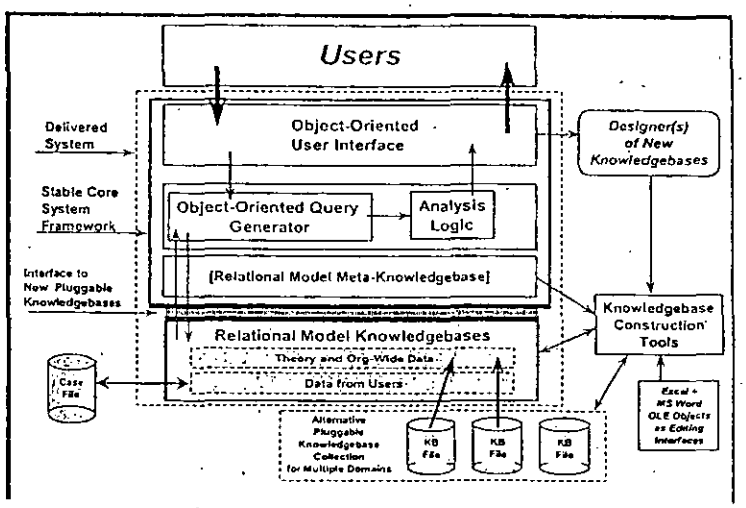


Figure 24: Top Modeler System Architecture.
Source: Top integration, Inc.(www.topintegration.com).

Top-Modeler is a tool to facilitate interdisciplinary manufacturing systems design and support complex strategic and operational decision-making. The merit of Top-Modeler is that it contains a knowledge base of expert advice without the need for extensive tailoring or custom building. Moreover, the knowledge base has predictive validity based of a benchmarking study of 90 companies (Majchrzak 1997), including five major companies (General Motors, Hewlett-Packard, Hughes, Boeing Rocketdyne and Texas Instruments) so that the gap analysis results have credibility in the industry.

HITOP-A provides several advances in methodologies and implementation of multi-expert KBSs, including techniques for developing and integrating

knowledge from a diverse set of domains with different conceptual models, techniques for developing and handling large knowledge bases, techniques for flexible interaction of several reasoning modules, and techniques for effectively managing the human aspects of input and output.

HITOP-A has also integrated a large body of knowledge about the implementation of advanced manufacturing technologies, stated this knowledge in a precise and operational form, and provided a test bed for experiments to verify the theories that this knowledge exemplifies. As a practical matter, the embodiment of this theoretical modeling software provides one of the first practical platforms for analysing human infrastructure and technological choices in situ.

Finally, the core concepts of HITOP-A are applicable to a wider variety of domains, automation types, or work structures than those surrounding flexible manufacturing technologies.

HITOP MODEL ANALYSIS STRATEGY

HITOP DESIGN PRINCIPLES

Originally Cherns (1976) formulated nine principles of joint technical and organisational design.

1. Compatibility.

   This requires that we develop some form of participatory organisation structure, but such a system must be designing by involving the people.

2. Minimum critical specification.

   This implies a degree of flexibility and openness in job descriptions, group structures and technologies. This is exactly what is needed to achieve agility.

3. Variance control.

   It is important that we should control variances at source because, not to do so, often introduce time delay which tends to lengthen throughput times and so on. In agile manufacturing, response time is a critical variable, which must be kept as short as possible.

4. The multifunctional principle—organism versus mechanism.

5. Boundary location.

   Boundaries should be designed around a complete flow of information, knowledge and materials, so as to enable the sharing of relevant data,

information, knowledge and experience. In other words one should create natural groups.

6. Information flow.

   We need to provide information at the place where decisions and actions will be taken based on the information. This is also the requirement of agility manufacturing, such as empowerment and continuing improvement.

7. Support congruence.

   We need redesign our reward systems, performance measurement systems. For example, individual reward for individual effort is not appropriate if team behaviour is required.

8. Design and human values.

9. Incompletion.

   It includes power and authority and transitional organisation issue, because improvement will never end.

HITOP DESIGN METHODS

Majchrzak (1991) stated that the key feature of joint technical and organisational design is that it is a concurrent design method. This means that it is based on:

1. Addressing organisation, people and technology issues in parallel, with trade-offs made between all three areas.

2. An interdisciplinary approach.

3. Recognition that the organisation and people issues within the design process itself, are as important as the organisation and people issues that need to be addressed as part of the system design.

Majchrzak also stated that the benefits of joint technical and organisation design lie in the area of improved design and implementation process, better system designs, more appropriate organisation structures, better matching of organisation, people and technology and engaged and motivated people.

HITOP comes in the form of a work book that is in effect, an easy to read analysis manual, providing step-by-step guidance, rationales for analysis, blank analysis forms and worked examples. It covers a wide range of issues and is based on a six stage methodology.

The first stage of the methodology involves making an assessment of our organisational readiness for change, which is followed in the second stage by an assessment of the technology that we have proposed, in order to identify its critical features. The third step is an analysis of the essential task requirements, which leads to the fourth step, an assessment of the skill requirements. The fifth step is concerned with determining how people should be rewarded. The final step is concerned with designing organisational changes which need to be achieved given the technology and people requirements, which leads to the generation of a specific implementation plan.

Majchrzak (1991) stated that the HITOP design tool would therefore lead us through:

1. An assessment of organisational readiness for change.
2. A definition of the critical technical features of advanced technologies.
3. The determination of essential job requirements, job design options, skills, training and selection requirements.
4. The determination of requirements and options for pay, promotion and organisational structure.

The analysis thus provides a direct and ordered consideration of critical technology, organisation and people factors, and helps to identify those factors which require in-depth attention. The analysis also gives an expanded insight into the total organisational and people impacts of specific technologies, going well beyond skills and training. Identification of people and organisational cost drivers in technology implementation is also another result of the analysis.

HITOP allows us to specify alternative organisations and different ways for managing people given specific technology plans. HITOP also provides guidance in determining the appropriate time for implementing technology plans, and helps to identify those equipment and system choices that are likely to create the greatest number of people and organisational problems, so that we may be better prepared to deal with them.

By performing HITOP analysis, we are guided by and iterative, system based process in which all critical features of the organisation, people and technology environment are systematically assessed and all implementable options are identified. This enables us to define the consequences of major decisions before they are implemented. As a result, surprises downstream will be reduced and

necessary changes to the technology, organisation or the people involved can be identified.

HITOP DESIGN STRATEGY: USING SPIRAL STRATEGY

Hickman (1989) presented his spiral model: the vertical axis in the top half of the figure represents increasing stability of the design. The horizontal axis on the left side shows the increase in cost as the number of turns around the spiral increases. The vertical axis in the bottom half represents the progress that is being made in the development towards a completed product. Finally, the horizontal axis in the left half represents the degree to which the commitment to the design increase as the number of turns around the spiral increases.

For enterprise design, I need to re-label these axes because I am considering strategies and systems. This leads to figure 25. I can now consider typical turns around the spiral.

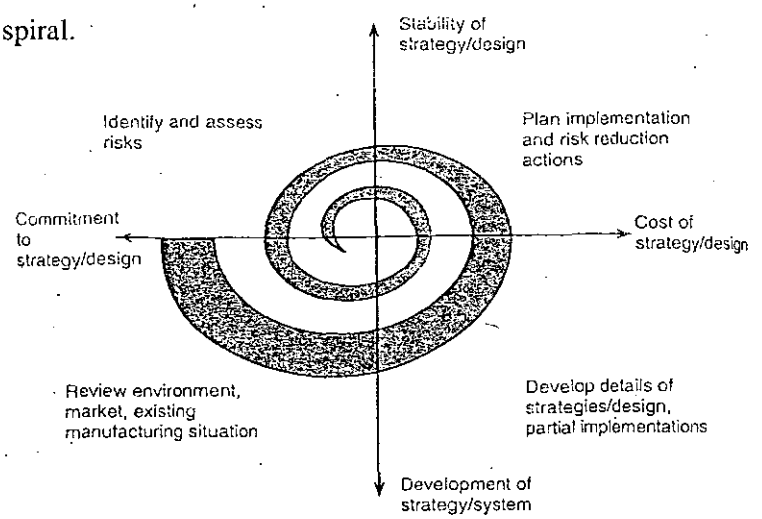


Figure25: Agile manufacturing enterprise design spiral life cycle model.

Source: Manufacturing Knowledge Inc.1993.published with permission.

The first cycle around the spiral starts with the initial identification of the business objectives, opportunities, threats, competitors' performance and so on. Then an initial audit to establish the current situation is now undertaken. Thus far, I have established several possible business strategies. The next step is to take these strategies and undertake some preliminary design, planning financial analysis and preliminary implementation activities. There are several ways to collect this information, including workshops with employees to analyse and discuss the options, rough cut financial analysis to determine costs and benefits, logical data flow diagrams, mock-ups, simulation of factory layouts, the use of

computers to emulate proprietary IT systems and software, organisational simulation to experiment with organisation options, job designs and so forth.

The basis of this cycle around the spiral is to move rapidly from outline business strategy right through to considering details of manufacturing systems design and implementation, and then returning to consideration of business strategy.

Once I have decided upon a particular manufacturing strategy, the speed at which I cycle around slows down and I move into the more detailed design and implementation. I am still on the spiral. However, there will come a time when it will be necessary to return to the start of the process and review the business strategy and if necessary devise a new one. So the whole process restarts.

In summary, the spiral approach provides an opportunity of reintegrating designers and users, bringing the users' perspective back into the process. Thus I can start the process of change, long before that process becomes evident in the form of new technologies, new machines, new organisational structures and new working practices. Also in adopting the spiral approach, I not only seek to identify and eliminate risks, but also to achieve the intertwining of problem solving and problem seeking and the rapid adaptation of strategies and systems to the continuously changing needs of the market place.

TOTAL AGILE ENTERPRISE DESIGN USING HITOP METHOD

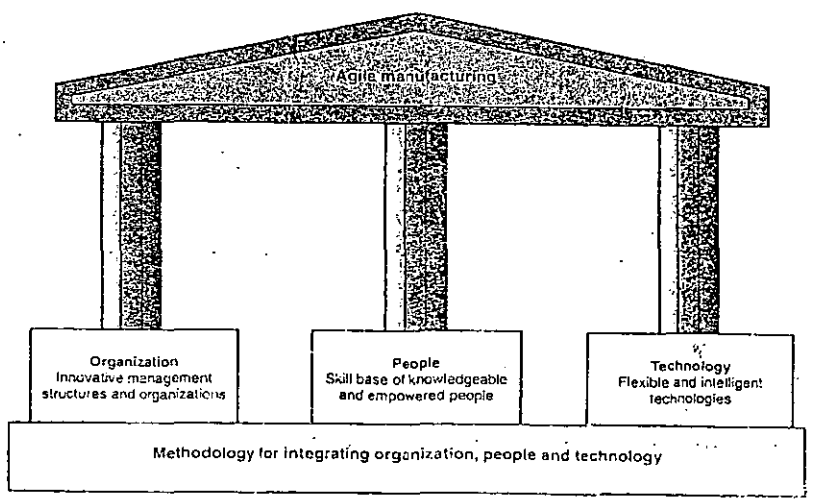


Figure26: The Structure of agile manufacturing enterprises.

Source: Manufacturing Knowledge Inc.1993.published with permission.

TOTAL AGILE ENTERPRISE DESIGN FRAMEWORK: USING THE FOUNDATIONS OF WORLD CLASS MANUFACTURING SYSTEM AS A FRAMEWORK

The national academy of engineering has defined what are called the foundation of world class practice of manufacturing systems. (Heim 1992) These eleven foundations are ideally suited to agile manufacturing.

1. Goals and objectives.
2. Customers.
3. Organisation.
4. People.
5. Suppliers.
6. Management approach and philosophy.
7. Metrics.
8. Describing and understanding.
9. Experimentation and learning.
10. Technology.
11. Environment.

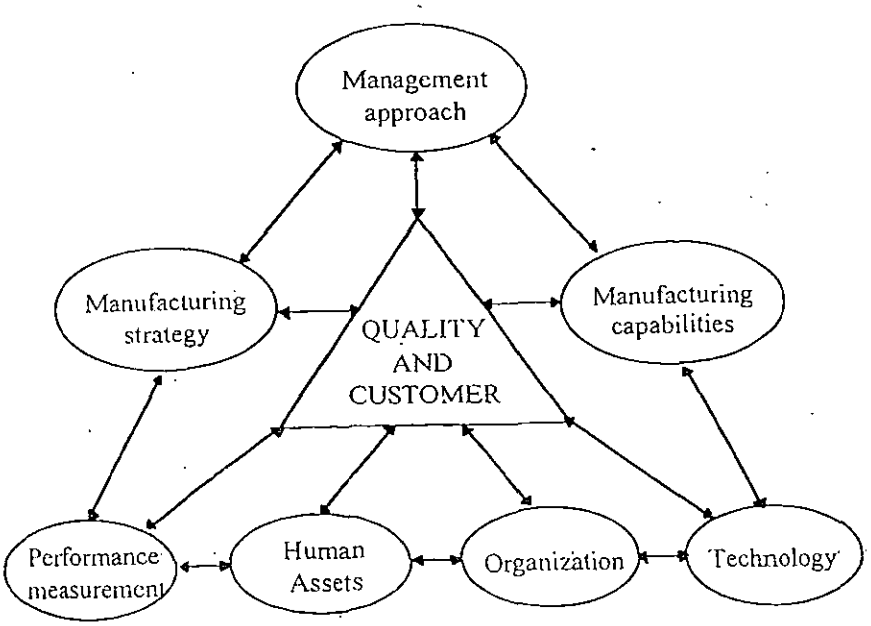


Figure 27: World class manufacturing framework.

Source: Manufacturing strategy. (Giffi, Roth et al., 1990, P.9)

Focusing on interdisciplinary design by building the network of interrelationship among the world class manufacturing foundation frameworks

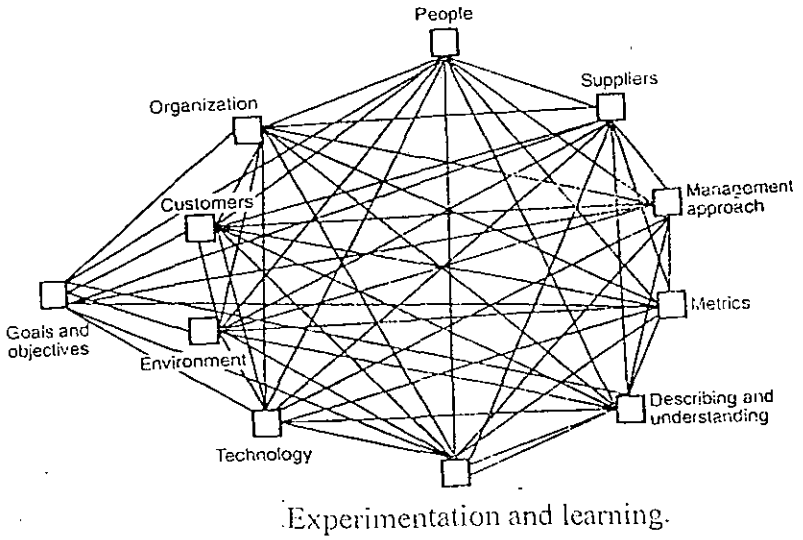


Figure28: Network of interrelationships between manufacturing systems foundations.

Source: Manufacturing knowledge inc.1993.

THE JUSTIFICATION OF HITOP METHOD—USING HITOP METHOD FIND THE BOUNDARY AMONG LEAN AND AGILE AND TQM AND CIM

Increasing technological integration →

Increasing Organisation integration ↓

Current state of factories. (dis-integrated technology and organisation)	High technological integration. (eg. CIM) but dis-integrated Organisation.
High organisational Integration —the Japanese model.(TQM/JIT)	Integrated technology and organisation.

Majchrzak (1991) describes her HITOP Method analysis procedures:

1. Describing and refining an organisation's strategic vision.

An organisation's strategy-setting can be described as three dimensions using Top-Modeler's Ferris wheel, it includes:

(1) Business Objectives. (using Top-Modeler's knowledge base "Objectives-by-objectives" matrix)

(2) Process variance control strategies (using Top-Modeler's "Objectives-by-variance" matrix)

(3) Organisational values (using Top-Moderler's "Objective-by-organisational value" matrix).

2. Describing the organisation's current (as-is) state for structuring its organisation and technology to achieve the vision.

Top-Modelers describe the organisation's as-is state by 11 feature sets:

(1) Information resources.

(2) Production process characteristics.

(3) Empowerment characteristics.

(4) Employee values.

(5) Customer involvement.

(6) Skills.

(7) Reporting structure characteristics.

(8) Norms.

(9) Activities.

(10) General technology characteristics.

(11) Performance measures and rewards.

3. Comparing the as-is state to the ideal best-practice state generated using Top-Modeler's knowledge base to identify gaps.

Top-Modeler's can bring three types gaps, such as critical, helpful and neutral.

(1) Mission-critical gap is not having the feature will demonstrably hurt the organisation's ability to achieve a specific business objective.

(2) Helpful gap is the feature is useful but not essential for achieving the business objective.

(3) Neutral gap is the presence or absence of the feature will neither hurt nor help the organisation's ability to achieve the business objective.

4. Deciding which gaps to close first

Top-Modeler provides a detailed design model as a decision tree, where decisions about the number of features in place are aggregated to a decision about the likelihood of achieving the desired business objective.

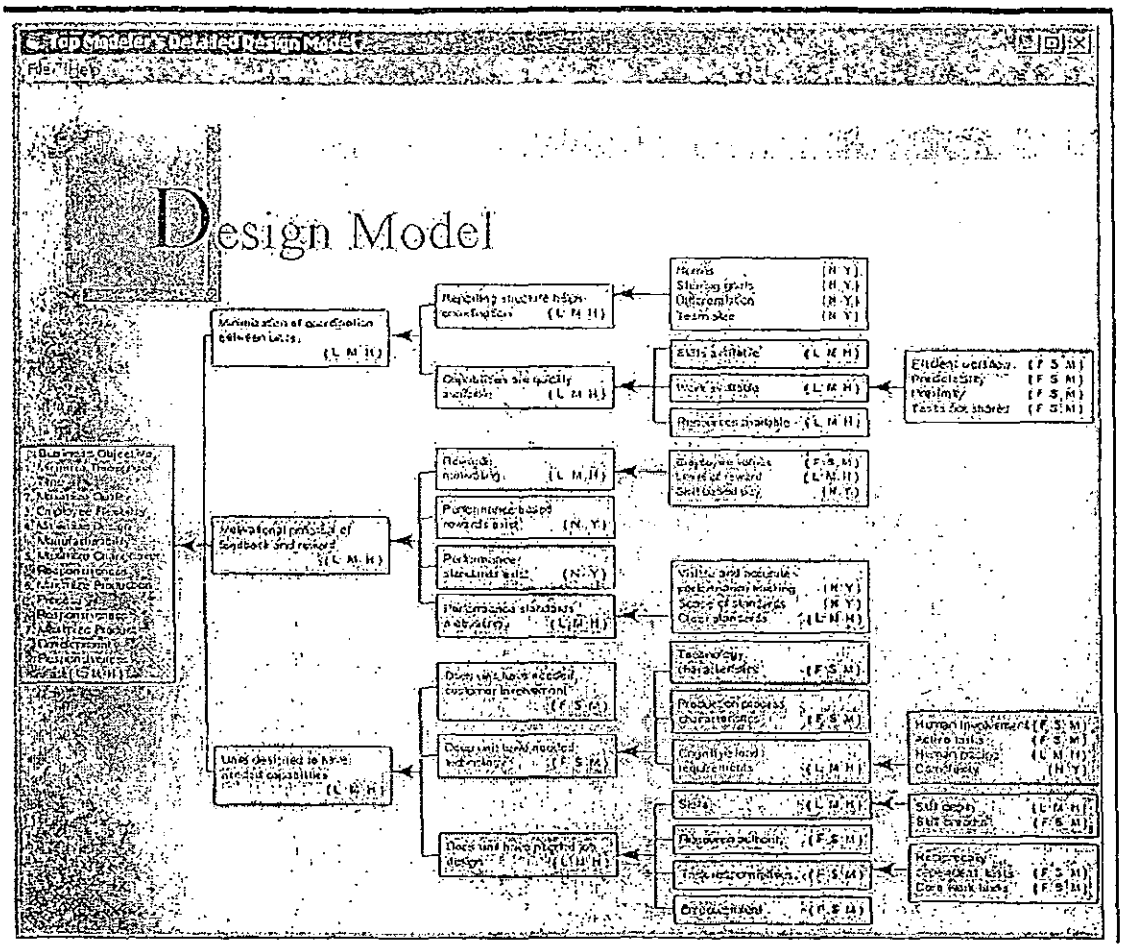


Figure 29: Detailed design model.

Source: Ann Majchrzak (2000): Top-Modeler: Supporting complex strategic and operational decision-making. Information knowledge systems management 2(2000) 95-110.

In sum, Top-Modeler has been used to test new midrange socio-technical system theory for emergent knowledge process. Also Top-Modeler has been applied to help streamline and clarify strategic and operation decisions for a wide array of strategist, designers and managers in manufacturing organisation, such as GM, HP, Hughes, Rocketdyne, and Texas Instruments. Thus, it can used to find the boundary between lean and agile organisation, and TQM and CIM organisation.

However, Top model should not be viewed as the optimal organisation model. Thus from the previous literature, here we will compare HITOP model with other innovation process models.

1: From Mass production transfer to lean.(MPIM model)

Manufacturing Paradigm Innovation Model (MPIM), (Tang 2005) which pioneer examined the lean production adopting period in Toyota Motor Corporation between 1948 and 1963.

Table16: Manufacturing Paradigm and Performance matrix

Manufacturing paradigm	Order-winners	Order-qualifiers	Order-neglecters
Craft production	Customization	No	Cost, customer lead time, etc.
Mass production	Cost	Customer lead time	Customization, etc.
Lean production	Cost, quality	Customer lead time, service	Others
Agile manufacturing	Customer lead time, service	Cost, quality	Others
Mass customization	Cost, customization	Quality, customer lead time	Others

Source: Zhongjun Tang(2005): Operational tactics and tenets of a new manufacturing paradigm 'instant customerisation' International Journal of Production Research. Volume 43, Number 14 / 15 July 2005.

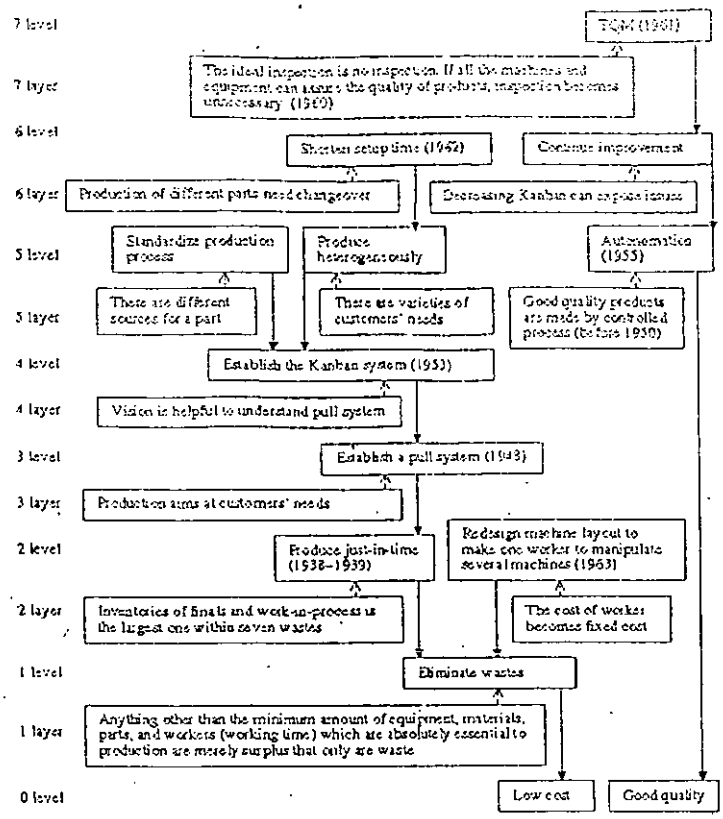


Figure30: Manufacturing Paradigm tree of the Toyota Production system. Summarized from Sugimori et al. (1977), Ohno (1978), Pegels (1984), Cusumano (1988) and Udagawa (1995).
Source: Zhongjun Tang(2005): Operational tactics and tenets of a new manufacturing paradigm 'instant customerisation' International Journal of Production Research. Volume 43, Number 14 / 15 July 2005.

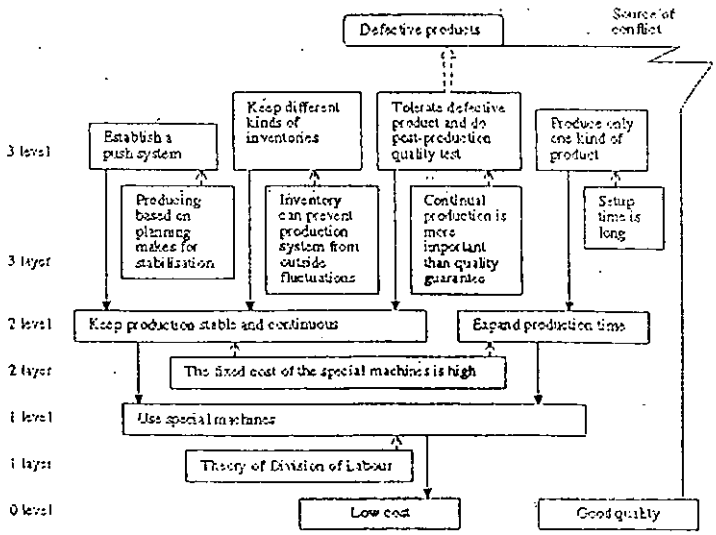


Figure31: The conflicting practices and principles of mass production with new performance measure 'good quality' of lean production according to MPIM.
Source: Zhongjun Tang (2005): Operational tactics and tenets of a new manufacturing paradigm 'instant customerisation' International Journal of Production Research. Volume 43, Number 14 / 15 July 2005.

MPIPM model shows that comparing with mass production, lean production has many merits, for instance, lean production has intensified the non-conflicting practices, such as rigid standardization, the excessive division of work, the definition of restricted roles, short work cycles, and a hierarchical organisation. Thus, lean production has succeeded to the practices, principles, theories, and unquestioned assumptions of mass production, which do not conflict with the objectives of lean production.

2: Lean STS innovation model.

Research carried out by Lathin (2001) from US Lean Enterprise Action Network LLC shows that Socio-technical systems (STS) integration is a conceptual model that enables organisations to introduce the new processes and methods of lean manufacturing more effectively. The lean methods are more likely to yield promised benefits where the characteristics of the existing social system are capable of supporting and sustaining the new technical system. Joint optimisation is the process of simultaneously designing the social and technical subsystems to create an overall work organisation that is capable of high performance.

This lean socio-technical design process follows four steps:

Step1: Design the preliminary technical system. Value stream mapping is a relatively new technique that has helped many companies planning the technological changes necessary to transform their mass production systems into lean production systems.

Step2: Test the preliminary technical system against the existing social system.

The first step in conducting the joint optimisation analysis is to conceptually determine the individual, organisational and cultural variables relevant for implementing lean production.

The second step is to determine whether these variables facilitate, impede or are neutral with regard to the ideal future state, you can construct a joint optimisation matrix I call the lean implementation planning matrix.

Table 17: Lean implementation planning matrix

Technical system / Social system	Strategy	Implement continuous flow production							..	Sum
	Technical changes	Organize equipment into product cells		Schedule production to match Takt time		Utilize multi-skilled workers				
	Required behaviour changes	Management focus will change from departmental (machines) to products (cell)	Management will implement a fast response system to correct production systems	Workers will follow standard work methods	Cell workers will perform as part of a synchronized Product team	Machine operators will be able to perform own setups	Machine operators will be able to run all machines in the cell	Machine operators will be able to perform quality and maintenanc e checkout		
Individual factors										
Desire for autonomy				-2	-2	+1	+1	+1		-1
Management understandin g and ability in new coaching role										0
Teamwork skills					-1					-1
Understandin g of new system		-1								-1
Employee motivation										0
Group factors										
Understandin g of new roles and responsibiliti es										0
Understandin g of results expected										0
Mass production Mind-set		-2		+1		-1	-1	-2		-5
Continuous improvement /Kaizen activities in place										0
Experience in team concept					-1					-1
Summary		-3	0	-1	-4	0	0	-1		

Note: plus=facilitates 0=is neutral Minus=is a barrier TAKT time= rate of consumption

Source: Drew Lathin and Ron Mitchell (2001): Learning from mistakes. Quality Progress, Milwaukee: Jun 2001.Vol.34.Iss.6; pg.39.7pgs.

At the top of the matrix the various features of the technical changes (strategy, technical changes and behavioural changes) are entered. These are fairly predictable. And the social variables are entered along the left-hand column. They are organised into five categories: individual, group, inter-group, company and inter company factors. Then a determination is made in each cell indicating whether the existing social system variable strongly or weakly facilitates, is neutral, or weakly or strongly impedes the lean behaviour at top.

A rating scale is used to determine the strength of facilitation or impediment (+2, +1, 0, -1, -2). A summary score can be determined by adding the values entered in the cells to determine whether the particular lean behaviour is at risk or not (column sums) or whether a social system factor is supportive or not (row sums).

Step3: Design the final socio-technical system. In cells where mismatches are identified (in other words, where the present social system factor impedes the lean technique), system designers face two choices.

First, they can change the social system. For example, when individuals are performing individual jobs, and continuous flow manufacturing requires the implementation of work teams, it may be necessary to address a variety of individual, organisational and cultural factors to facilitate multiskilling and working together as a team. Changes could include developing team skills for workers and management, developing a culture of mutual respect and cooperation across functional groups and making changes to the labour agreement.

The second option for dealing with mismatches is to modify the preliminary technical system design. Where it is determined that the organisation will initially be too resistant to changes, some compromise in the ideal technical future state may be needed. This is often disheartening to system designers and management. If it is remembered that the change process incorporates an ongoing continuous improvement phase, many of these ideal technical features can often be implemented later in kaizen (continuous improvement) activities when the organisation is more amenable to the concept.

Step4: Assemble and place all the changes to the technical and social systems into an implementation plan after the new socio-technical system is complete. A

good project management methodology and tool are essential to keep track of the changes being implemented.

However, No further detail test between Lean production and agile production from previous literature review. Thus, in this research, I will use HITOP model test innovation process between lean and agile production system in new technology based firms in the UK.

3: From CIM transfer to agile.

Source: Architecture for agile manufacturing and its interface with computer integrated manufacturing (CIM). Z.Y.Wang. Journal of materials processing technology 61(1996) 99-103. This research is supported by Machine-Tool Agile Research Institute (MTAMRI) from university of Illinois.

Architecture for Agile Manufacturing Central Network Server (CNS):

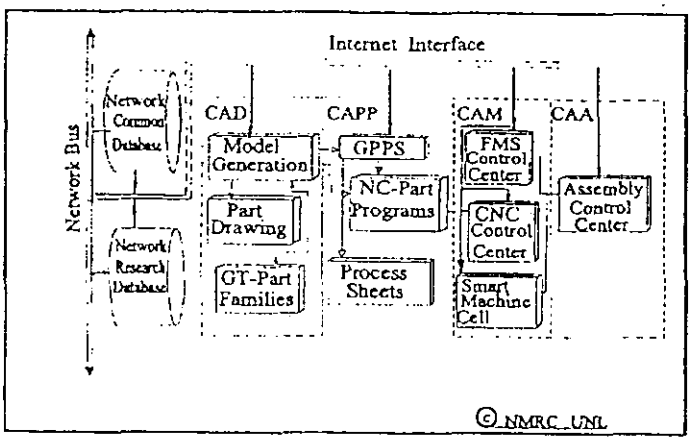


Figure33: Architecture for central network server (CNS).

Source: Architecture for agile manufacturing and its interface with computer integrated manufacturing (CIM). Z.Y.Wang. Journal of materials processing technology 61(1996) 99-103.

It is crucial for approaching agility in manufacturing by combining the common manufacturing database and standardized research database. Agile manufacturing is a concept to standardize common manufacturing data, research data, CAD/CAM structure and integrate them into a macro network. Thus the central network service will create the specific CAD/CAM files and a series of

commands to operate designated local CNC machines to accomplish the whole machine operations and assembly operations.

4: From TQM/JIT transfer to lean.

Source: Work organization in lean production and traditional plants what are the differences? Forza, Cipriano. International journal of operations & production management. Bradford: 1996. Vol.16, Iss.2; pg 42.

INTRODUCTION:

Proposes a framework which will be useful to research the linkages between work organization and lean production practices, The framework considers two types of work organization practices: type (a) which is directly linked to lean production practices such as JIT/TQM (worker autonomy, multifunctional employees, feedback to workers, etc.) and type (b) which influences the setting up and the maintenance of type (a) practices (training, compensation, etc.). Tests hypotheses concerning the practices which can be said to be directly linked to JIT/TQM on data collected on 43 manufacturing plants through valid and reliable measurement instruments.

SURVEY RESULT:

The results show that lean production plants seem to use more teams for problem solving, to take employees' suggestions more seriously, to rely more heavily on quality feedback both for workers and supervisors, to document production procedures more carefully and to have employees able to perform a greater variety of tasks including statistical process control. Lean production plants, however, show almost no differences with regard to aspects of work organization which involve hierarchy.

5: From HITOP transfer to agility.

Source: Research agenda for agile manufacturing. F.B.Vernadal. International journal of agile management systems. Bradford: 1999.Vol.1, Iss.1; pg 37.

INTRODUCTION:

Manufacturing agility can be defined as the ability to closely align manufacturing enterprise systems to changing business needs to achieve competitive performance. Agility has therefore three fundamental dimensions:

organization, technology and human, in addition to financial aspects. This research discusses organization, technological and human aspects of agility with respect to product design, manufacturing system design and innovation management.

SURVEY RESULT:

Agile Manufacturing can be characterised by three fundamental dimensions dealing with:

1: Organisation aspects: covering organisational structure, collective competencies and people empowerment.

2: Technological aspects: covering product-related, business process-related, technology-related and integration-related imperatives.

3: Human aspects: covering teaming aspects, individual competencies and people attitude.

Furthermore, in any manufacturing enterprise, agility must cohesively be taken into account at least at the level of:

1: Product design: including integrated teams and Cohesiveness of collective competencies and Knowledge and know-how capitalisation.

2: Manufacturing system design and control: including Enterprise engineering (EE) methods and Reusable components and Enterprise modelling and integration (EMI) technology.

3: Innovation management: including Performance indicators and drivers and Competency management and Employee satisfaction.

2.23: FORMULATION OF THE RESEARCH QUESTIONS

Based on above literature review on lean and agile relationship on innovation and technology management, the following research questions have been posted:

1: Since lean and agile relationship base on the same socio-technical system (STS) theory, it is possible to combine lean and agile into a leagile organization model under the more broad operation environment—both hostile and normal operation environment.

2: HITOP leagile organisation can satisfy the need of innovation and technology management for British new technology-based firms.

3: lean, agile and leagile manufacturing organisation performance can be compared using innovation and technology management as the measure indicators.

2.24: CASE STUDIES ON HITOP MODEL PRACTICES IN NEW TECHNOLOGY-BASED FIRMS (NTBFs) IN UK

CASE STUDY 1: SURVEY ON AGILE PRACTICE FROM UK DTI BEST PRACTICE FIRMS (Brunel University, UK).

Source: Expecting the unexpected. Lee Hibbert. Professional Engineering. Bury St. Edmunds: Mar 24, 1999. Vol.12, Iss. 6; pg.39, 1 pg.

INTRODUCTION:

While many UK companies appreciate the broad concepts of agile manufacturing, few seem to have much idea how to initiate the process or how to monitor their progress. This apparent confusion has led a team of researchers at Salford and Brunel universities to create a conceptual model of agile manufacturing that sets out clear under principles and enables companies to assess how far down the path toward agility they are.

SURVEY RESULT:

Led by John Sharp of Salford University, the researchers surveyed 48 companies identified by the Department of Trade and Industry (DTI) as leading practitioners of best practice. The results confirm that even many of the bluest of blue-chip companies still have some way to go before they can be viewed as truly agile. The researchers identified four key underlying principles of agility.
First, all agile companies must have the ability to thrive on change, unpredictability and uncertainty. Sharp says this means companies with traditional hierarchical and bureaucratic structures and with "command and control" management techniques are often unable to respond quickly to the needs of changing markets.

Of the companies surveyed, 65% said their company's management had moved from a command and control structure to one that is based on policies designed to coach and co-ordinate. For an agile company, says Sharp, "companies must learn how to rapidly mobilise their people through the use of a flatter, more

entrepreneurial structure. This requires people to have broader responsibilities and the authority to respond to changing customer demands."

Second, agility is the ability to provide customers with total solutions. Sharp says traditional manufacturers often miss the opportunity of additional business from extras such as customisation, maintenance, enhancements and upgrades, and thus fail to fully meet their clients' needs. To give customers what they really want, he says, agile organisations should integrate rapid prototyping, concurrent engineering and information technology, through empowered teams, continuous improvement and marketing strategies. Such an approach, he says, will enable the capture of valuable niche markets.

Third, agility is the ability to rapidly introduce new products. In order to achieve this goal, the leveraging of people through knowledge and information was vital for the creation of an agile manufacturing organisation. They reckon that continuous education and training enhances people's skills so informed decisions can be made closest to the problems being addressed.

In the survey, 92% agreed that continuing training and education of the workforce was an investment rather than a cost, yet only 51% had identified the core skills and competencies of all employees, with only 16% benchmarking the process.

Fourth, agility is the ability to co-operate with other companies to raise competitiveness. Agile organisations foster collaboration internally, across departments and externally among suppliers and customers, to solve problems or seize opportunities.

The survey shows that top companies generally (84%) see such co-operation as reducing costs and risk. But 41% felt it would not be easy for them to enter a temporary alliance. The researchers identified that while there was often an awareness of the importance of strategic alliances, the mechanisms to make them happen were frequently not in place.

CASE STUDY 2: SURVEY ON HITOP ORGANISATION IN BRITISH NTBFS.

HITOP stands for "Technology, Organisation, and People" integration and the system called Top Modeler was developed to support the process of organisation design in manufacturing organisation. Top Modeler was funded with a $3Million Grant from the US National Centre for Manufacturing Sciences and included the active involvement of four companies: Hewlett-Packard, General Motors, Digital Equipment Corporation, and Texas instruments.

Some HITOP Users include:

1. Boeing Aerospace
2. Digital Equipment Corp
3. Douglas Aircraft Co (Division of McDonnell Douglas Corp)
4. GEC ALSTHOM T&D
5. General Motors
6. Hewlett Packard (Boise Printer Division)
7. Philip Morris
8. Solar Turbines (Subsidiary of Caterpillar Co)
9. Swiss metal
10. Westinghouse Defence

And its typical benefits include:

1. Cost savings.
2. Improved production quality.
1. Cross-functional team building.
2. More effective use of technologies.
3. Faster implementation times.
4. Better process understanding.
5. Improved communications and understandings.
6. Better motivation.
7. Identification of key operational issues.
8. Identification of internal weaknesses (e.g. strategy, change management capabilities, etc).
9. Clarification of roles and responsibilities.
10. Enabling empowerment, participation and culture change.
11. Create inter-organisational Far-Flung Virtual team or VC^3 team for radical innovation.

2.3: CONCLUSION FROM THE LITERATURE REVIEW

In chapter two, I present a comprehensive literature review on lean and agile relationship and its influence on innovation and technology management. Through literature review on both academic research paper and real-world case studies, I find lean and agile sharing the same theoretical platform for innovation and technology management—socio-technical system (STS) theory, in other words, manufacturing organisation integrating through highly integrated technology, organisation and people. However, lean focus on original lean thinking, cutting waste and create value flow stream from supplier to customer and Agile focus on virtual agile enterprise creating using virtual information technology. HITOP leagile can combine the merits of both lean and agile principles, because it based on mid-range socio-technical system (STS) theory that compromise between theoretical level and operation level to create a knowledge-based expert system, for instance, it can work on both the emergency knowledge process and normal knowledge process.

Based on above literature review on lean and agile relationship on innovation and technology management, the following research hypotheses have been posted:

1: Since lean and agile relationship base on the same socio-technical system (STS) theory, it is possible to combine lean and agile into a leagile organization model under the more broad operation environment—both hostile and normal operation environment.

2: HITOP leagile organisation can satisfy the need of innovation and technology management for British new technology-based firms.

3: lean, agile and leagile manufacturing organisation performance can be compared using innovation and technology management as the measure indicators.

In the following chapter, I will test the above research hypothesis using survey instrument design and survey data analysis method (DEA).

CHAPTER THREE: METHODOLOGY

INTRODUCTION:

In chapter three, I present the research design, which includes the research hypotheses and describe the research methods and the survey data collection process and statistical procedures that will be used to test them. The first section presents an operationalisation of the constructs, formulation of the hypotheses, and the experimental design. The second section discusses the issues that influence survey research, development of the survey instrument, and the pilot test. The third section discusses the administration of the testing, including lean and agile best practices and HITOP leagile best practice in British new technology based firms, respectively. The fourth section discusses the use of DEA and statistical processes. Finally, the threats to validity and steps taken to reduce their impact on the results of the study are discussed.

3.1: OPERATIONALISATION OF THE CONSTRUCTS

Lewis (2000) presents that lean production minimises general innovative activity, because innovation resource development process involved technology push, short-term cost penalties and deliberately generated system complexity, however, this contradiction with lean production principles. Thus it needs to reformulate some form of trade-off between degree of lean and production and innovation, or in other words, is comparable to the distinction between adaptation and adaptability (Boulding1978) in evolutionary theory. Also a number of operations authors have suggested that it is possible to create a strategically flexible production model that accommodates this apparent contradiction (Spina 1996, Bartezzaghi1999).

Meanwhile, Fisher (1997) defines agile operating environments as economic trade-offs. Economic trade-offs based on physical assets, labour, capital and land are most relevant in the functional, lean, environment that is focused on eliminating waste in operational processes. Trade-offs based on time, information and knowledge are more relevant in the innovative, agile, environment. Recall that leveraging information and knowledge is one of the primary dimensions of the agility concept.

However, past literature review shows that Socio-technical systems integration is a conceptual model that enables organisations to introduce the new processes

and methods of lean and agile manufacturing more effectively. (Lathin 2001, Majchrzak 2001). Therefore, in this study, I will try to combine lean and agile organisation through STS system using HITOP model, which was originally introduced by Ann Majchrzak as a new midrange STS theory for agile systems that can support emergent knowledge processes using TOP-Modeler stimulus tools.

HITOP STS system model is based on a six-stage methodology (Majchrzak 1991):

The first stage of the methodology involves making an assessment of our organisational readiness for change, which is followed in the second stage by an assessment of the technology that we have proposed, in order to identify its critical features. The third step is an analysis of the essential task requirements, for instance, in this study we focus on innovation and technology management, which leads to the fourth step, an assessment of the skill requirements. The fifth step is concerned with determining how people should be rewarded. The final step is concerned with designing organisational changes which need to be achieved given the technology and people requirements, which leads to the generation of a specific implementation plan. For instance, HITOP model application in British new technology-based firms.

3.2: FORMULATION OF THE HYPOTHESES

The literature review and the research questions lead to both lean and mean team and agile virtual team can create innovation and technology management.

Thus, the research hypothesis is:

Hypothesis1:

In managing steady-state processes like production or logistics or agility 2, lean and mean's CCT teams are able to create innovation more effectively using lean principles.

Hypothesis2:

In managing emergent knowledge processes (EKP) or agility 3, Virtual agile' Far-flung teams are able to create innovation more effectively using agile principles.

Hypothesis3:

In managing uncertainty processes (mixed steady-state processes and emergent knowledge processes or agility 4, HITOP boundaryless teams are able

to create innovation more effectively using HITOP method by combing lean and agile principles, Especially in new technology-based firms .

3.3 DESIGN OF THE STUDY

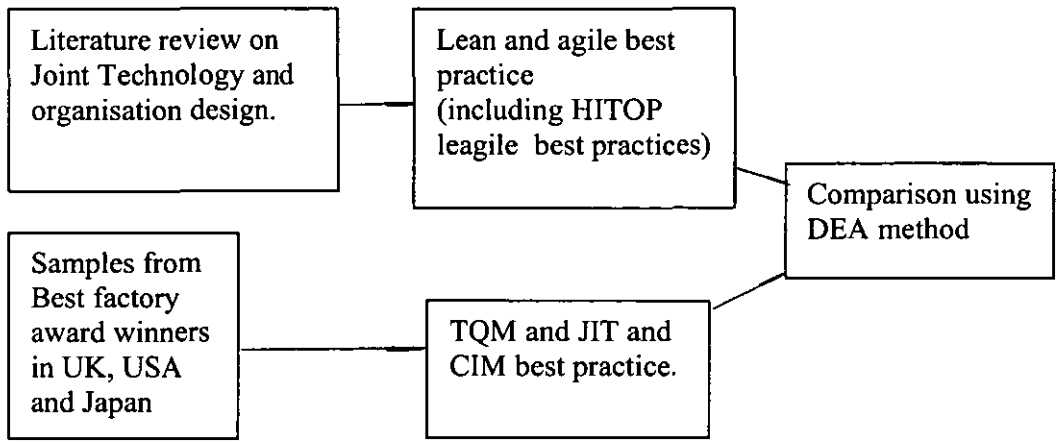


Figure 34: Design of the study

3.4: DEVELOPMENT OF THE SURVEY INSTRUMENT

IMPORTANT ISSUES IN SURVEY DESIGN

I: SURVEY INSTRUMENT AND ADMINISTRATION

The basic instruments used to test the hypotheses are the data derived from an 11-page mail survey of best factory award winning firms in UK, USA and Japan. Survey questionnaire focuses on how to build a new boundaryless organization structure in new technology-based firms.

The survey contained 88 items. Approximately 40% were concerned with aspects of organisation's boundary (vertical and horizontal boundary) and 20% were concerned with aspects of organisation's performance (value chain) and 20% were concerned with aspects of global world-class organisation journey and 20% were concerned with aspects of leadership for future organisation.

The questionnaire was pilot tested on six sites in British NTBFs and subsequently revised. It was then sent to the operation managers of some 200 British and 2000 American and 200 Japanese best factory award winning firms. All responses were returned over 3 months.

II SAMPLE

The sample population involved a cross-sectional survey of 2400 new technology-based firms in UK, US and Japan. We identified this sample NTBFs through the best factory awards winners in UK, USA and Japan. For example, UK survey companies are from the best factory awards (www.some.cranfield.ac.uk) and SMART achievement & Micro Award winners (www.dti.gov.uk). US survey companies are from Department of Energy (DoE)'s Small business innovation research (SBIR) and Small business technology transfer (STTR) award. Also U.S. Department of Commerce and Technology Administration/National Institute of Standards and Technology's Advanced Technology Program (ATP) award. Japanese survey companies are from Deming prize winners.(www.deming.org)

Of the 2400 questionnaires dispatched, responses were received from 750 sites, 600 in US and 100 in UK and 50 in Japan, representing yield response rates of 33%, 50% and 40%, respectively. The main reason that many firms refuse to join this survey is their firms are too small, (below 20 people) or they are not manufacturing organisation. The following reply has been chosen as case studies, for instance, the reply from four UK best factory award companies,(Rocket medical ltd and Stannah stairlift ltd and Flow crete ltd and RF engine ltd), and one US SBIR company, (Nomadics inc in Oklahoma).

III DATA PREPARATION

There are three distinct stages of data preparation required before conducting the main analyses. Each step of construct measurement and treatment of missing data and preliminary data checks are discussed in turn.

(1) CONSTRUCT MEASUREMENT

For the purposes of this research, questions were grouped into four sets of factors: Organisation boundary, Organisation value chain, Global world-class organisation Journey, and future organisation leadership. The majority of questions employed five-point Likert scales, scales generally required the respondent to indicate the extent to which she/he agreed or disagreed with each statement and ranged from strongly agree to strongly disagree. The total number

of variables used was 88 and a list of the questions used to measure each construct is provided in table 21.

Table18: Factor analysis of each construct.

	Factor 1 (UK data)	Factor 2 (US data)	Factor 3 (Japan data)
A: Find Organisation boundary	3	5	4
A1: Factor vertical boundary	3	4	4
A2: Factor horizontal boundary	4	4	4
Cronbach alpha%	79	91	86
B: An assessment of technology and identify its critical feature	4	5	4.5
Cronbach alpha%	78	90	85
C: Innovation & Technology management analysis	4	5	4.5
C1:Lean organisation	3	4	4
C2 : Agile organisation	3	4	3
C3: JIT/TQM Organisation	4	4	5
C4: CIM Organisation	4	4	4
Cronbach alpha%	79	89	88
D: An assessment of people's skill for organisation change	4	4.5	4.5
D1: new organisation structure	3	4	4
Cronbach alpha%	72	86	86
E: HITOP organisation for British NTBFs	4	5	4.5
D1: Leadership	4	4	4
D2: HR management	4	4	4
Cronbach alpha%	73	85	80

A: Find Organisation boundary

In this study, 41 questions were used to assess these four constructs. Vertical and horizontal boundaries were assessed with a ten-point scale, external and geographic boundaries were assessed with a ten-point scale.

B: Organisation performance (Value chain).

Organisation value chain was evaluated from five perspectives:

Strategies/operating plans; Information sharing/problem solving; Accounting, measurement, and reward systems; Sales processes and Resources/Skills.

Measures of organisation performance tend to be catalogued in terms of business, organisational and customer perspectives. As the unit of analysis for this research is a manufacturing site, an effort was made to adopt measures that primarily focus on operation management (lean and agile innovation management). In this research, organisation performance was assessed using lean and agile measuring method. The lean analysis will use lean inventory control model from Arizona University and agile measures will use agile virtual enterprise reference model from Agile focus group.

C: Global world-class organisation journey and future organisation leadership.

This study considers 4 key practice investments that were assessed using 20 questions. The seven practices considered are

Human resource practices (5 questions) and organisational structure (5 questions) and organisational processes and systems (5 questions) and overall global mindset (5 questions)

The ability to implement change within an organisation has been identified by many scholars as a key capability underpinning the success or failure of organisational improvement processes. In this research, the ability to implement change is assessed both internally and externally. The internal assessment is conducted at three different levels: senior management, supervisory and production operative and the impact of external barriers include the improvement of employee relations and dynamic supply chain management. In other words, new technology based firms (NTBFs) would have to ensure the lean virtues of internal efficiency as well as the agile value of supply-chain based responsive adaptation.

(2) TREATMENT OF MISSING DATA

Of the original 750 responses, only 550 were complete. The variables of interest were divided into 4 constructs (organisation boundary, organisation value chain, global world-class organisation journey and future organisation leadership) and the following criteria used to accept/reject responses. If for any individual respondent: (1) more than one-third of the variables assigned to a given construct were missing or (2) there were more than seven empty cells across all 88 variables for that respondent, then the entire response were deleted from the data set. This approach yielded 750 responses with only 0.04%of the 30000 cells as missing cells. With this sample set of 750, the variable means were substituted for missing cells.

The 200 deleted cases were tested for response bias by comparing them with the retained data set using MANOVA. Using exploratory factor analysis 12 key variables were identified and these variables plus indicators of firm size, firm type and ownership were used in the MONOVA. No significant difference was detected ($F(12,750)=1.26$, $p=0.275$) between retained and deleted data sets. Amongst some of the variables (lean and agile, JIT, TQM, Leadership and ability to implement change) higher score were detected for the 750 usable responses than for the 200 deleted responses, but the difference did not reach the 0.05 level of significant.

(3) PRELIMINARY DATA CHECKS

The third stage of data preparation is the screening for outliers and checking for normality (skew and kurtosis), multicollinearity and interval level measurement. Additional checks are also performed as required for each statistical techniques applied. This study makes extensive use of multiple regression, as well as MANOVA and discriminant analysis in some areas of analysis. The use of multiple regression is a relatively robust procedure (kerlinger and Pedhazur 1973), but requires the following additional assumptions to be checked: homoscedasticity, additivity, measurement error, normality of the varite, independence of residuals and recursion. The development and use of cross products (violation of additivity) need also be considered. For MANOVA to be valid, three assumptions must be met: independence, equality of the variance/covariance matrices and normality of any linear combination of

dependent variables (Lachenbruch 1975). The key assumptions in discriminant are multivarible normality of the independent variables and unknown (but equal) dispersion and covariance structures for the groups as defined by the dependent variable. The methodology used to check these assumptions is discussed in considerable detail in Challis et al. (2002)

VALIDATION OF THE SURVEY INSTRUMENTS: VALIDITY AND RELIABILITY CONSIDERATIONS

The approach taken to the analysis of the data commenced with the development of constructs and assessment of construct reliability and validity.

I VALIDITY

There are three aspects of validity that concern this study. The first, construct validity, refers to the extent to which a theoretical relationship between constructs is supported by the empirical relationship between the measures used to operationalise constructs. (Carmines 1979) A discussion of the measures used in this study has been adopted from leading edge documentation in this field (e.g. Malcolm Baldrige Awards Criteria, the Deming Prize Criteria and UK best factory Awards Criteria). It is therefore assumed that the requirement for construct validity is satisfied. Convergent validity refers to the extent to which multiple items measure the same construct and discriminant validity measures the extent to which multiple items measure separate and distinct constructs. (Campbell 1995)

Covergent and discriminant validity were assessed using exploratory factor analysis. Factor loadings greater than 0.3 are evidence of convergent validity. Discriminant validity, on the other hand, is evidenced by factor loadings less than 0.3. Factor analysis was performed on the initial pool of data. The maximum likelihood method of extraction, with orthogonal rotation was used, as recommended by Kim (1978) and Tabachnick (2001).

II FACTOR RELIABILITY

The second measure issue, reliability, refers to the extent to which a measuring instrument or procedure yields the same result on repeated trials.(Carmines and Zeller 1979) According to Nunally (1978), in the later stages of research programme, it is considered desirable to have reliability coefficients of 0.80 or greater. In the early stage of a program, reliability coefficients should be at least

0.6 (Nunally 1978). Table 19 shows that the reliability coefficients of the measures all exceed the 0.60 threshold and are therefore acceptable for the purpose of this research with the possible exception of manufacturing performance, which has a reliability coefficient of 0.592. As this item is only very marginally below the 0.60 threshold it has also been accepted.

SUMMARY OF THE TEST RESULTS

A pilot test version of the survey instrument was distributed to members organisation of DTI best factory award winner in UK and DoE SBIR award winner in US and Demming prize winner in Japan. In an effort to increase the usable number of responses, extra mails were made to a sample of companies which adopts lean and agile practices in UK and US, such as Manufacturing Foundation group in UK and Agile Focus group in US. For this test, we intentionally selected a heterogeneous sample in order to test the robustness of the instrument. A summary of the results is presented in table 22.

Table19: Summary of the pilot test results

Construct (joint technology and organisation design)	Sub Dimension items (HITOP model application in British NTBFs)	Cronbach Alpha%	No. of scale
Organisational readiness for change (ORFC)	Find organisation boundary	79	3
An assessment of the technology (identify its critical feature) (AOT)	Measure organisation performance	90	5
An analysis of the essential task requirements	innovation and technology management analysis (IATA)	80	5
An assessment of the people's skill requirements (AOPS)	Benchmarking best organisation practices	78	7
Design organisational changes DOC-HITOP	HITOP organisation application in British NTBFs	80	3

3.5: FINAL DATA COLLECTION

Data for the final study will be obtained from two sources:

(1) Archival data will be obtained from manufacturing foundation group in UK and Agile Focus group in US and will be analyzed in the DEA analysis.

(2) Self report data will be collected from company respondents using the validated mail survey instrument discussed in preceding sections and it will be analyzed in the factor and reliability regression.

3.6: SELECTION OF THE TARGET INDUSTRIES

In this study, we define modern business environment as hostile-dynamic environment: limited resources; high competition for a limited supply of customers; customer demands for responsiveness and product scope and; high competition on the basis of price and quality. Samples were drawn from New technology-based firms or small and medium size high-technology firms that met the criteria of this hostile-dynamic environment and the goal of this research on joint technology and organisation design. The definition of new, technology-base firms are a particularly resource-intensive type of business firms, their core technology resource tends to dominate other characteristics of these firms, and the growth of new, technology-based firms tends to be 'resource-intensive' growth. This means that the growth is sought through the innovation combination of firm-specific technology resources with external complementary assets, such as organisation integration. (EIMS: European innovation monitoring system 2000)

The notion that successful new technology-based firms in these hostile-dynamic environments should have lean and agile-like characteristics through joint technology and organisation design is a fundamental assumption of this study.

3.7: DATA ANALYSIS METHODOLOGY

Collection of the final data is followed by a three stage numerical and statistical analysis to test the hypotheses in this study. Figure provides a general description of the role each process provides in the overall analysis of the data.

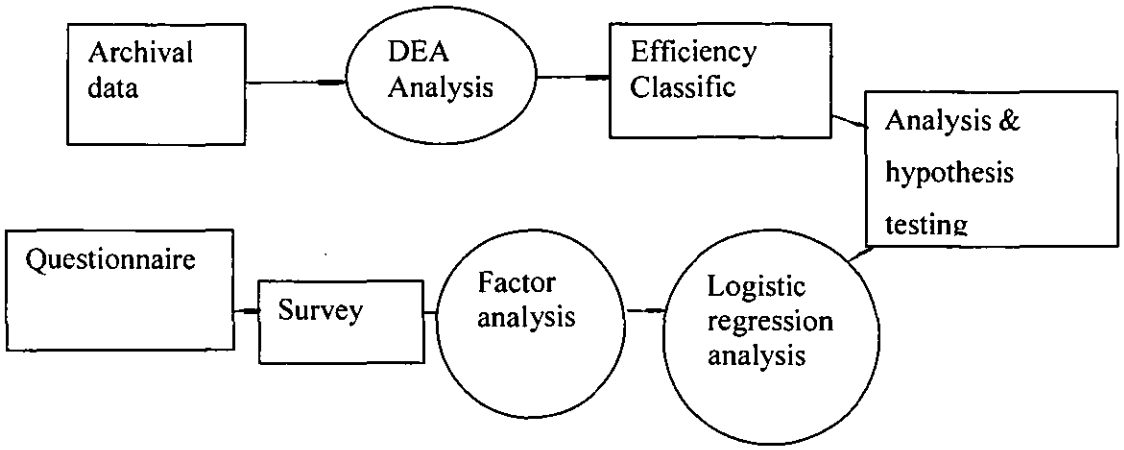


Figure35: Data analysis model

I DATA ENVELOPMENT ANALYSIS (DEA)

There is an increasing concern with measuring and comparing the efficiency of organizational units such as local authority departments, schools, hospitals, shops, bank branches and similar instances where there is a relatively homogeneous set of units.

The usual measure of efficiency, i.e.:

$$\text{efficiency} = \frac{\text{output}}{\text{input}}$$

is often inadequate due to the existence of multiple inputs and outputs related to different resources, activities and environmental factors, DEA is a novel approach to relative efficiency measurement where there are multiple incommensurate inputs and outputs. A suitable set of measures can be defined DEA provides an efficiency measure not relying on the application of a common weighting of the inputs and outputs. Additionally the method identifies peer units and targets for inefficient units. The aim of my research is testing the efficiency among lean and agile and leagile organization performance for innovation and technology management, thus DEA is the suitable method for my survey data analysis.

DEA Malmquist index can measure the efficiency of the organisation using multi-input and multi-output data resource. For instance, in order to measure the significant of five HITOP leagile enablers on innovation and technology

management, I choose input variables as Cost of Goods Sold, innovation and (GS&A+ R&D), and Assets were obtained directly from the financial statements, and the output variables as Sales (SLS), Gross Margin (GM), Sale- Cost of Goods Sold (SLS-CGS), Operation Margin (OM)....SLS - (GS&A+ R&D).

The final DEA analysis results indicate that lean organization can create a perfect platform to integrate agile organization, from statistical graph, lean organization policy plot builds a frontline to cover agile and leagile organization. However, agile organization performance is more dynamic and flexible due to the ability to respond successfully to change in their hostile-dynamic environments. Meanwhile, leagile organization performance is in the middle of lean and agile organization. This knowledge allows me to move closer to a more definitive description of the leagile company as: leagile companies rely more heavily on responsive manufacturing process and interactive communication process within the organization than either lean or agile organization, in other words, leagile organization should be highly integrated their technology, organization and people (HITOP) for more effective innovation and technology management.

Data Envelopment Analysis (DEA) provides an independent, quantitative method for classifying the sample organisation into one of three mutually exclusive groups: lean, agile and leagile organisation. These groups will, in turn, become the classification groups (DV) in the logistic regression and discriminant analyses. Selection of the appropriate DEA model is governed by whether the subject organisations exhibit constant, variable, or non decreasing returns to scale (CRS, VRS, and NDRTS).

The CCR (ratio) model is the fundamental DEA formulation and is appropriate for the condition of constant returns to scale. The CCR model, introduced by Charnes, Cooper and Rhodes, tests for an optimal solution where $\theta=1$ indicates that the organisation (DMU) under test is relatively more efficient than other organisations, in its peer group, on one or more dimensions of performance. The basic CCR model is defined as:

$$\text{Minimize: } \theta$$

$$\text{Subject to: } Y\lambda \geq Y_0$$

$$X\lambda - \theta X_0 \leq 0$$

$$\lambda_1 \geq 0$$

Where θ = technical efficiency of the organisation being tested, Y is a matrix of outputs, X is a matrix of inputs, Y0 is the vector of outputs for the unit under examination, X0 is the vector of inputs for the unit under test, and λt are the envelopment multipliers. This model is also considered to be in the Archimedian form because it tests only for "weak" Pareto-Koopmans efficiency. In the optimal solution, θ=1 indicates weak CCR efficiency; the presence of positive slacks indicates inefficiency. If the Archimedian form of the model fails to adequately discriminate between lean and agile successful and leagile successful organisations, the more sensitive Non- Archimedian Model defined below, is a variable alternative.

$$\text{Minimize: } \theta - \varepsilon[\sum S_i] - \varepsilon[\sum S_i]$$

$$\text{Subject to: } Y\lambda - S = Y_0$$

$$X\lambda - \theta X_0 + S = 0$$

$$\lambda, S, S \geq 0$$

This model distinguishes between weakly efficient units (θ=1 and slacks>0) and strongly efficient units (θ=1 and slacks=0 in all optimal solutions). The CCR model imposes three restrictions on industries in the sample space: Constant return to scale (CRS), weak disposability of inputs and outputs and, convexity of the input-output set of combinations.

However, constant-returns-to-scale can often be relaxed (Fried 1993), and this leads to another model proposed by Banker, Charnes, and Cooper referred to as the "Variable-return-to-Scale" (VRS) model. The VRS model is obtained by adding the constraint $\sum\lambda t = 1$ to the CCR model. It envelops the data more closely, and provides a larger number of efficient companies than the CCR model. Since returns to scale of the sample organisations cannot be determined precisely, the VRS model is also used as a DEA classification tool in the analysis. The VRS model, also referred to as the Banker, Charnes and Cooper (BCC) model, is defined as:

$$\text{Minimize: } \theta$$

$$\text{Subject to: } Y\lambda \geq Y_0$$

$$X\lambda - \theta X0 \leq 0$$

$$\sum\lambda_1 = 1$$

$$\lambda t \geq 0$$

The non-Archimedian extension of the CCR can also be found in many treatments of the BCC.

Selection of the BCC model, which allows for variable returns to scale, can be justified under the following rationale: For the case of the CCR model, output must increase proportionately with input (Nicholson 1992) and if this were true for the companies in this study we would select the CCR model (constant return to scale). However, Green (1993) showed that manufacturing companies do in fact exhibit either increasing or decreasing returns to scale, and this supports a proposal that the BBC model maybe more appropriate for this analysis.

A third model, assumes that return to scale are not decreasing and suggests instead that they either constant or increasing. This model will be defined as the "non-decreasing returns to scale"(NDRTS) (Yaisawarng 1994), and is obtained by replacing the BCC constraint, $\sum\lambda I=1$, with $\sum\lambda I\geq 1$. Use of the NDRTS is justified if it can be shown that economies of scale for the manufacturing organisations in this study are either constant or increasing.

Since the choice of DEA model depends on the nature of the returns to scale for sample companies, one of the first tasks in the use of DEA is to test for this condition prior to selecting the actual model. This is accomplished with a regression analysis to test the hypothesis, slope=0, in a relationship between sale and operation margin. If the slope is greater than zero, statistically significant and positive, one can assume that returns to scale are constant and the CCR is the appropriate model for this study. If the hypothesis (slope=0) is no rejected then it must be assumed that the relationship between sale and operating margin is either non-linear or zero. This condition would lead to the selection of either the BCC or the NDRTS model.

The DEA model uses three measures of output: sale revenue, gross margin and operating margin. Sale revenue can be considered to be a proxy output measure of the production function if we assume that there is high price competition in the company's markets. If this assumption is supportable, then revenue should exhibit a direct relationship to output. Furthermore, by confining the samples to a narrow industry segment we can further support the notion that output of uniform product sets should be directly correlated with annual sales revenue. This assumption is based on the premise that in a highly competitive market all suppliers should be selling at a comparable price. (Tirole1993, Nicholson1992).

Gross margin (GM), on the other hand, can be considered to be a proxy measure of manufacturing efficiency. Companies which manufacture similar products should employ somewhat similar manufacturing processes and deal with simply supply sources. Because of this, the company with the higher percentage of gross margin can be assumed to have higher manufacturing technical efficiency and/or more efficient supply chain processes. The third output, operating margin (OM) is considered to be a proxy measure of overall organisational and administrative efficiency.

The input variables represent those resources and internal processes that management control and adjust to earn sale revenue. Barr, Seiford and Siems (1993), in a study of bank failures, used this rationale when they selected labour, materials, machines and facilities as the input variables. Input variables selected for this study are cost of good sold (CGS), general selling and administrative expense (CS&A), research and development (R&D), inventory (INV) and Assets (ASTS). These variables were selected because decisions relating to their consumption lie within the control of management. As a result, their efficient use should be a reasonable measure of management's ability to create an efficient organisation such that the above inputs are used to produce the three outputs, GM, OM and, sales.

Table20: Studies that have been used lean and agile manufacturing performance measures as inputs/ outputs in a DEA model.

Authors	Purpose	DEA model	Approach
Hoyt James. (1996)	Demonstrate that classical organisation theory and strategy research methods are useful for studying agile organisations.	BCC And NDRTS model	Data Envelopment Analysis (DEA) and Regression analysis
Marvin B. Lieberman (2004)	Assessing the resource base of Japanese and U.S, Auto Producers: A stochastic Frontier Production Function Approach.	DEA SFPF model (stochastic frontier production Function model)	Data Envelopment analysis (DEA) comparing lean manufacturing performance between Japanese and US automotive industry.

ANALYSIS OF THE SURVEY DATA

Scale items for each HITOP enabler in the survey will be reduced to a more parsimonious set of latent variables that represent the dimensions of each construct. An important output from the factor analysis is the corresponding factor score coefficient matrix for each dimension of the construct. This matrix is defined as: B=RA

Where R is the inverse of the correlation matrix, A is the matrix of correlations between the factors and the variables (factor loading matrices) and B is a matrix of factor score coefficients. To estimate an enabler's score (F) for a particular observation, we multiply the standardized scores of the scale items, (Z) by the factor score matrix coefficients (B) as defined by: F=ZB.

For each observation, there will be a set of F scores which corresponds to each enable. F is an (n)x(m) matrix where n=(the number of observations) and m=the number of factors. In this study, where we have a single factor for each constructor (unidimensionality), F will be an (n)x(1) matrix with each row representing the observed organisation's score for that dimension of the construct. These scores can then used as predictor variables in a discriminant analysis to test their ability to classify the organisation into its correct group defined by the DEA analysis.

The statistical assumptions for factor analysis as they apply to this analysis are taken from Tabachnick (1989) and Berenson (1983):

(1) Normality is not a critical requirement if the purpose of the factor analysis is to summarize the relationships in a large set of variables. Lack of normality may degrade the results but they can still be useful.

(2) Linearity is important because correlation measures a linear relationship and it ignores non-linear relationships.

(3) For estimations of factor scores, singularity or multicollinearity will cause problems. This problem will manifest itself in a value of the R matrix determinant approaching zero.

Sample size is also an important consideration for the factor analysis, since correlation coefficients tend to be unstable when they are estimated from small samples. Minimum sample size will be a function of the number of factors produced. If I have few factors and reliable correlations, a sample size of five observations /factor may be adequate for the final survey.

3.8: THE ADMINISTRATION OF THE TESTING: Testing the significance of the HITOP Enablers

Two statistical techniques, logistic regression and discriminant analysis are used to test the significance of the HITOP enablers. The discriminant model provides a set of standardized coefficients that can be easily interpreted to assess the contribution of each enabler to the classification. However, discriminant analysis is sensitive to non-normal data distributions, or heteroscedasticity between the classification groups. Because of this, the discriminant analysis will be used only to support the results of the logistic regression which is less sensitive to deviations from normality or heteroscedasticity.

I DISCRIMINANT ANALYSIS OF THE HITOP ENABLERS' SIGNIFICANCE

Discriminant Analysis allows one to simultaneously study the differences between two or more distinct groups, measured at the nominal level, with respect to a set of groups (Tabachnick 1989, Berenson1983). In this study, the discriminant analysis compares lean and agile and leagile organisation by testing the contribution that each HITOP enabler makes toward correctly classifying the subject new technology-based firms as either efficient or non-efficient.

The discriminating variables for the discriminant function are derived from the factor score matrix. Variance of the discriminating variables determines their ability to distinguish between groups, hence they must be measured in either interval or ratio scales. The seven point of Likert Scale used in the survey satisfies this requirement, since it leads to a factor score matrix which ultimately produces a set of discriminating variables which are also expressed on an interval scale.

The assumptions for multivariate discriminant analysis are: 1) Linear independence among the discriminating variables, 2) The population covariance matrices, for each group, must be equal. (Equal group covariance matrix will lead to simplified discriminant function formulas and test for significance). 3) Each group should be drawn from multivariate normal distribution. Normality enhances the precision of tests of significance and probabilities of group membership. Violation of this assumption degrades the probabilities but they may still be useful. Normality is also important for classifications that depend on the probabilities associated with group member.

Through the use of discriminant analysis, the relative importance of each discriminating variable's contribution to the discriminant score can be determined. While the unstandardized coefficients describe the absolute contribution of a variable to the discriminant score, the standardized coefficients describe the relative importance of the variables. The standardized coefficients "Ci" are calculated from the unstandardized coefficients of the discriminant function using the following transaction.

$$Ci=Ui\sqrt{Wii}/(n-g)$$

Where Wii is the sum of squares of the variable "i", the total number of cases is defined by "n" and "g" is the number of groups. The standardised coefficients are used to determine which variables contribute most significantly to the discriminant score, and in this case which enabler contributes most to classifying company as efficient or non-efficient. Standardized coefficients for the discriminant function are obtained directly from the SPSS output.

II LOGISTICS REGRESSION ANALYSIS

Because of its relaxed demands on multivariate normality (Kennedy 1992, Pindyck 1991), Kennedy (1992) suggests that an additional advantage of the Logit model over the Discriminant model is its ability to handle "dummy variables". This feature is useful for introducing qualitative variables into the analysis to test for industry effects. The logistic regression model also permits the introduction of interaction terms. This feature permits testing for the presence interaction between planning and scanning.

Logistic regression is appropriate when the dependent variable can take on only two values and the requirements for normality and equal variance-covariance of the two groups cannot be met. Furthermore, with logistic regression, one can directly estimate the probability of an event occurring because the predicted values fall in a range between "0" and "1". For a group of "i" predictor variables, the logistic regression is represented as:

Prob (company is successful) = $1/(1+e)$

Where Z is a linear combination written as:

$$Z= \beta 0+ \beta 1X1+\beta 2X2...+\beta iXi$$

Hypothesis tests for $\beta 1= 0$ are based on the Wald statistic which has a chi-square distribution. For $\chi i > \chi i$ (critical) the hypothesis is rejected and the coefficient βi

is assumed to be significant in the model. The Wald statistic can be compared to the "t" statistic in multivariate regression.

The "R" statistic is useful for assessing the partial correlation between the dependent variable and each of the independent variables in the model. A positive value of the R statistic indicates that the likelihood of the event increasing with the value of the independent variable. If R is negative, the opposite condition will concur. Small values of R indicate that the variable under consideration makes a small contribution to the model's ability to predict an event.

Three methods are used to test the "goodness of fit" of the model. The first indication of the model's fit with the data is the classification table which compares predications with the actual observed outcomes. The second method for assessing the fit of the model is to look at the probability of the observed results given the parameter estimates. This information is provided by two -2* log-likelihood estimates (-2LL). The first log likelihood estimate is for the model with only the constant and the second is for the model with all independent variables included. The "Model Chi-square" statistic provides the third test of the model's goodness of fit. The model chi-square statistic tests the null hypothesis that the coefficients for all terms in the current models (except the constant) are zero. In this sense, the Chi-square test is similar to the "F" test in multivariate regression.

3.9: THREATS TO VALIDITY

This section reviews three classes of research problems that have the potential to degrade the validity of this study's results. "Threats to internal validity" degrade the ability to imply causality or falsify the null hypothesis. "Threats to external validity" reduce the ability to generalize the results to other contexts. And, "Threats to construct validity", reduce the ability to measure the constructs reliably and accurately. Potential problems from each of these threats, and steps taken to minimize their effect, are presented in the following sections.

I THREATS TO INTERNAL VALIDITY

Randomization of the subjects is a first step toward reducing threats to internal validity (Cook 1976, McGrath 1982). However, because the number of subject

organisations in each of the target industries is limited, a random selection of is not practical and this situation will presents a threat to internal validity. Furthermore, the inability to control the subjects and selectively apply a treatment, observational studies are always vulnerable to threat internal validity (Kerlinger 1986).However, this research method is common in studies that involve functioning organisations where controls and treatments are sacrificed at the expense of unobtrusive data collection. Two threats to validity have the potential to affect this study.

1: Selection: Occurs when the effect may be due to differences between persons rather than treatment (Cook 1976). Since the actual respondent's position cannot be guaranteed, this threat is real. Attempts to insure that the survey is completed by a senior executive who is qualified to answer each of the questions will help to reduce this problem.

2: Local History: An internal or external event within a responding organisation may influence the pattern of response (Cook 1976). To deal with this threat, a question will be added to the survey asking if any unusual events might have occurred in the time preceding the estimate of the survey.

II THREATS TO EXTERNAL VALIDITY

External validity is an inductive process and when it is violated, the ability to extrapolate the results to other companies in other industries is compromised. (Cook 1976, McGrath 1982, Kerlinger 1986) The basis of threats to external validity resides with the researcher's inability to conclusively measure interaction effects from other factors in this study. (Cook 1976, McGrath 1982) This problem can be dealt with in three ways: (1) Random sampling from populations; (2) Deliberate creation of heterogeneous groups and; (3) Generalization of the results only to target instances.

This research applies method (2) and (3) to deal with external validity threats. This will be accomplished first, by combining the three industries for the final test of the enabler's significance (heterogeneous samples). However, company size will be held to a range between small and medium size new technology-based firms and this will provide some measure of stratification which, in turn, will reduce variability. In accordance with item (3), we will generalize the results only to target cases, and this will help to improve external validity.

III THREATS TO CONSTRUCT VALIDITY

Construct validity was dealt with extensively in the sections for the survey design and the pilot study. To minimize this threat the guidelines of Peter (1979) and Churchill (1979) were followed when the survey instrument was developed. This included a rigorous definition of the construct and thorough reference to the literature when we developed the question items. Specific threats to construct validity are addressed below along with a discussion of how we deal with them.

1: Mono Operation Bias occurs when a single item scale is used to measure a particular construct. In this study, all primary survey scale are multi-items.

2: Mono Method Bias occurs when only one method of data collection is used. (Cook 1976, McGrath 1982) Although the survey instrument is the primary data collective device, measurement will be corroborated with results of the DEA analysis developed from the archival data. In addition, follow-up telephone conversations with a random selection of the respondents may be used.

3: Hypothesis Guessing causes the respondent second guess the purpose of the survey and to bias his/her answers accordingly (Cook 1976, McGrath 1982). This is a common problem and difficult to control in mail survey. The problem can be managed by explaining the purpose of the survey in a cover letter, a pre-mail phone call, and follow up after the survey.

4: Inadequate Pre-operational Analysis results in a failure to understand the construct sufficiently. (Babbie 1989) For this study each construct was thoroughly research in order to identify its relationship to organisational performance when the environment is considered to be hostile.

3.10: CONCLUSION

In chapter 3, I describe the research design from survey questionnaire design to survey data test procedures. My goal is to capture the accurate information on lean and agile practices from those best factory award winners firms in Japan, UK and USA. One thing need mention is this survey questionnaire original designed by Harvard business school, which can measure the organisation performance from four criterion—speed, Flexibility, integration and innovation. Through finding the four boundaries of organization—vertical, horizontal, external and geographic boundaries, leagile organization can create a boundaryless organization. Following survey instrument design, I describe how to use statistical

methods test the significant of five HITOP leagile enablers from survey reply data. Finally, I present how to compare the lean, agile and leagile organization performance on innovation and technology management using DEA method.

This chapter presents a set of operationalized constructs and falsifiable hypotheses to test the significance of each enabler in the HITOP model organisation performance relationship. The experimental design uses a stratified sample of companies drawn from new technology-based firms or small and medium size high-technology firms that satisfy the characteristics of a "hostile-dynamic environment". A designed and validated survey instrument was presented along with the result of the pilot test. Application of the analytical method in this study, data envelopment analysis, factor analysis, logistic regression and discriminant analysis were discussed at length along with an acknowledgement of possible problem from any violation of the statistical assumptions. Finally the threats to internal, external and construct validity were addressed.

Chapter 1, 2 and 3 have established a framework for conducting a scientific study of the significance of five selected enablers to the HITOP organisation performance relationship. This work is both new and relevant. It is an integrated study that combines theory from operations, strategy, innovation and technology management and organisation research. It uses a multivariate analysis of survey and DEA results, and presents a new and innovative contribute to organisation research.

CHAPTER FOUR: DATA COLLECTION AND ANALYSIS

Introduction:

In chapter four, I present the summary of survey data analysis results in six sections. Section 1 presents the classification of companies into lean and agile and leagile groups. Section 2 presents the results of survey data collection and analysis. Section 3 presents the calculation of regression variable with factor analysis and section 4 discusses the statistical test using DEA method. Section 5 discusses the tests of the hypotheses and section 6 provides a summary of the findings of the empirical analysis.

This chapter reviews the procedures and processes that were used to collect, evaluate and, analyse the data in order to determine the statistical significance of the enablers of HITOP leagile organisation selected for this study. Firstly, I present three classification of organisations—lean, agile and leagile organisations. From the survey reply data, a set of comparative rankings and composite DEA efficiency scores were developed. Secondly, I present the results of the survey data collection process. This section includes the results of non-response bias tests, and interrater reliability assessment and a comparison of the pilot test and final survey results. Thirdly, I present the calculation of regression variables that were derived in a factor analysis. Fourthly, I combine the results of the company classifications and the factor analysis by using the classifications as criterion variables and the factor analysis results as the predictor variables in a logistic regression analysis/discriminant analyses to assess the statistical significance of the enablers. Fifthly, I present the results of hypothesis testing. Finally, I present a discussion of the findings of the data analysis.

4.1: CLASSIFICATION OF COMPANIES

An accurate classification of sample companies is critical to the validity of the discriminant and logistic regression analysis. This section presents the results of four methods that were used to obtain an accurate and reliable classification of the subject companies into one of three groups: lean and agile and leagile organisations. The leagile group was intentionally kept small in order to create two bipolar groups of companies with opposite degrees of successfulness. If the sample data is normally distributed, the three groups are appropriate for a discriminant model. If the sample data is not normal distributed, then two bipolar

groups are appropriate for the logit model but, up to fifteenth companies would be lost from the sample if this occurs.

REVIEW OF THE ARCHIVAL DATA

Sample organisations were selected from new technology based firms in UK and US and Japan. Of the three groups, 50 are lean organisations and 50 are agile organisations and 50 are leagile organisations. Fiscal year 2000-2004 financial report obtained from Dow Jones investor Service and London FTSE stock exchange and Tokyo stock exchange provided the necessary archival performance data. GS&A and R&D expenditures had to be combined into a single input variable (G+R) because many of the disclosures failed to list item accurately.

The variables of interest for this study, obtained from the above financial reports are: Sales (SLS), Gross Margin (GM), Operation Margin (OM), Cost of Goods Sold (CGS), General selling &Administrative (GS&A), Research and Development (R&D), innovation (INO) and Assets (ASTS). The DEA input and output variables were derived directly from these figures as discussed below.

Output variables:

Sales (SLS).....Taken directly from the financial statement

Gross Margin (GM).....Sale- Cost of Goods Sold (SLS-CGS)

Operation Margin (OM)....SLS - (GS&A+ R&D)

Input variables:

Cost of Goods Sold, innovation and (GS&A+ R&D), and Assets were obtained directly from the financial statements.

NON DEA CLASSIFICATION ANALYSIS

This section presents two, non-DEA, classification methods:

(1) Testing for negative operating margin.

(2) Comparing the performance metrics of the subject companies.

NEGATIVE OPERAING MARGINS

Companies with negative operating margins for fiscal year 2000-2004 were classified as ineffectively innovation organisations. Companies in this group are listed below in table21.

Table21: Companies with negative operating margins

Industry group	Ineffectively innovation organisations because of negative operating margins
Lean organisations	Negative operating margins < 1 million dollars
Agile organisations	Negative operating margins < 1 million dollars
Leagile organisations	Negative operating margins < 1 million dollars

COMPARATIVE RANKINGS BY PERFORMANCE

Comparative rankings of the remaining companies in each data set more opportunities to identify efficient and inefficient innovation companies prior to performing the DEA. This is accomplished by designating companies that score consistently in the upper quartiles of the listings as efficient innovation organisation and those that appear consistently in the lower quartiles as inefficient innovation organisation. This action improves the homogeneity of each data set by removing outlier companies that consistently ranking high or low on each of the performance factors defined above. Remaining companies are more suitable for DEA. The performance ratios/percent-ages used in this study are traditional measures of an organisation financial success. They are described below:

1. Gross Margin Percent.....(GM/SLS)X 100
2. Operation Margin percent.....(OM/SLS)X 100
3. Return on Assets.....(OM/ASTS)X 100
4. Asset Turnover..... SLS/ASTS
5: Innovation Turnover..... SLS/INO

Inspection of these performance variables identified two negatively correlated relationships. The sales/assets ratio versus gross margin and the sales/assets ratio versus operating margin both displayed negative Pearson correlations. These observations suggest that companies which exhibit good performance (defined as above average: gross margin and operating margin) tend to have low sales/asset

ratios while the opposite is true for companies with below average operating and gross margins.

Companies classified in the comparative performance analysis are listed below in table 22.

Table 22: Companies removed in the comparative rankings

Industry group	Defined as efficient innovation group	Defined as inefficient innovation group
Lean organisation	gross margin and operating margin > average	gross margin and operating margin < average
Agile organisation	gross margin and operating margin > average	gross margin and operating margin < average
Leagile organisation	gross margin and operating margin > average	gross margin and operating margin < average

The comparative rankings show that a number of companies in the sample with high gross margins and high operating margins, also have a low sales/assets ratio and (or) a low sale/innovation ratio. The reverse was also observed for poor performers. This condition, cause the DEA to have a tendency to falsely score some companies as efficient and is dealt with in the next section.

DEA CLASSIFICATION ANALYSIS

This section presents the DEA classifications of the remaining companies for each of the three manufacturing organisations: lean and agile and leagile.

OUTPUTS AND INPUTS OF THE DEA MODEL

The outputs of the DEA model are sales (SLS), gross margin (GM), and operating margin (OM). The DEA inputs are cost of goods sold (CGS), general selling and administrative + research and development (G+R) and innovation (INO). Each variable was normalized by dividing the observed value for each company by the average for the industry group. Assets were deleted as an input because of the negative correlations discussed above.

For this study, operating margin is assumed to be the most important output because it provides the best overall measure of a company's financial performance. Gross margin was assumed to be the second most important indicator of performance because it provides a proxy measure of manufacturing and supply chain efficiencies. However, gross margin does not effectively measure the efficiency of a company's administrative or product development processes. Consequently, a company which has high a gross margin and a low operating margin should not receive a higher efficiency score than a company with a mid-range gross margin and high operating margin. This condition is deal with under the calibration of the model.

Innovation performance data is also useful because an efficient and effective innovation system could be an indicator of lean or agile performance. However, the observed negative correlations of sales/ innovation with operating margin create a risk of incorrect classifications in the DEA model. In accordance with the rationale presented above, a company with a poor operating margin and high sale/ innovation ratio should not receive a higher efficiency score than one with a mid-range operating margin and low sales/innovation ratio. This situation is dealt with subsequently.

SELECTION OF THE DEA MODEL

Returns to scale in the target industry directly influence the selection of the DEA to be used in classifications. The CCR model is most appropriate when constant returns to scale (CRS) can be assumed while the BCC model will be preferred if the returns to scale can be shown to be variable. Finally, the NDRTS model will be the model of choice if returns to scale can be assumed to be non-decreasing. A regression analysis for OM =f (sales) provides insight to this condition. If the slope of the regression model is positive, and statistically significant, we can reject the hypothesis (all $\beta=0$) and conclude that the relationship between sales and operating margin is linear (slope$\neq$0). A positive, linear relationship between sales and OM suggests that, returns to scale are constant and the model of choice should be CCR. If the hypothesis is not rejected, we can conclude that the relationship is either non-linear, or there is no relationship. In this case, either the BCC or the NDRTS model would be

selected. Results of the regression analyses for each industry are summarised in table 23.

Table 23: Summary of the regression analysis

Industry group	F	Pval	R Square	H0: β=0	Model
Lean organisation	31.78	0.0000	0.5801	Reject	CCR
Agile organisation	45.89	0.0000	0.7382	Reject	CCR
Leagile organisation	51.24	0.0000	0.9236	Reject	CCR

The regression analyses indicate that the relationship between sale and operating margin is positive and linear for all three manufacturing organisations data sets. As a result, it can be assumed that returns to scale are constant for all three manufacturing organisations and the CCR model is appropriate for the classification of companies.

CALIBRATION OF THE DEA MODEL

I have already discussed the need to restrict the influence of innovation and gross margin on the classification scores. This is accomplished by assigning weights (w) to the INO and CGS constraint equations as follows:

$$X\lambda - w(\theta X_0) \leq 0$$

The size of the weight can be determined through a calibration of the model. This is accomplished by selecting, a DMU with a low gross margin and low operating margin in addition to a high sales/innovation ratio. This DMU then becomes the unit under test and values of theta (θ) are recorded for a given weight (w). The results of the calibration of innovation for the three manufacturing organisations are shown below in figure 36.

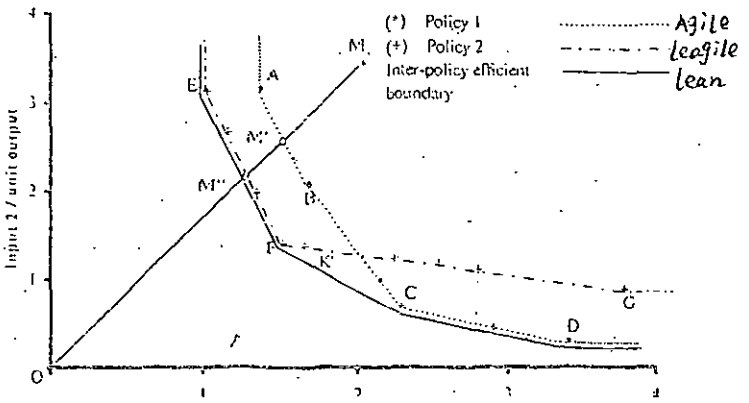


Figure 36: Calibrating the DEA for the innovation effect.

It can be seen that each calibration graph exhibits a change in slope as the value of "w" is increased. Values of w to the left of the break point ($W<W_{break}$ point) suggest that the sale/innovation ratio dominant the efficient score. However, the values greater than W_{break} point indicate that the effect of sale/innovation is now combined with other effects and sale/innovation ratio no longer dominates the score. For this study a value of $W=W_{break}$ point was chosen to reduce the sales/innovation effect as much as possible without removing the contribution of innovation completely. When innovation weights were applied as described above the classification scores agreed more closely with the financial performance metrics.

A similar calibration restricted the influence of gross margin to assure that operating margin would be the dominant contributor to the DEA score. The objective here was to preclude the possibility that a company with very low operating margin would be classified as efficient on the basis of a high gross margin. However, since the objective was only a slight reduction in the effect of Gross Margin/sales, after several calibration runs, a weight equal to 50% of the break point weight was selected to most appropriate. As with innovation, when the weights were added to the CGS constraint the reliability of the efficiency scores improved significantly. A summary of the weights applied to the model are presented in table 24 below.

Table 24: Calibration weights for the DEA model

Industry model	Innovation	CGS
Lean organisation	1.09	1.10
Agile organisation	1.15	1.14
Leagile organisation	1.60	2.50

THE DEA MODEL AND RESULTS

The DEA model was run on the Solver module of Microsoft Excel 5.0. All three models (CCR, BCC, and NDRTS) were run for the data sets of each manufacturing organisation group. When compared with the company financial data, the CCR model scores were observed to be the most representative of relative company performance; this result also supports the assumption of constant returns to scale observed in the regression analysis. Comparative rankings derived from the efficiency scores are presented in table15. These scores are presented in descending order starting with the most efficient organisations down to the least efficient organisations.

The DEA efficiency scores from the BCC and NDRTS models were not used to classify organisations but the results from them were used to verify the CCR scores. In all cases the BCC scores were equal to or higher than the CCR scores and this result was expected. The lean manufacturing organisation had the lowest R^2 of the three regression analyses suggesting that the returns to scale, although still constant, may have been closer to non decreasing returns to scale than the other two manufacturing organisations, agile and leagile. For lean manufacturing organisation, the CCR model scores were also closer to the NDRTS model scores than the other two organisations. One explanation for this effect is the increased levels of heterogeneity that appears to exist among the lean manufacturing organisation.

COMPOSITE CLASSIFICATION OF COMPANIES

In the final phase of classification, the efficiency scores from the DEA model are combined with the ranking by group average to classify the remaining companies. This is accomplished first by calculating and ranking companies on the basis of their percent over the group average (POA) for gross margin, operating margin and, sales/innovation. These scores are combined with the DEA

scores for each manufacturing organisation to obtain a final classification score for each company. Effective innovation companies are designated as 2, ineffective innovation companies are designated as 0, mid range companies are designated as 1 and this class was intentionally kept small to preserve sample size for the logistic regression analysis.

The DEA efficiency score is the primary benchmark for company classifications. However, as noted, there is a risk of misclassifications when a large sale/innovation ratio or high Gross margin percent is combined with low operating margin percent. To avoid this condition, it was necessary to visually compare the DEA rankings with the financial performance scores for each company. For situations where there was an obvious misclassification, the final score had to be adjusted to take into consideration the true financial performance of the DMU.

Alternatives to the above classification approach would have been to evaluate the relationship of inefficient companies to their reference companies on the efficient frontier or, to construct a set of cross efficiency matrices. In either case, because the classifications are so critical to the final results of the analysis, they would still have required a visual inspection of the final ranking and, adjustments would still have been made in the manner described above.

Combined classifications of all companies across all populations is summarised below in table 25.

Table25: Composite Rankings of all companies.

Lean manufacturing organisation		Agile manufacturing organisation		Leagile manufacturing organisation	
2	Oxford engineering Ltd	2	GKN	2	Remmele Engineering Incorporatd
1	Ilford Imaging Ltd	1	Clyde Blowers	1	Flex Cell
0	Medical instruments ltd.	0	Styles Precision Components	0	Westinghouse

CONCLUSION OF THE CLASSIFICATION SECTION

By first eliminating companies that are clearly efficient or inefficient, the remaining data set was compressed to a more homogeneous group which was less responsive to classifications by simple inspection. When this condition exists, the DEA model is a useful and valid method for ranking the remaining subject companies by composite efficiency scores. However, when analyzing samples of companies similar to the ones in this study, the DEA model must be managed closely to avoid problems with misclassifications caused by heterogeneity in the samples. Functional difference among manufacturing companies is unavoidable and, this can lead to misclassifications. Introducing other measures of performance and making adjustments when they were justified improved the reliability of the DEA classifications. The addition of weights to troublesome inputs also reduced their impact on the final classifications. Applying weights to the DMU under test and calibrating the model to remove the unique influence of that resource significantly improved the performance of the DEA model by reducing the number of false positive classifications. Such action was justified in order to achieve a high level of confidence in the classification results that would ultimately become the criterion variables in the following logistic regression and discriminant analysis.

4.2: COLLECTING AND EVALUATION OF THE MAIL SURVEY DATA

This section discusses the refinements to, and implementation of, the survey; it reviews the results of reliability and construct validity assessment and; it addresses the test for non response bias and interrater response bias.

EXECUTION OF THE MAIL SURVEY

The pilot test of the survey instrument identified several possibilities for improving the enabler construct measurement scales. The same companies identified in the classification analysis were also connected in the mail survey. Survey questionnaires together with covering letter were sent to each company in an effort to improve interrater reliability and this resulted in a mailing of 250 surveys.

Names of the respondents were obtained from best factory award winning firms in UK and US and Japan from 1999 to 2005. Selection of the CEO as the

primary respondent is supported by Maidique and Zirger (2003) who argued that the CEO is the ideal respondent. However, to reduce bias and improve interrater reliability, a second respondent was selected from the list of executives in the report. Because many of the questions were related to manufacturing organisation issues, the VP of operations was the preferred alternative respondent. Competency of the respondents was evaluated by: (1) asking how long the respondent had been in his/her current position, and (2) through a set of questions relating to the respondents perception of the environment and company profiles.

Of the 2400 questionnaires dispatched, responses were received from 750 sites, 600 in US and 100 in UK and 50 in Japan, representing yield response rates of 33%, 50% and 40%, respectively. For instance, the reply from four UK best factory award companies includes Rocket medical ltd and Stannah stairlift ltd and Flow Crete ltd and RF engine ltd, and one US SBIR company is Nomadics inc in Oklahoma state. One Japan Deming prize winning company is Nissan motor company.

VALIDATION OF THE SURVEY

The final validation of the survey produced no significant deviations from the results obtained in the pilot study. All scales demonstrated acceptable reliability (Chronbach alpha) and unidimensionality (factor analysis). These results support the internal consistency and operationalization of the constructors in this study. Coefficient alpha, the measure of reliability, was observed to be well within the acceptable range for all construct scales. This supports the assumption that the survey instrument provides a reliable measurement of each HITOP enable construct.

Although several scale items from the pilot test failed to load on any construct factor and, several items loaded on a different factor than they have previously. However, these reassignments are still interpretable, and appear to provide a better measurement of the construct. One explanation for this improvement is the fact that the final survey was distributed to a more stratified, homogeneous sample drawn from the three manufacturing organisation group, lean and agile and leagile, but the pilot survey was distributed to a more heterogeneous group of companies across a wider range of industries.

Also in this research, I compare the efficiency among lean and agile and leagile policy using DEA Malmquist index model. These additional measurements are useful for explaining misclassifications and they can also be used as alternatives to the DEA classifications in future research. A comparison of reliability assessments for the measurement scales of the pilot test and final survey is summarised below in table 26.

Table 26: Comparison of the pilot test and final survey

Pilot test results			Final survey results		
construct	Alpha	Var%	construct	Alpha	Var%
ORFC	0.760	71.3	ORFC	0.756	59.6
AOT	0.913	74.6	AOT	0.817	58.4
IATA	0.791	61.7	IATA	0.759	67.5
AOPS	0.864	55.8	AOPS	0.771	48.4
DOC-HITOP	0.818	52.5	DOC-HITOP	0.712	54.2

ASSESSMENT OF INTERRATER RELIABILITY

Since the surveys were distributed to three manufacturing organisation groups, lean, agile and leagile from three different countries, USA and Japan and UK. It was necessary to test for any differences in their response patterns. Interrater reliability was tested with a one way analysis of variance to measure differences in variability within and between each pair of respondents.

(Dess 1964) The results of this analysis are summarised below in table 27.

Table 27: Interrater response bias assessment

	Company	Lean organisation	Agile organisation	Leagile organisation
Construct	Fcritical	Fvalue	Fvalue	Fvalue
ORFC	4.350	4.050	4.159	4.590
AOT	4.490	4.023	4.112	4.587
IATA	4.410	4.012	4.134	4.567
AOPS	4.425	4.023	4.156	4.532
DOC-HITOP	4.429	4.056	4.134	4.512

Interrater reliability was assessed by testing for the difference in means for the paired responses for each company. The null hypothesis for this test is H0: $\mu 1=\mu 2$. For values of Fvalue > Fcritical H0 is rejected, the means are assumed to be different and, interrater reliability for that item is low. If H0 is not rejected, there is insufficient reason to conclude that the mean responses are different and, therefore interrater reliability for that item is assumed to be high.

Out of 42 possible tests, 32 suggested that interrater reliability was within an acceptable range, five tests had missing data and could not be analysed, and five response pairs produced an Fvalue that rejected Ho. However, 60% of the unfavourable tests were from the HITOP scale suggesting that the perception of the value of employees with leagile culture may differ among various executive positions within the company. Overall, since perceptual differences between managers, in different positions in the company, is inevitable. We can assume that interrater reliability for this study is acceptable.

ASSESSMENT OF NON RESPONSE BIAS

To test for non response bias, the respondent and non respondent companies were compared along the dimensions of relative success established before. This was accomplished with a Chi-square test of independence of the respondents and non respondents.(conant1990) Two separate tests were performed to account for the possibility that a three group data set (discriminant analysis) or a two group data test (logistic regression) might be required.

(1) Successful-mid range-non successful (SMRNS)

(2) Successful-non successful (mid range group omitted) (SNS)

The data structure for these tests is presented in table 28.

	Response	Non Response	Totals
Successful	19	31	50
Mid range	14	10	24
Non –successful	35	30	65
Totals	68	71	139

Hypotheses for both tests were: Ho: (There is no difference in the proportion of respondents and non respondents, i.e: independence), and HA: (There is a difference in the proportion of respondents and non-respondents, i.e: dependence). If the value of computed Chi-square (χ^2) is less than the Chi-square critical (χ^2critical) the null hypothesis is not rejected, and the respondents and non-respondents are assumed to be from the same population. Both tests showed no significant difference between the respondent groups and non respondent groups. Results are summarised below:

1. (SMRNS) (χ^2)=4.236<5.991 = (χ^2critical) (fail to reject Ho).

2. (SNS) (χ^2)=2.731<3.841 = (χ^2critical) (fail to reject Ho).

Results of the Chi-square test support the assumption that non response bias is not significant and that findings of the study can be generalised to the non respondent organisation.

INSPECTION OF THE DATA

Inspection of the data indicated no serious conditions with its overall integrity. Three surveys were incomplete and they were removed from the sample. A fourth was removed because the company was too small, below twenty employees and a fifth was deleted because the respondent was no longer was a manufacturer. Multivariate normality is not a critical requirement when the objective is data reduction. As a result, tests for normality were performed regression analysis obtained from the factor scores.

It is generally accepted that two hundred responses are sufficient to test three independent variables. As a result, late responses were assigned to a hold-out sample for testing the robustness of the final model.

4.3: CALCULATION OF THE REGRESSON VARIABLES USING FACTOR ANALYSIS

Predictor variables for the classification model are obtained by multiplying an (n x m) data matrix by an (m x 1) factor score coefficient matrix for each construct. This calculation results in an (n x 1) matrix of conversion factors for each observation of the construct under evaluation. .Two additional, new data

matrices, lean and agile, were also derived from the survey data. These added constructs measure management's business strategy for dealing with environment uncertainty and are used, as needed, to reconcile any problem with misclassification by the logit model.

THE PRIMARY PREDICTOR VARIABLES

The factor score coefficient matrices, calculated with SPSS 6.1, were used to combine the survey scale items into a single predictor variable for each observation of the construct. The measurement scales and resulting factor score (conversion) matrix was discussed below for each construct used in the study.

ORGANISATIONAL READINESS FOR CHANGE (ORFC)—FIND ORGANISATION BOUNDARY

The Organisational readiness for change (ORFC) was obtained from the survey questionnaires #1, 2 and 3 items:

Organisation boundaries:

Vertical boundary, Horizontal boundary, External boundary, Geographic boundary

These items measure the degree to which management collects information on the state of organisation readiness for change. They produced the following factor score matrix:

Organisation boundaries:

Vertical boundary: 0.38151

Horizontal boundary: 0.35575

External boundary: 0.34352

Geographic boundary: 0.28504

AN ASSESSMENT OF THE TECHNOLOGY AND IDENTIFY ITS CRITICAL FEATURE (AOT)

The AOT construct exhibits the new four success criteria: speed, flexibility, integration, and innovation. These four items measure the degree to which a formal, long rang successful organisation exist through joint technology and organisation design. They produced the following factor score matrix:

The new success criteria:

Speed: 0.37581

Flexibility: 0.36481

Integration: 0.36941

Innovation: 0.39874

AN ANALYSIS OF THE ESSENTIAL TASK REQUIREMENTS - INNOVATION AND TECHNOLOGY MANAGEMENT ANALYSIS (IATA)

The innovation and technology management construct exhibits two dimensions, one for relationships with organisation read for change (ORFC) and a second for relationship with assessment of the technology change (AOT).The innovation and technology management analysis (IATA) was obtained from the survey questionnaires # 4.

Organisation's value chain:

Strategies/operating plans, Information sharing/problem solving, Accounting, measurement and reward systems, Sales processes and Resources/Skills.

They produced the following factor score matrix:

Strategies/operating plans: 0.25226

Information sharing/problem solving: 0.23662

Accounting, measurement and reward systems: 0.24987

Sales processes: 0.26541

Resources/Skills: 0.25847

AN ASSESSMENT OF THE PEOPLE'S SKILL REQUIREMENT (AOPS)— FIND NEW ORGANISATION STRUCTURE.

The assessment of the people's skill requirement (AOPS) was obtained from the survey questionnaires # 5.

The Path to globalisation or world-class organisation:

Human resources practices, organisational structures and organisational processes and systems.

They produced the following factor score matrix:

Human resources practices: 0.26474

Organisational structures: 0.25471

Organisational processes and systems: 0.28741

DESIGN ORGANISATION CHANGES - HITOP MODEL ORGANISATION APPLICATION IN BRITISH NTBFs (DOC-HITOP)

Design Organisation changes—HITOP model organisation application in British NTBFs (DOC-HITOP) was derived from survey questionnaires #6.

Building a boundaryless leadership In British NTBF organisation:

Leadership to break down vertical boundaries/horizontal boundaries /internal boundaries/geographic boundaries and overall Leadership to make it happen

They produced the following factor score matrix:

Leadership to break down vertical boundaries: 0.28754

Horizontal boundaries: 0.25471

Internal boundaries: 0.23698

Geographic boundaries: 0.27584

Overall Leadership to make it happen: 0.21451

BUSINESS STRATEGY VARIABLES: LEAN AND AGILE ORGANISATION

Two dimensions of business strategy that relate to lean and agile organisations were derived from demographic section of the survey instrument. The first dimension measures the extent to which the company employs a "lean" and "agile" strategy and first dimension measures the extent to which the company employs a "leagile" strategy. The question set and factor score matrix for each question set is presented below:

Map the relationship between operational models:

I: Lean six sigma and agile organisation business strategy

II: Leagile organisation business strategy

III: TQM/JIT/CIM or others business strategy

They produced the following factor score matrix:

I: Lean six sigma and agile organisation business strategy: 0.22647

II: Leagile organisation business strategy: 0.21478

III: TQM/JIT/CIM or others business strategy: 0.28496

4.4: SIGNIFICANCE TESTS OF THE HITOP MODEL

This section is presented in eight parts:
(1) logistic regression tests for significance,
(2) test for interaction and industry effects,
(3) discriminant analysis tests for significance,
(4) analysis of variance of the survey responses,
(5) comparing lean and agile and leagile organisation performance using DEA Malmquist model, (6) validation of the model with holdout data,
(7) hypothesis test,
(8) a discussion of the results of the empirical analysis.

INSPECTION OF THE DATA

Survey data for this study was processed in two formats. The first data set of regression variables was converted to a standardized format in the factor analysis. Standardised input variables have the advantage of a common interval scale that also accounts for variability in the observations, it has a disadvantage of being not easily interpreted. To deal with this difficulty, a second model was developed by applying the factor score conversion matrices directly to the survey data to produce a second part of input data. Although the second data structure is more interpretable, the standardised data model is the primary method for determining the significance of the enablers and their relationship observed financial performance.

The distributional characteristics of the data for each group of enablers (successful=2 and unsuccessful=0) was tested using the Kolmogorov-Smirnov one sample test from non-parametric statistics (Conover 1980). The enabler data sets for each group were tested under the null hypothesis: Ho: F(x) =Normal distribution. For values of the observed KS statistic greater than the 95% quartile of the KS Test Statistic, the null hypothesis is rejected in favour of the alternative Hypothesis HA: F(x) is not normally distributed. The test results indicate that the null hypothesis was rejected for all data sets (standardised and survey) indicating that ORFC variables have non normal distributions. The variance-covariance matrix indicates that the assumption of equal variance between groups is also

violated. Failure of the normality and equal variance assumptions supports the decision to use logistic regression rather than discriminant analysis as the primary model for testing the significance of the HITOP enabler. Although the results of the discriminant analysis may still be useful when normality is violated, interpretations of the results must be performed with caution when this condition exists. (Ramanujam 1986) Because of this, it was concluded that logistic regression should be the primary statistical procedure for testing the significance of the enablers and discriminant analysis would be used only to validate the results of logistic regression.

LOGISTIC REGRESSION TESTS

This section reduces instability caused by high leverage outliers. The primary logistic models were developed using standardized data from the factor analysis. Once an optimal model was achieved, a secondary model was developed using the same dependent variable classifications and predictor variables; however, the observations presents the logistic regression test of the significance for each enabler. With the selection of the logit model, the dependent variable is restricted to two discrete groups which require elimination of the mid-range group of observations. The observations were subsequently reclassified and re-entered in the second model. In the third model, misclassified cases that exhibited high leverage effects on the model were re-evaluated and reclassified if such action could be justified. In the fourth model, non significant predictor variables were removed to improve the ratio of observations to predictor variables and erved values of the predictor variables in this model were obtained directly from the survey results multiplied by the factor score matrix. Each step of the model building process is summarised below, and summary statistics are provided in table 29.

Table29: Results of the primary logistic model development

		Model1	Model2	Model3	Model4
No of observations	52	54	54	54	54
Classification %		80.77	79.63	85.19	90.74
-2 log Liklihood		51.409	53.086	20.858	25.672
Goodness to fit		51.459	54.983	18.192	42.525
Model Chi Sq. Significant.		15.674	16.961	40.949	36.134
Model dof		8	8	8	4
ORFC	Coefficient	-1.161	-1.237	-6.606	-4.122
	Wald	3.452	3.811	4.819	7.184
	Signific	0.063	0.051	0.029	0.007
AOT	Coefficient	1.373	1.470	7.860	5.337
	Wald	5.467	6.332	5.498	9.501
	Signific	0.019	0.012	0.019	0.002
IATA	Coefficient	0.909	0.935	6.105	4.771
	Wald	3.480	3.607	4.604	9.307
	Signific	0.062	0.058	0.032	0.002
AOPS	Coefficient	0.812	0.829	5.301	3.864
	Wald	5.108	5.334	5.234	5.287
	Signific	0.024	0.023	0.015	0.026
Doc-HITOP	Coefficient	0.713	0.729	3.301	2.864
	Wald	4.108	4.334	4.234	4.287
	Signific	0.014	0.013	0.015	0.016
Constant	Coefficient	0.612	0.629	2.301	2.864
	Wald	3.108	3.334	3.234	3.287
	Signific	0.025	0.026	0.028	0.029

LOGISTIC REGRESSION MODEL NO.1

The first logistic model was run using standardized data for the five HITOP enabler constructers with the midrange cases excluded. The first model was marginally significant with a Chi-square statistic of 15.674 (Pval=0.047). It correctly classified 80.77% of the cases and lean and agile organisation only, were significant at $\alpha=0.05$.

LOGISTIC REGRESSION MODEL NO.2

The second logistic model was developed after midrange case were reclassified and re-entered into the data set. Lean organisation case has a DEA score of 0.89, a gross margin 15.6% above its group average and operating margin 9.9% above its group average. This set of characteristics justified reclassifying into the successful group ("2"). Agile organisation case also had a DEA score of 89% and an operating margin that was 19% over its group average. However, gross margin for this case was 17% below its group average and because of this, it was re-entered into the data set as unsuccessful ("0"). The second model showed a slightly improved over the first. It had a Chi-square statistic of 16.961 significant (Pval=0.031). It correctly classified 79.63% of the cases and only leagile organisation was significant. The model exhibited a number of high leverage cases which were dealt with in model 3.

LOGISTIC REGRESSION MODEL NO.3

The third logistic model was run following a series of adjustments that were made to the classifications of high leverage cases. A case is considered to be high leverage if its Cook's Distance exceed 0.5 (Neter 1990) and five observations exhibited this condition. Model #3 was considerably better than the preceding models. It has a Chi-square of 40.95 (dof=8, Pval=0.000) and five HITOP enabler were all significant.

LOGISTIC REGRESSION MODEL NO.4 (REDUCED MODEL)

This model was run using the data set for model#3 but the predictor variables including only the significant parameters that were identified in the last model (#3). Elimination of the non-significant variables improved the ratio of observation to predictor variables and subsequently reduced the problems with

high leverage observations. Model #3 had nine, high leverage outliers. Four observations had Cook's distance values greater than 2 and, two had values between 1 and 2 and three observations were between 0.5 and 1. The reduced model (model#4) had only two high leverage observations, although this is still an excessive value for Cook's distance, there was no reason to justify the removal of these observations from the data set. Therefore, no further adjustments were made to the classifications and model #4 was selected as the final primary model using standardized data inputs. The final and primary model, using standardized input data, is defined as:

Prob(Company is classified as a "2")=1/(1+e)

Where Z=-3.8636-4.085(ORFC)+4.771(AOT)+5.337(IATA)-4.122(AOPS)

LOGISTIC REGRESSION MODEL NO.5 AND NO.6 (NO STANDARDIZED DATA)

Two additional logistic regression models were developed using a set of predictor variables derived directly from the survey data and the factor score conversion matrices. The objective of this action was to develop an alternative model that could be more easily interpreted. These models (referred to as the non-standardized data models) were running using the same predictor variables identified in the reduced model (#4). Model No.5 supported the findings of the standardized data models however, the intercept was not significant at α=0.05. Model #5 had a Chi-square of 33.328 (dof=4, Pval=0.000), a classification accuracy of 87.04% and HITOP enablers were all significant. The sixth model was running without an interpret (NOINT) and it had a Chi-square of 45.696 and it classified 87.04% of the observation correctly. As a result of this action, the no intercept model was selected as the secondary model for this study. Results of the model building process using non standardized input data is summarized in table 20.

The secondary logistic regression model, based on non-standardized input data and no intercept, is defined as:

Prob(company is classified as a "2") =1/(1+e)

Where: Z=(0)-2.495(ORFC)+2.395(AOT)+2.471(IATA)-2.047(AOPS)

Table 30: Results of the logistic model building (NON STD DATA)

		Model5	Model6
No of observations		54	54
Classification %		85.19	90.74
-2 log Liklihood		22.858	23.672
Goodness to fit		16.192	22.525
Model Chi Sq. Significant.		0.000	0.000
Model dof		4	4
ORFC	Coefficient	-4.606	-4.122
	Wald	4.819	7.184
	Signific	0.029	0.007
AOT	Coefficient	6.860	4.337
	Wald	4.498	6.501
	Signific	0.017	0.002
IATA	Coefficient	5.606	3.122
	Wald	3.819	5.184
	Signific	0.025	0.006
AOPS	Coefficient	3.606	2.122
	Wald	3.819	5.184
	Signific	0.029	0.007
Doc-HITOP	Coefficient	3.860	3.337
	Wald	3.498	3.501
	Signific	0.017	0.002
Constant	Coefficient	2.606	3.122
	Wald	2.819	2.184
	Signific	0.015	0.006

4.5: TESTS FOR INDUSTRY EFFECT

Since there were three distinct manufacturing organisation groups (lean, agile and leagile) in this study, it was necessary to also test for any significant differences introduced by one or more of these groups (TQM/JIT/CIM). Results of this test indicate that no industry effects were observed in the model and they are summarised below in table 31.

Table 31: Test results for industry effects

Model	Coefficient	Wald	Sig.	R
JIT	1.3258	1.4871	0.1364	0.0146
TQM	1.5255	1.3792	0.1468	0.0245
CIM	1.3291	1.3891	0.1366	0.0143
Others	1.3455	1.2632	0.1268	0.0124

REVIEW OF THE LOGISTIC REGRESSION RESULTS

Each logistic regression model consistently demonstrated that the five HITOP enablers are significant in leagile organisation, but in lean organisation, innovation and technology management is not significant and in agile organisation, assessment of people's skills is not significant. Meanwhile in other organisation model, for instance, in JIT and TQM model, organisation ready for change is not significant and in CIM model, assessment of technology change is not significant.

As noted, each dimension of the HITOP enablers construct exhibited a reciprocal relationship with its partner. The same relationship was also observed for the bi-dimensional construct and additional exploratory research was necessary to obtain a better understanding of this relationship and to validate it. This was accomplished through a discriminant analysis and an analysis of variance. These two additional tests are discussed in the following sections.

DISCRIMINANT ANALYSIS OF THE HITOP ENABLERS

Since the assumptions of normality and equal variance are violated, the findings of the discriminant model must be interpreted with caution. Consequently, the discriminant analysis was performed to only support the findings of the logistic regression analysis. To keep the models as comparable as

possible, the same classification groups and data set for the logistic regression model (0 and 2) are used in the discriminant model and this action restricts the model to a single discriminant function.

The usefulness of discriminant model is accompanied by testing the null hypothesis: (Ho: the model does not discriminant between groups). The model achieved a Wilk's Lambda=0.5073, and a Chi-square=32.58 (Pval=0.0001) and it correctly classified 88.89% of the group cases. Based on this result, we can reject the null hypothesis and conclude that the model does, in fact, discriminant between the groups.

The discriminate analysis defined two group centroids:

Group(0).....-0.57219

Group(2)....1.63483

The discriminant analysis confirms the findings of the logistic regression analysis in two ways: First, classification results for the discriminant model and reduced logistic regression model (model#4) were within 1.0% (88.9% vs 90.4 respectively). Second, the reciprocal relationships between lean and agile manufacturing organisation, and their relative magnitudes, were unchanged from what was observed in the logistic regression models. This indicates that the survey data should produce the same classification results for either model.

Standardized coefficients for the discriminant model also suggest that HITOP leagile enablers contribute to the classification of companies as either successful or non-successful and they also exhibit a reciprocal relationship.

The pooled within-groups correlations between the discriminant variables and canonical discriminant functions and the standardized canonical discriminant function coefficients, are presented in table 32.

Table 32: Standardized coefficients and correlations

Standardized Coefficients		Discriminant Function Coefficients	
ORFC	-1.1941	ORFC	-0.2624
AOT	1.0787	AOT	0.2299
IATA	1.3437	IATA	0.1858
AOPS	-0.9043	AOPS	0.159
DOC-HITOP	0.4700	DOC-HITOP	0.0833

ANALYSIS OF VARIANCE OF THE SURVEY RESPONSES

Results of the logistic regression analysis suggest the presence of three distinct classes of company in this study, lean and agile and leagile manufacturing organisation. The first two groups are either clearly, successful or unsuccessful. The third group consists of companies that companies that occupy the middle range on the logistic curve. (figure 34) The three groups were established by ranking all companies in order of their descending logit scores.

The output of the logistic model is a probability estimate that the company under analysis is innovation and technology management efficient. For each company there is a unique "Z" score which is a function of the survey responses and, for each "Z" score there is a unique probability that the observed company is successful (defined as "2"). Figure 30 shows the three regions of this logistic regression output.

Figure 37: Classification regions of the logit model.

Leagile companies in region 2 have a high probability of being in the effective innovation and technology management and lean companies in region 0 have a high probability of being in the ineffectively innovation and technology management. Agile companies in region 1 are midrange, and the probability of their being reclassified either into group 0 or 2 is very sensitive to slight perturbations to its Logit score because of the steepness of the slope in that region.

In order to test the research hypothesis that Leagile organisations have a high probability of being in the effective innovation and technology management than

lean and agile organisation, ANOVA (analysis of variance) test was accomplished with one way analysis of variance of the survey responses, across the three groups. ANOVA results are summarized in table 23. Differences in the mean response were tested under the null hypothesis, Ho: the mean survey responses are equal for companies in group 0,1 and 2.

Table 33: (I) Classification of companies for the ANOVA test

Group 2		Group 1		Group 0	
Leagile company	Prob(2) 0.9819	Agile company	Prob(2) 0.7925	Lean company	Prob(2) 0.0850

(II) One Way ANOVA test of the survey responses

Construct	Group	Mean	S.D.	F statistic	P(Val)	Rej Ho?
ORFC				1.354	0.2548	NO
	0	5.506	1.262			
	1	5.183	1.493			
	2	5.348	1.365			
AOT				1.348	0.2157	NO
	0	5.922	1.399			
	1	5.122	1.506			
	2	5.848	1.381			
IATA				1.352	0.2678	NO
	0	5.318	1.498			
	1	5.364	1.578			
	2	5.369	1.547			
AOPS				1.369	0.2478	NO
	0	6.047	1.578			
	1	5.479	1.523			
	2	5.874	1.498			
DOC-HITOP				1.357	0.2654	NO
	0	5.647	1.561			
	1	5.149	1.529			
	2	5.984	1.579			

COMPARING ORGANISATION PERFORMANCE FOR INNOVATION MANAGEMENT AMONG SINGLE LEAN OR AGILE ORGANISATION AND LEAGILE HITOP ORGANISATION THROUGH DEA METHOD

The notion of assessing policy effectiveness by means of DEA was first introduced by Charnes (1981). Then Fare (1989) first uses DEA to measure the productivity change in single-input single-output context and multi-input multi-output contexts using a Malmquist index which measures a unit's overall productivity change. Following Thanassoulis (2000) developed a modification to the Malmquist index to reflect productivity changes in terms of the combined effect of input costs or output values and physical quantities relating to the two time periods over which productivity change is being measured using Warwick DEA software.

In this research, we will first analysis single-input single-output context, such as single lean and single agile policy effectiveness. Then we will analysis Multi-input Multi-output context, such as leagile policy effectiveness. The detail analysis procedure is following:

1: Single-input and Single-output context.

Charnes (1981) provides a way to disentangle managerial from policy effectiveness. The approach involves a two-stage assessment process. In the first stage, the analyst assesses each unit within its own policy group. The DEA efficiency rating of each unit within its policy group is referred to as its managerial efficiency.

The first stage assessment makes it possible to estimate a set of input-output levels that would render the unit Pareto-efficient within its own policy group. These input-output levels are referred to as radial targets because they reflect the attainment of Pareto-efficiency through pre-emptive priority to radial input contractions or output expansions.

At the second stage assessment, The DEA efficiency rating corresponding to the radial targets of a unit is referred to as the policy efficiency at the input-output mix of the unit concerned.

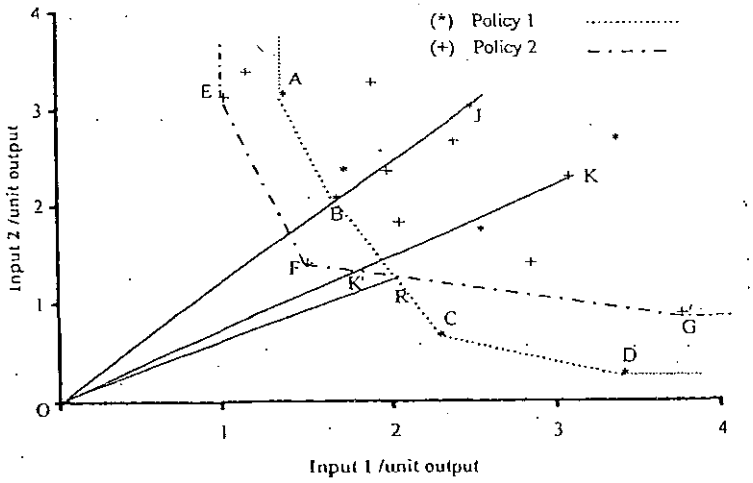


Figure 38: Separating managerial and policy efficiencies.

Source: Thanassoulis (2003): Introduction to the theory and application of data envelopment analysis.

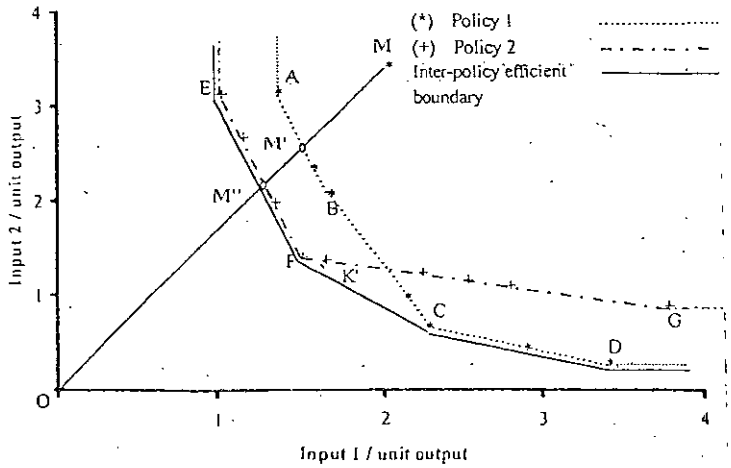


Figure 39: Assessing policy efficiency using adjusted input levels.

Source: Thanassoulis (2003): Introduction to the theory and application of data envelopment analysis.

Thus, inter-policy efficiency=Managerial efficiency x Policy efficiency at the input mix. In summary, comparison of policies on intrinsic efficiency needs to be designed to capture all the input-output mixes on which the user wishes to compare the policies.

2: Multi-input and Multi-output context.

Fare (1989) has used DEA to compute a Malmquist index of productivity change. They allowed for the fact that productivity change may be due to a combination of industry-wide productivity change over time and efficiency change at the level of the operating unit. Fare (1994) decomposed the efficiency change component of the Malmquist index into a pure technical and a scale efficiency change component.

The Malmquist Index can be computed in the input orientation, controlling for output levels and measuring changes in input use, or alternatively in the output orientation, controlling for input use and estimating output level changes. However, The DEA efficiencies needed are computed maintaining a constant return to scale assumption irrespective of the actual returns to scale characterising efficient production in the technology operated by the units being assessed.

As the Malmquist index is always computed maintaining a constant return to scale assumption, its value is the same whether it is computed in the input or in the output orientation. Hence, to simplify matters, we shall use the input orientation.

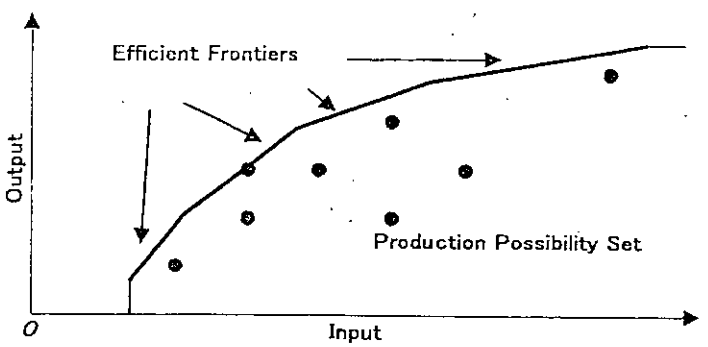


Figure 40: Measuring Productivity change

Source: Thanassoulis (2003): Introduction to the theory and application of data envelopment analysis.

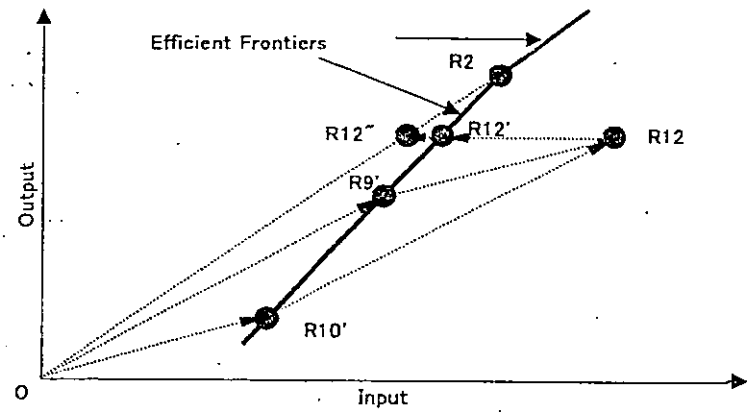


Figure41: Measuring Productivity Change when the Efficient Boundry moves over time.

Source: Thanassoulis (2003): Introduction to the theory and application of data envelopment analysis.

Table 34: Decomposition of the Malmquist index of DMU Jo

$$MI_{J_0} = \frac{V\_EF_{T_{t+1}}^{D_{t+1}}}{V\_EF_{T_t}^{D_t}} \times \left[\frac{C\_EF_{T_t}^{D_{t+1}}}{C\_EF_{T_{t+1}}^{D_{t+1}}} \times \frac{C\_EF_{T_t}^{D_t}}{C\_EF_{T_{t+1}}^{D_t}}\right]^{1/2}$$

↑ Malmquist Index

↑ 'Pure technical efficiency catch up'

↑ 'Boundary shift'

Thus, Malmquist index of productivity change of company = 'Catch-up' component X 'Boundary shift' component. The catch-up term is a measure of how much closer to the boundary the company is in period t+1 compared to period t. Meanwhile, the boundary shift term measures the movement of the boundary between period t and t+1 at two locations: the ratio OE/OI measures the distance of the two boundaries at the input mix of the company in period t+1. The ratio OD/OH measures the distance of the two boundaries at the input mix of the same company in period t, the boundary shift is the geometric mean of these distance.

When the units being assessed operate a technology where efficient production is not characterised by constant returns to scale the change in the productivity of a unit may be impacted inter-alia by changes in scale size.

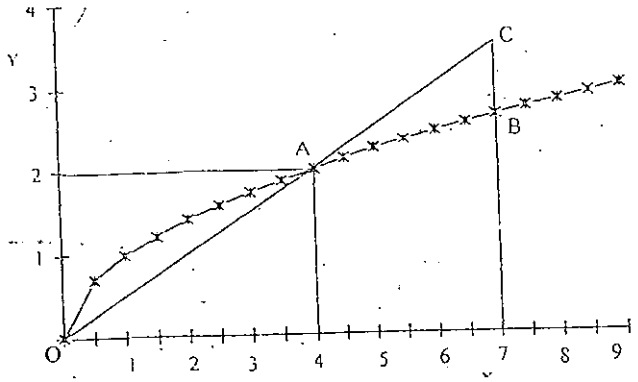


Figure 42: Measuring the impact of scale size on productivity.
Source: Thanassoulis (2003): Introduction to the theory and application of data envelopment analysis.

Table 35: Capturing the impact of Scale on the Malmquist index of Productivity change.

$MI_{J_0} =$	$\frac{V\_EF_{Tt+1}^{Dt+1}}{V\_EF_{Tt}^{Dt}} \times$	$\frac{SC\_EF_{Tt+1}^{Dt+1}}{SC\_EF_{Tt}^{Dt}} \times$	$\left[\frac{C\_EF_{Tt}^{Dt+1}}{C\_EF_{Tt+1}^{Dt+1}} \times \frac{C\_EF_{Tt}^{Dt}}{C\_EF_{Tt+1}^{Dt}}\right]^{1/2}$	
↑	↑	↑	↑	
Malmquist Index	'Pure technical efficiency catch up'	'Scale efficiency catch up'	'Boundary shift'	

Thus, Malmquist index='Pure technical efficiency catch up' X 'Scale efficiency catch up' X 'Boundary shift'. The pure technical efficiency catch up term is now measured relative to the efficient boundary corresponding to a variable rather than a constant return to scale technology. The scale efficiency catch up term captures the impact of any change in scale size of DMU Jo on its productivity. And the boundary shift term measures the shift of the constant returns to scale boundary.
Because lean and agile and leagile organization are multi-input and multi-output context, Malmquist index can measure the organization efficiency change

component into a pure technical and a scale efficiency change component. It can be computed in the input orientation, controlling for output levels and measuring changes in input use. For example, leagile organizations test five HITOP enablers using output variables:

Sales (SLS).....Taken directly from the financial statement

Gross Margin (GM).....Sale- Cost of Goods Sold (SLS-CGS)

Operation Margin (OM)....SLS - (GS&A+ R&D)

Input variables:

Cost of Goods Sold, innovation and (GS&A+ R&D), and Assets were obtained directly from the financial statements.

Through test the efficiency of leagile organization and its five HITOP enablers, I will find the relationship between them using statistic method, such as DEA Malmquist index which shows how significant five HITOP enablers are influenced the leagile organization performance.

These findings are summarised in figure 43:

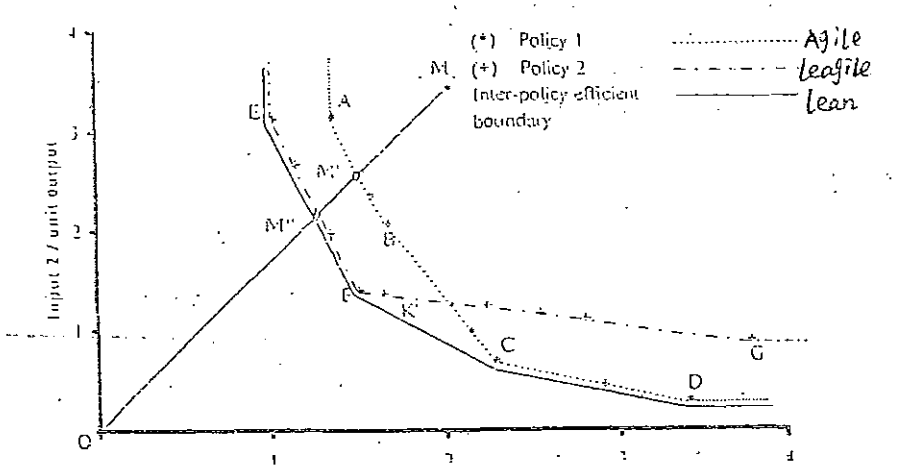


Figure 43: leagile and lean and agile innovation and technology performance comparing using DEA method

Statistical analysis result shows that lean organization can create a perfect platform to integrate agile organization, from statistical graph, lean organization policy plot builds a frontline to cover agile and leagile organization. However, agile organization performance is more dynamic and flexible due to the ability to

respond successfully to change in their hostile-dynamic environments. Meanwhile, leagile organization performance is in the middle of lean and agile organization. This knowledge allows me to move closer to a more definitive description of the leagile company as: leagile companies rely more heavily on responsive manufacturing process and interactive communication process within the organization than either lean or agile organization, in other words, leagile organization should be highly integrated their technology, organization and people (HITOP) for more effective innovation and technology management.

TESTING THE MODEL WITH HOLDOUT DATA

Several surveys which arrive late were placed into the holdout data set for subsequent validation of the model. The responses were tested in both the standardized data model (model #4) and the non standardized data model (model #6). Seven surveys had responses that were suitable for testing in the logistic models. The results of these tests are presented below in table 38.

Table 36: Testing with holdout data

	Model #4	Model #6	Observed
Company	P(2)	P(2)	Class
Lean organisation (3 companies)	0.004	0.0016	0
Agile organisation (4 companies)	0.0154	0.0254	1
Leagile organisation (4 companies)	0.0197	0.0196	2
Others (4 companies)	0.003	0.008	0

The above analysis results are same with the previous data test.

TESTS OF THE HYPOTHESES

The hypotheses, presented in Chapter 3, were based on the assumption that leagile companies were organisations with the ability to thrive in a hostile-dynamic environment. A fundamental assumption of this research proposed that, if a leagile organisation truly existed, it would most likely be a highly integrated technology, organisation and people (HITOP) organisation and more effective

innovation and technology management than existed lean and agile organisation. It was also assumed that once identified, these HITOP leagile companies could be test for the existence of a set of enablers. As the study evolved there was increasing evidence that lean and agile companies may in fact not be the most successful organisations in their industry groups despite the fact that they may be more responsive to customers than their competitors. As a results, the hypotheses failed to present a testable statement about the presence or absence of these enablers in a leagile companies because they were all phased in terms of most successful or least successful. This condition should not detract from the findings of this study. There is a relatively little published empirical research on the leagile organisation and there are few established benchmarks or tested theories upon which researches can develop realistic and testable hypotheses. Consequently, this research should be regarded as exploratory and unexpected findings must also be considered if they ultimately provide a better understanding of the leagile organisation. A discussion of the relationship of each hypothesis to the statistical results follows:

ORFC—organisation ready for change

Hypothesis H1 was not supported by both the logit model and the discriminant model. This suggests that the degree of ORFC performed by companies in all three groups, lean and agile and leagile, is statistically the same.

AOT—Assessment of technology change

Hypothesis H2 was supported by both the logit model and the discriminant model. The logit model showed a positive relationship between technology change and agile organisation performance and this finding was supported by the standardized coefficient for AOT in the discriminant model.

IATA— assessment of Innovation and technology management

Hypothesis H3 was supported by both the logit model and the discriminant model. The logit model showed a positive relationship between effective innovation and technology management and leagile organisation performance and this finding was supported by the standardized coefficient for IATA in the discriminant model.

AOPS—assessment of people's skill requirement for new Agile organisation structure

Hypothesis H2 was supported by both the logit model and the discriminant model. The logit model showed a positive relationship between people's skill requirement and agile organisation performance and this finding was supported by the standardized coefficient for AOPS in the discriminant model.

DOC-HITOP—Design of organisation change using HITOP method

Hypothesis H3 was supported by both the logit model and the discriminant model. The logit model showed a positive relationship between HTOP management and leagile organisation performance and this finding was supported by the standardized coefficient for DOC-HITOP in the discriminant model. However, it may be sensitive to the detail application procedures of HITOP model leagile organisation is an issue for future research.

4.6: SUMMARY OF THE EMPIRICAL ANALYSIS RESULTS

In chapter four, I describe how to compare lean, agile and leagile organisation performance on innovation and technology management using DEA method, the reason I choose DEA method to measure the lean, agile and leagile organisation performance is that DEA Malmquist index can measure the efficiency of the organisation using multi-input and multi-output data resource. For instance, in order to measure the significant of five HITOP leagile enablers on innovation and technology management, I choose input variables as Cost of Goods Sold, innovation and (GS&A+ R&D), and Assets were obtained directly from the financial statements, and the output variables as Sales (SLS), Gross Margin (GM), Sale- Cost of Goods Sold (SLS-CGS), Operation Margin (OM)....SLS - (GS&A+ R&D).

The final DEA analysis results indicate that lean organization can create a perfect platform to integrate agile organization, from statistical graph, lean organization policy plot builds a frontline to cover agile and leagile organization. However, agile organization performance is more dynamic and flexible due to the ability to respond successfully to change in their hostile-dynamic environments. Meanwhile, leagile organization performance is in the middle of lean and agile organization. This knowledge allows me to move closer to a more definitive description of the leagile company as: leagile companies rely more heavily on responsive manufacturing process and interactive communication process within

the organization than either lean or agile organization, in other words, leagile organization should be highly integrated their technology, organization and people (HITOP) for more effective innovation and technology management.

This study was proposed with the understanding that HITOP leagile companies were the most successful organisation operating in a hostile and dynamically changing environment because they had been described as the combination of lean and agile merits. However, the empirical findings of this study suggest that this statement requires some serious qualifications such that, although this research only focuses on new technology-based firms (NTBFs), leagile organisation should be highly integrated technology, organisation and people (HITOP) and create more effective innovation and technology management in their industry group. These findings transcend the original expectation of the study by demonstrating:

(1) The existence of reciprocal relationships between technology and organisation.

(2) The existence of reciprocal relationships between lean and agile organisation.

(3) Leagile organisation should be highly integrated technology, organisation and people (HITOP) to create more effective innovation management than lean and agile organisation.

(4) For the British new technology based firms, they would have to ensure the lean virtues of internal efficiency as well as the agile value of supply-chain based responsive adaptation and create boundaryless HITOP Leagile manufacturing organisation.

Therefore, since leagile boundaryless organisation appears to place additional demands on a company's resources, it maybe incorrect to state that "leagile organisations thrive in hostile environments". Instead it may be more appropriate to say that they are simply able to survive amidst the changing demands of successful innovation and technology management.

CHAPTER FIVE: DISCUSSION

Introduction:

In chapter five, I present the discussion of HITOP method for British new technology-based firms. It provides a discussion of the statistical results, a review of the limitations that were encountered, a discussion of the significance and contributions of the study, and a plan for future research directions.

This chapter is presented in four sections. Firstly, I will discuss the overall conclusions derived from the statistical and DEA analyses; Secondly, I will describe the recommendations for improvement and limitation of the findings; Thirdly, I will discuss the significance of contributions of the research to the body of knowledge; Fourthly, I will present a list of follow on research opportunities that were identified in the study.

5.1: DISCUSSION OF THE STATISTICAL RESULTS

This study was based on the premise of HITOP leagile organisation were able to thrive in an environment of unpredictable and dynamic change. I decided that a financial successful organisation operating in a hostile dynamic environment would be an acceptable proxy of the leagile company. I assumed that these "thriving" companies could effectively serve as subjects testing the significance of a set of predefined enablers. However, the data collection only focus on those new technology-based firms (NTBFs) from best factory award winning companies in UK, US and Japan, through comparing their lean, agile and leagile practices, the five HITOP construct enablers have been tested in detail.

SUMMARY OF THE DATA COLLECTION AND ANALYSES

The DEA classifications were useful for assigning companies to their respective groups. However, the DEA analysis on the sample of manufacturing companies experienced limitations caused by unavoidable heterogeneity in the three industry samples, lean and agile and leagile manufacturing organisations. Because of this, the DEA analysis was supplemented with additional classification procedures based strictly on financial metric. This combination of procedures produced a reliable estimate of each company's relative ranks or efficiency score.

In the next phase of the study, self report data was collected with the use of a mail survey. The instrument was successfully pilot tested and tests for non response bias and interrater were both acceptable. The survey instrument had a total of six measurement scales all of which satisfied the conditions for reliability and unidimensionality and this, in turn, supported construct validity.

RESULTS AND OBSERVATIONS

The logistic regression model provided the first results of the significance tests. One prospective enabler, organisation ready for change (ORFC) showed no statistical importance as a classifier of company into its observed groups. Three HITOP enablers assessment of technology change (AOT) and innovation and technology management (IATA) and assessment of people skill's requirement for organisation change (AOPS) however, were significant in the model.

Each dimension of the construct exhibited a reciprocal relationship with its associate. The positive coefficients for HITOP enablers predict that leagile manufacturing organisation which responded more positively to these item scales should have a higher probability of appearing in the successful innovation group (region2). Alternatively, the negative coefficients for HITOP enablers predict that lean organisation more likely appear in the ineffective innovation group (region0) and agile organisation more likely appear in the midrange group (region1).

The literature argues that leagile organisation are better innovation and technology management than lean and agile organisation, this proposition provides a benchmark for interpreting the results of this study. However, previous lean and agile practices in UK and European bring many arguments, for example, no standard operation strategy to adopt lean and agile principles and no special financial benefits obtained from lean and agile practices etc. This scenario provides a benchmark for defining the leagile organisation as one which is most appropriately located in region 2 of the logit curve.

One of the advantages of the logit model is the ability to introduce dummy variables and interaction items. Both of these features were used and they produced the following results: (1) Interaction test produced no significant effects. (2) Tests for industry effects, with dummy variable industry

organisations, also produced no significant results related to a company's membership in a particular industry.

Discriminant analysis supported the findings of the logistic regression model. First, the model was significant in spite of problems with non normality and unequal variances. Second, the standardized coefficients for the two dimensions of technology and manufacturing organisation change exhibited the same reciprocal relationship that was observed in the logit model. Third, the ratios of the coefficients in the discriminant and the logit models were comparable and this confirmed the belief that each dimension of the construct made the same relative contribution to the final score of either model.

Finally, six out of seven observations in the hold out data sample classified correctly in the logit model.

AN EXTENSION OF THE ANALYSIS

Logit scores for each company produced by the final model presented an opportunity to test for differences in the response patterns of companies in the three regions of the curve. To test for these differences, survey responses for each company were sorted by logit score of the subject company and three groups were established from this ranking.

(1) Region 2 companies had the largest logit scores giving them the highest probability of being a group 2 company (leagile manufacturing organisation).

(2) Region 0 companies had the lowest scores giving them the highest probability in the 0 group.

(lean manufacturing organisation)

(3) Companies in the mid range were designated members of thel group.(Agile manufacturing organisation)

In an analysis of variance between these three groups, DEA Malmquist model had been used to compare their efficient innovation and technology management. The result of the ANOVA showed that leagile companies rely more heavily on integrated technology and organisation for effective innovation and technology management, and lean companies rely more heavily on inter-organisational communication and people skills requirements, and agile companies rely more heavily on virtual enterprise technology. These conditions should ultimately be the defining characteristics of a leagile company.

5.2: A DISCUSSION ABOUT HITOP IMPLEMENTATION IN BRITISH NEW TECHNOLOGY-BASED FIRMS

Discuss question 1:

HITOP stands for "Technology, Organisation, and People" integration and the system called Top Modeler was developed to support the process of organisation design in manufacturing organisation. Top Modeler was funded with a $3Million Grant from the US National Centre for Manufacturing Sciences and included the active involvement of four companies: Hewlett-Packard, General Motors, Digital Equipment Corporation, and Texas instruments.

Some HITOP Users include:

(1) Boeing Aerospace

(2) Digital Equipment Corp

(3) Douglas Aircraft Co (Division of McDonnell Douglas Corp)

(4) GEC ALSTHOM T&D

(5) General Motors

(6) Hewlett Packard (Boise Printer Division)

(7) Philip Morris

(8) Solar Turbines (Subsidiary of Caterpillar Co)

(9) Swiss metal

(10) Westinghouse Defence

And its typical benefits include:

(1) Cost savings.

(2) Improved production quality.

(3) Cross-functional team building.

(4) More effective use of technologies.

(5) Faster implementation times.

(6) Better process understanding.

(7) Improved communications and understandings.

(8) Better motivation.

(9) Identification of key operational issues.

(10) Identification of internal weaknesses (e.g. strategy, change management capabilities, etc).

(11) Clarification of roles and responsibilities.

(12) Enabling empowerment, participation and culture change.

(13) Create inter-organisational Far-Flung Virtual team or VC^3 team for radical innovation.

Can HITOP model leagile organisation build future Operation Management model in British NTBFs?

Discussion:

HITOP Model has been used for agile manufacturing organisation design in USA since 1993. However, so far there is no evidence to show that HITOP model has been used to build leagile organisation in British NTBFs. Thus, in this research, I try to build HITOP leagile organisation in British NTBFs using its five enablers. The test result shows that this new HITOP leagile organisation can satisfy future operation management need in British new technology based firms.

Discussion Question 2:

Yusuf (2002) concludes that market instability would intensify and become universal. UK Companies would therefore be compelled to look beyond their internal boundaries for enhanced competitive advantage. They would have to ensure the lean virtues of internal efficiency as well as the agile value of supply-chain based responsive adaptation. The question is leagile model really can combine lean and agile principles in British new technology-based firms using HITOP leagile organisation model?

Discussion:

Firstly, HITOP leagile organisation can combine lean and agile merits, because HITOP method is able to find the gap between lean and agile practices using its knowledge expert systems. Secondly, the test result shows that HITOP method is able to create a leagile boundaryless organisation through combing lean and agile principles at Agility 3 stage. (Ted Goranson 1999) The test results support that leagile boundaryless organisation can combine lean and agile principles in British new technology based firms.

Discuss question 3:

From Harvard business review, both Ann Majchrzak's Far-Flung team or VC^3 team (Virtual cross-value-chain collaborative creative teams) and Jim Womack's lean and mean team can create innovation effectively. The question is which team can create innovation more effectively in British NTBFs firms?

Discussion:

Ann Majchrzak's paper <Radical innovation without collocation: a case study at Boeing-Rocketdyne> shows that agile virtual team can create innovation more effectively in multi-functional global companies. Meanwhile, Jim Womack's paper <Lean consumption> shows that lean and mean team can create innovation more effectively using their first floor customer contact team (CCT), such as Tesco in UK. In my research, I have already found those cases that combine lean and agile principles together in British new technology-based firms, Like BT and Tesco. Based on previous survey results show that hybrid lean organisation is able to create innovation more effectively than solo lean organisation. Also Ted Goranson's four types of virtual agile enterprise (Type 3 VE includes lean principles) support my test results.

This agile matrices have been used to measure the agility from social cultural infrastructure, legal/Explicit infrastructure and physical infrastructure to support the best decision-making. Recall my research objective is to analysis to what extent HITOP leagile organization will combine lean and agile organization merits to achieve optimal innovation and technology management. I will compare lean innovation implementation matrices with Ted Goranson's agile measuring matrices.

Through comparing lean and agile measuring matrix, I find they have one thing in common, the best lean and agile decision-making all rely on highly integrated technology, organisation and people. Lean measuring matrix using socio-technical system and utilizing multi-skilled workers, while agile measuring matrix using social culture infrastructure and human collaboration with virtual enterprise technology. Thus I conclude HITOP method can combine lean and agile measuring matrices to create a new leagile organisation in the future.

Discuss question 4:

An international survey (Clegg 2002) of modern manufacturing practices shows that the UK lagged significantly behind Australian, Switzerland and Japan on the uptake of best practices and report less effectiveness with them. They also report less planned future investments in best practice. Survey evidence (EEF/NOP productivity survey 2001) shows that US and EU owned firms operating in the UK are more likely to adopt lean manufacturing methods than their UK peers. However, research carried out by UK Warwick University shows that lean practices in European have lots of disadvantages. Does UK company should adopt lean or not? Why lean and agile principles are reluctant to be adopted in British new technology-based firms (NTBFs)?

Discussion:

From the above survey data, I can see that UK lean and agile best practices are lower than their peers from US and Other EU countries. In my research, I have already found the reason behind the fact. Firstly I use Ted Goranson's VE agility measuring metrics measure the agility among lean, agile and TQM/JIT practices firms in UK, USA and Japan. I find that leagile organisation needs highly integrated technology, organisation and people (HITOP). Secondly, I use HITOP Model find the boundary among Lean and agile and TQM/JIT/CIM practices, I find that leagile organisation can bring new competitive advantages through combing the merits between lean and agile principles in British NTBFs, because the test data from those best factory award winner firms in UK support my test results.

5.3: THE SIGNIFICANCE AND CONTRIBUTIONS OF THE RESULTS

This study provided several significant contributions to the body of knowledge. (1) It produced a HITOP framework for addressing the concept of leagile within structure of traditional and validated principles of organisation theory, such as joint technology and organisation design. These principles were then applied to achieve one of the first empirical studies of the leagile organisation. Prior to my research, publications and discussion of the agile company were developed primarily within the context of anecdotal data that had little, if any, validation

through empirical research. In my research, I pioneer use HITOP leagile organisation in British new technology-based firms.

(2) It demonstrates the existence of reciprocal relationships between lean and agile organisation, mainly focus on innovation and technology management. in my research, I compare the innovation and technology management between lean and agile practices in British new technology-based firms (NTBFs).

(3) HITOP leagile organisation model is more likely that it clusters in a group between the top industrial performers. In this research, I mainly focus on HITOP leagile organisation's innovation and technology management analysis and find the reasons that British NTBFs are reluctant to adopt lean and agile principles, because HITOP model needs highly integrated technology and organisation and people to obtain the new business competitive advantages through innovation and technology management.

In sum, my research finding includes:

1: HITOP leagile organization brings a new academic concept to integrate Lean and agile organizations through highly integrated technology, organization and people.

2: It brings a new mid-range social-technical organization theory to tradeoff lean and agile practices focusing on innovation and technology management.

3: HITOP five enablers can build the backbone of future leagile organization in British new technology-based firms.

4: HITOP leagile organization design contribute both academic and industry emergency need, especially for those new technology-based firms to transfer to lean and agile organization in the future.

However, this new leagile organization is a knowledge-based system that means it need continue absorbing the expert opinions from best lean and agile practice across different industry sectors from Japan, Europe and USA in the future. The final test of this leagile organization should base on the following criteria:

1: leagile organization can help lean and agile organization reach the best innovation and technology management.

2: leagile organization can help new technology firms transfer to lean and agile practices more efficiently and effectively even under the hostile-environment circumstance.

3: leagile organization can create a knowledge based organization structure to solve the conflict between organization, people and technology.

HITOP leagile model academic and industrial implications:

The significant contribution of this research for the academic research includes finding the literature gaps between lean and agile relationship on innovation and technology management, then using HITOP leagile organization model fill in these gaps from both theoretical level and operation level, because this HITOP leagile organization model is a knowledge-based system which will continue improving through absorbing lean and agile best practices in Japan, UK and USA.

The significant contribution of this research for industry includes designing the five HITOP leagile enablers and testing them in British new technology-based firms, the statistical results show that they have significant correlated with innovation and technology management. Also from the real operation practices point of view, it make sense that highly integrated technology, organization and people can bring the optimal organization integration solution for those British new-technology based firms

5.4: RECOMMENDATION AND LIMITATIONS

The limitation of this research includes the following items:

1: In this research, I only focus on lean and agile relationship on innovation and technology management for those British new technology-based firms and design a HITOP leagile organization with five HITOP enablers. However, lean and agile relationship is very comprehensive, the same as innovation and technology management research, maybe in the future, more advanced theories will replace current popular socio-technology system (STS) theory, then HITOP leagile organization will need more solid theoretical ground to support.

2: In this research, I only find limited lean and agile measure methods, one is Arizona University's multi-echelon inventory theory for lean system analysis, another one is Ted Goranson's agility measuring metric. However, in the future, more and more advanced lean and agile organization performance measure methods will be developed, maybe this five HITOP leagile enablers' test need redefined by those new lean and agile measure methods.

3: In this research, I only focus on those British new technology-based firms, because I assume that innovation and technology management is the key for their future business contest, and they are new organization easy to adopt modern advanced lean and agile practices. However, many fortune 500 companies are also adopted lean and agile practices, maybe this five HITOP leagile enablers test will bring different results from those well-organized fortune 500 companies than those British new technology based firms. Actually, it is much better for HITOP leagile organization test through comparing those different test results, but due to the time limit, I have not yet started it.

4: In this research, I only choose DEA method to measure the lean, agile and leagile organisation performance, because DEA is current most popular organisation efficiency measuring method and its malmquist index is suitable for the multi-input and multi-output data resource, such as innovation and technology management.

However, innovation and technology management has no standard measure method so far, the same as lean and agile and leagile organisation measuring method. Maybe in the future, more standard measure methods have been developed, HITOP leagile organisation performance will be measured more accurately.

In spite of the above limitations, this research has pioneer designed the HITOP leagile organisation with five HITOP enablers for those British new technology-based firms through consolidating current most popular socio-technology system (STS) theory and state-of-art DEA measuring method comparing lean, agile and leagile organisation performance. Recall the lean production development, in 1990 Jame Womack's < the machine that changes the world>, now lean production has evolved from lean manufacturing to lean enterprise, lean consumption, future lean research will broad to lean and green relationship, lean design, lean accounting and financial management. It is very possible for leagile organisation in real operation practices. My idea on leagile organisation is a knowledge-based system, it will continue improvement through absorbing best lean and agile practices in Japan, UK and USA.

5.5: DIRECTIONS FOR FUTURE RESEARCH

(1) The role of lean and agile relationships:

The role of lean and agile relationships is very import issue for future research, because it is the backbone of leagile organisation design for innovation and technology management. Recently research on next generation lean thinking (Michael 2006) states that production life cycle management will drive next generation lean thinking. His point is lean innovation should include green design, green manufacturing and recycle/reuse all those steps of product life cycle management in the closed-loop lean and green supply chain management. In this way lean thinking is not just eliminating waste on manufacturing process, now lean innovation can create more income revenue through green design and service together with its cutting waste merits. Meanwhile MIT lean Aerospace initial model (Nightingale 2002) describes that integrated closed-loop lean control will likely be closed link with sustainable lean transformation. In this sense, Loughborough university Manufacturing organization research group's postpone management (Yang 2005) will solve the decouple relationship between lean and agile relationship in this closed-loop control.

However, lean and agile relationship is very complex. Some argue that agile is logical evolution of lean. Such as Ted Goreanson's four type virtual enterprise model, lean only works on type 2 and type 3 steady-state process, when hostile business environment is coming, only type 4 agile enterprise will survive. Some argue that lean and agile practices is conflict in real world manufacturing practices, that is why Postpone management is becoming popular strategy recently. On the other hand, many scholars bring the ideas like combining the merits of lean and agile principles, for instance, lean optimises processes and agility optimises the ability to adapt processes to new conditions. In my research, I try to combine the merits of lean and agile principles on innovation and technology management.

In my research, I find both lean and agile principles can create innovation and technology management with real world case studies. Also many British firms have already adopted both lean and agile practices at the same time, like BT and Tesco. Their experience shows that synergy lean and agile principles will lead to optimal leagile innovation practices. Base on this initial idea, I find lean and agile innovation and technology management share the same organisation theory, mid-

range socio-technical theory. The basic idea of this theory is highly integrated technology, organisation and people (HITOP). This I design five HITOP leagile enablers and test them from those best factory award winner firms in Japan, Europe and USA. Through survey data analysis, I find leagile HITOP model can transfer traditional organisation to new leagile organisation to overcome four traditional organisation boundaries: horizontal, vertical, external and geographical barriers. Also it dramatically improve those best award firms organisation performances through four success factors: speed, flexibility, innovation and integration. Finally, comparing lean, agile and leagile organisation performance using DEA method also shows that leagile organisation will more likely to survive in uncertain business hostile environment through combining the merits of lean and agile on innovation and technology management.

However, future lean and agile relationship research need explore the whole picture of leagile practices in the closed-loop supply chain. It should not only focus on special industry sectors, like automobile or aerospace, it should spread from tier 1 supply design to tier 2 assembly to tier 3 service and tier 4 recycle and reuse. But the principle of HITOP need keep in mind at all the level organisations.

(2) Bridge the gap between leagile organisation performance and HITOP measurement method.

Form past literature survey, I find there is no enough empirical evidence to support leagile organisation design. In order to fill in this gap, I design five HITOP enablers to measure the leagile organisation performance in British new technology-based firms. The result shows that five HITOP enablers have strong connection with leagile organisation practices. Then I compare lean, agile and leagile organisation performance using DEA method, the statistical result shows that lean organisation bring a perfect platform for agile and leagile organisation innovation practices and leagile organisation can combine the merits of lean and agile principle to survive in hostile uncertainty business contest environment.

However, there is no standard measure method for lean and agile organisation performance measurement, I choose Arizona university's lean multi-echelon inventory theory and lean enterprise's lean innovation implementation matrix as

reference methods. Also I choose Ted Goranson's agile enterprise measure matrix and US agile virtual enterprise reference model as reference methods. Probably in the future, more and more lean and agile measurement matrix will be designed, focus on leagile organisation innovation implementation plan, agility measurement, lean performance measurement, but one thing is in common, lean and agile is the ability to adopt organisation change in the future business contest, thus leagile organisation performance measurement will focus on how to combine the merits of lean and agile principles to successful transfer traditional organisation to future leagile organisation under hostile and uncertain business contest environment.

Finally, HITOP is the key to address the combination of lean and agile organisation performance measurement. Past research shows that Ted Goranson's agility virtual enterprise metric measures the agility through social/ legal/ physical infrastructure to support operation decision. In other words, VE agility measurement method includes social, technical and people issues. Also lean enterprise address social, technical and people issues can be used to measure the lean innovation performance. For example, lean innovation implementation plan. However, lean and agile enterprise measurement is still lack of standard measure methods. people try to measure lean and agile enterprise innovation and technology management through holistic measure method, for example, highly integrated technology, organization and people, it make senses at the qualitative stage, but future research need carry on more quantitative measurement methods, in other words, more leagile toolkits need design to support lean and agile enterprise innovation and technology management. In this research, I try to use recently most popular organization efficiency measurement method: Data envelopment analysis, because its merits include multi-input and multi-output analysis complex organization performance efficiency. In the future, more organisation measurement statistic tools need developed to measure leagile organisation performance.

(3) Design a mid-range socio-technical theory for HITOP leagile organisation.

Design a new organisation theory to support leagile organisation design is very important for future research. Because traditional contingency organisation theory (Woodward 1965) cannot satisfy modern hostile business contest environment, but

its principles, such as joint technology and organisation design, flexible organisation structure and innovation strategy still can support future leagile organisation design. On the other hand, lean and agile practices are born from modern industry practices. So far, lean and agile practices have been successfully adopted by manufacturing, service industry and financial and accounting management. But the weakest link is lean and agile principles are coming from real-world practices and lack of solid theoretical background. The trouble is it cannot be well-defined and measurement, imagine, totally 40% US companies now announced that they are using lean and agile practices, only 10% firms accept lean and agile practices bring dramatically improvement for their business. How about those non-lean and agile practices firms, especially those new technology-based firms, how can they successful transfer to those 10% lean and agile benefit firms without making same mistakes as those non-profit lean and agile practices firms?

In order to design a new organisation theory for lean and agile organisations through consolidating traditional organisation theory merits, Majchrzak (2004) presents a new mid-range socio-technical theory (STS) design to abridge the gaps between traditional contingency organisation theory and current advanced lean and agile practices. The main idea is highly integrated technology, organisation and people (HITOP) to build a socio-technical theory (STS). Past literature review shows that lean and agile innovation and technology management are all rely on this STS theory. The question is how to in-depth analysis to what extent this new STS theory will influence lean and agile practices in the future real-world business contest. Modern organisation scholars recommend organisation structure and strategy research should be carried on in parallel directions. Modern organisation strategy is based on four success factors: speed, flexibility, innovation and integration. And modern organisation structure is based on overcoming four traditional boundaries: horizontal, vertical, external and geographic boundaries. Future leagile organisation theory should focus on design a boundaryless organisation theory with success organisation strategy and dynamic organisation structures. However, leagile organisation is not the only way for boundaryless organisation design, in my opinion, it should be treated as a knowledge-based system, through combining traditional organisation theory and best advanced lean and agile practices in the future business competition.

5.6: Summary

In chapter five, I discuss the HITOP leagile organisation application in British new technology-based firms. From statistical test results, HITOP five enablers are significant connected with British new technology-based firms' innovation and technology management. From theoretical point of view, HITOP leagile organization can create a socio-technology system (STS) to support both lean and agile innovation and technology management. From real-world operation point of view, HITOP model has been used in Fortune 500 companies, such as Boeing, GM, Texas instrument. Because it is a knowledge-based expert system, it will continue absorbing the knowledge from both lean and agile best practices, thus this HITOP leagile organisation is more dynamic and flexible for those new technology-based firms due to the uncertainty operation environment.

However, HITOP leagile organisation is a concept model, even at academic level, it still need more research on many fields, such as organisation strategy, structure, supply chain management, reliability. In other words, it still need continuing improvement with lean and agile organisation together in the future.

CHAPTER SIX: CONCLUSION

Introduction:

In chapter six, I present the overall conclusion of this research. It includes the significant contribution of this research for both academic and industry, the limitation of this research and how to improve it in the future research.

Overall conclusion:

This research first find three literature gaps between lean and agile relationships:

1: Both lean and agile innovation and technology management share the same socio-technology system (STS) theory, but leagile organisation concept has not yet existed in both academic research and real industry operation management.

2: Both lean and agile research have been carried on in parallel direction, lean solution is based on lean principles and agile virtual enterprises focus on virtual information technology, but both of them are lack of standard measuring methods, even many scholars begin to analysis lean system using multi-echelon inventory theory and analysis agility using Ted Goranson's agility measure metric which are still exist at academic research level.

3: Both lean and agile principles has been adopted in UK, such as BT and Tesco, the question is which one can bring optimal organization performance on innovation and technology management, lean, agile or leagile organisation? How to compare their organisation performance?

Based on above literature gaps, I bring the following research hypotheses:

1: Since lean and agile relationship base on the same socio-technical system (STS) theory, it is possible to combine lean and agile into a leagile organization model under the more broad operation environment—both hostile and normal operation environment.

2: HITOP leagile organisation can satisfy the need of innovation and technology management for British new technology-based firms.

3: lean ,agile and leagile manufacturing organisation performance can be compared using innovation and technology management as the measure index.

Thus, the aim and objectives of this research has been made based on the above research hypotheses:

1: lean and agile relationships may provide a key way for modern manufacturing organisation to influence its innovation and technology management.

2: At the new technology-based firm level, this new leagile manufacturing system is a major contributor to the innovation and technology management through combining the merits of lean and agile manufacturing organisations.
3: HITOP leagile model and its five enablers are known to support the innovation and technology management in British new technology-based firms.

In order to test the five HITOP leagile enablers on innovation and technology management from those new technology-based firms, I choose Harvard university's boundaryless organisation performance survey questionnaires and send them to those best factory award winners firms in UK,Japan and USA. Quantitative survey data analysis results indicate that five HITOP leagile enablers are significantly related with innovation and technology management for those new technology-based firms. Meanwhile, qualitative survey results indicate that HITOP leagile concept is suitable for those new technology-based firms, because innovation and technology management is the key for their future business contest, on the other hand, they need adopt advanced manufacturing practices, such as lean and agile practices, but they are lack of well-organised organisation structure like those matured Fortune 500 companies, thus highly integrated technology, organisation and people is one of the optimal organisation integration solution for them, even with limited financial support budget under uncertainty extern operation environment.

Through comparing lean, agile and leagile organisation performance using DEA method, I find lean organization can create a perfect platform to integrate agile organization, from statistical graph, lean organization policy plot builds a frontline to cover agile and leagile organization. However, agile organization performance is more dynamic and flexible due to the ability to respond successfully to change in their hostile-dynamic environments. Meanwhile, leagile organization performance is in the middle of lean and agile organization and it relies more heavily on responsive manufacturing process and interactive communication process within the organization than either lean or agile organization, in other words, leagile organization should be highly integrated their technology, organization and people (HITOP) for more effective innovation and technology management.

The significant contribution of this research for the academic research includes finding the literature gaps between lean and agile relationship on innovation and

technology management, then using HITOP leagile organization model fill in these gaps from both theoretical level and operation level, because this HITOP leagile organization model is a knowledge-based system which will continue improving through absorbing lean and agile best practices in Japan, UK and USA.

The significant contribution of this research for industry includes designing the five HITOP leagile enablers and testing them in British new technology-based firms, the statistical results show that they have significant correlated with innovation and technology management. Also from the real operation practices point of view, it make sense that highly integrated technology, organization and people can bring the optimal organization integration solution for those British new-technology based firms.

The limitation of this research includes the following items:

1: In this research, I only focus on lean and agile relationship on innovation and technology management for those British new technology-based firms and design a HITOP leagile organization with five HITOP enablers. However, lean and agile relationship is very comprehensive, the same as innovation and technology management research, maybe in the future, more advanced theories will replace current popular socio-technology system (STS) theory, then HITOP leagile organization will need more solid theoretical ground to support.

2: In this research, I only find limited lean and agile measure methods, one is Arizona university's multi-echelon inventory theory for lean system analysis, another one is Ted Goranson's agility measuring metric. However, in the future, more and more advanced lean and agile organization performance measure methods will be developed, maybe this five HITOP leagile enablers' test need redefined by new lean and agile measure methods.

3: In this research, I only focus on those British new technology-based firms, because I assume that innovation and technology management is the key for their future business contest, and they are new organization easy to adopt modern advanced lean and agile practices. However, many fortune 500 companies are also adopted lean and agile practices, maybe this five HITOP leagile enablers test will bring different results from those well-organized fortune 500 companies than those British new technology based firms. Actually, it is much better for HITOP leagile organization test through comparing those different test results, but due to the time limit, I have not yet started it.

4: In this research, I only choose DEA method to measure the lean, agile and leagile organisation performance, because DEA is current most popular organisation efficiency measuring method and its malmquist index is suitable for the multi-input and multi-output data resource, such as innovation and technology management.

However, innovation and technology management has no standard measure method so far, the same as lean and agile and leagile organisation measuring method. Maybe in the future, more standard measure methods have been developed, HITOP leagile organisation performance will be measured more accurately.

In spite of the above limitations, this research has pioneer designed the HITOP leagile organisation with five HITOP enablers for those British new technology-based firms through consolidating current most popular socio-technology system (STS) theory and state-of-art DEA measuring method comparing lean, agile and leagile organisation performance. Recall the lean production development, in 1990 Jame Womack's < the machine that changes the world>, now lean production has evolved from lean manufacturing to lean enterprise, lean consumption, future lean research will broad to lean and green relationship, lean design, lean accounting and financial management. It is very possible for leagile organisation in real operation practices. My idea on leagile organisation is a knowledge-based system, it will continue improvement through absorbing best lean and agile practices in Japan, UK and USA.

In future, for a firm's long-term success it will be much more important to be leagile than it is at present (Oleson 1998). That means not only the capability to react quickly and flexible to change in technology and market but also to be the starting point of changes in technology and markets. These requirements can only be achieved by implementing innovative organisational structures (Gunneson 1997). One concept in this context is the approach of lean and agile principles of innovation management. Lean and agile principles combinations are able to overcome existing barriers. These barriers lead companies to a more static situation, where they are not able to react to future challenges. That means that barriers against innovations are similar to those against lean and agility in organisation. The research on innovation management developed two basic

concepts for overcoming these barriers: the HITOP model and the leagile boundryless organisation concept.

Until now, no attempt has been made in the literature to integrate lean and agile principles using HITOP mode linked with a specific innovative project in NTBFs firms. In this article, we have attempted this by applying a dynamic point of view. In particular, when a series of innovation projects is observed, it becomes evident that the performance of HITOP method makes it possible to build a leagile boundaryless organisation in NTBFs firms.

It must be point out, however, that empirical findings of this leagile boundaryless organisation with regard to the characteristics of HITOP method are still relative vague, despite the larger number of studies which have been carried out. Only when more results are available, which refer not just to one individual project but to a series of projects, will it be possible to proceed to make organisation recommendations for innovation management. For example, the boundary between lean and agile organisation, TQM and CIM organisation are still very deep. How to break this function mind still have a long way to go, because HITOP method is knowledge based system, it still need more experts from organisation science, information technology to understand this enterprise integration (EI) concept in depth. This would be a further step along the road to developing rules for institutionalised innovation management as a key factor of success for leagile boundaryless organisation.

Innovation and technology management is a challenge for those British new technology based firms, because controlling an innovation process is different with controlling a steady-state production process, such as the time dimension, the system boundaries, the amount of routinization and the amount of uncertainty. Thus modern operation management are considering 'organisational solutions' to this new challenge, using organisation integration solutions, in other words, highly integrated technology, organisation and people and build a mid-range social-technology system.

This thesis also examines lean and agile organisation innovation and technology management issues, to what extent combining lean and agile organisation through HITOP leagile organisation can obtain the optimal innovation and technology management in those British new technology based firms. This is also the aim of my research. Through carefully examining the best

factory award winners survey reply from Japan, UK and USA, I find lean organisation can build a perfect platform to integrate agile organisation, and leagile organisation can combine the merits of lean and agile organisation through HITOP method. For instance, lean and agile measuring matrices are all measuring technology change, social culture change, people attitude change to support best operation decision making.

However, from literature review and my survey questionnaires reply, I find pure leagile organisation only exists in academic concept, many companies prefer call themselves lean and agile organisation. Thus my question is what kind of theory of constraint that influences this leagile organisation in the real world practice? The question is also for management scholars and CEO, how best to apply this new HITOP leagile organisation in real world business contest? In my opinion, one path is the development of metrics and study that can make such translations more accessible to employees and managers. A second path, however, is develop new models of organisation and the contexts need to support them, in which lean and agile relationship can combine together to obtain the optimal innovation and technology management goal.

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APPENDIX 1: SURVEY QUESTIONNAIRES AND COVERING LETTER

THE COVERING LETTER

Mr YiYang Zhang

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Nottingham, England, UK

Post code: NG7 2PG

April, 2005

_____ Company Human Resource Department
_____ Street
_____ City
_____ UK
Post Code: _____

Dear Sir or Madam:

In my opinion, Manufacturing Organisation is the key for the success of next generation business contest. based on Manufacturing Organisation Integration Hypothesis from Harvard business school, MIT Sloan management school and Oxford University pioneer Journal "Industrial and Corporate change", Our Manufacturing research group in Nottingham want to design a new boundaryless Manufacturing Organisation model by combining the merits of both lean and agile manufacturing systems through 'HITOP' method –highly integrated technology, organisation and people in new technology-based firms in UK. Please fill in the following survey questionnaires, I promise send back this survey result to your company as soon as possible after we analysis this survey data.

Finally, we will be very grateful for your help and appreciate for your co-operation.

Sincerely yours

YIYANG ZHANG

SURVEY QUESTIONNAIRES

Questionnaire#1: How Boundaryless Is Your Organisation?

Instructions: The following sixteen statements describe the behaviour of boundaryless organisations. Assess the extent to which each statement characterises your current organisation, circling a number from1 (not true at all) to 5(very true).

	Speed	Flexibility	Integration	Innovation	Total Score
Vertical boundary	Most decisions are made on the spot by those closest to the work, and they are acted on in hours rather than weeks. 1 2 3 4 5	Mangers at all levels routinely take on frontline responsibilities as well as board strategic assignments. 1 2 3 4 5	Key problems are tackled by multilevel teams whose members operate with little regard to formal rank in the organisation. 1 2 3 4 5	New ideas are screened and decided on without fancy overheads and multiple rounds of approvals. 1 2 3 4 5	
Horizontal boundary	New products or services are getting to market at an increasingly fast pace. 1 2 3 4 5	Resources quickly, frequently, and effortlessly shift between centres of expertise and operating units. 1 2 3 4 5	Routine work gets done through end-to-end process teams; other work is handled by project teams drawn from shared centres of experience. 1 2 3 4 5	Ad hoc teams representing various stakeholders spontaneously form to explore new ideas. 1 2 3 4 5	
External boundary	Customer requests, complaints, and needs are anticipated and responded to in real time. 1 2 3 4 5	Strategic resources and key managers are often "on loan" to customers and suppliers. 1 2 3 4 5	Supplier and customer reps are key players in teams tackling strategic initiatives. 1 2 3 4 5	Suppliers and customers are regular and prolific contributors of new product and process ideas. 1 2 3 4 5	
Geographic boundary	Best practices are disseminated and leveraged quickly across country operations. 1 2 3 4 5	Business leaders rotate regularly between country operations. 1 2 3 4 5	There are standard product platforms, common practices, and shared centre of experience across countries. 1 2 3 4 5	New product ideas are evaluated for viability beyond the country where they emerged. 1 2 3 4 5	
Total score					

Questionnaire#2: How Healthy Is Your organisation's Hierarchy?

Part1: Success Factors.

Instructions: Determine how critical the four new paradigm success factors are in your organisation, circling High, Medium, or Low for each factor.

1. Speed.	High	Medium	low.
2. Flexibility.	High	Medium	low
3.Integration.	High	Medium	low
4.Innovation.	High	Medium	low

Part 2: Red Flags

Instructions: Evaluate how often the following five danger signs appear in your organisation, circling a number from 1(too often) to 10 (seldom).

	Too often								Sometimes	Seldom
1.Slow response time.	1	2	3	4	5	6	7	8	9	10
2.Rigidity to change.	1	2	3	4	5	6	7	8	9	10
3. Underground activity.	1	2	3	4	5	6	7	8	9	10
4.Internal employee frustration.	1	2	3	4	5	6	7	8	9	10
5.Customer alienation.	1	2	3	4	5	6	7	8	9	10

Part3: Profile of Vertical Boundaries.

Instructions: Assess where your company stands today on the four dimensions of information, authority, competence, and rewards, circling a number from 1 (traditional) to 10 (healthy).

Traditional Hierarchy		Healthy Hierarchy
Information closely widely held at top.	1 2 3 4 5 6 7 8 9 10	Information shared
Authority to make Decisions centralised distributed to the top.	1 2 3 4 5 6 7 8 9 10	Authority to make decisions wherever appropriate
Competence specialised widespread And focused—people do one job.	1 2 3 4 5 6 7 8 9 10	Competence -- people do Multiple tasks as needs
Rewards based on position.	1 2 3 4 5 6 7 8 9 10	Rewards based on skills and accomplishments

Questionnaire#3: How Congruent Are Your Organisation's Horizontal Boundaries?

Part1: Map Relationships

Instructions: In the space below, identify five or more functional disciplines or specialities that exists as different units in your organisation.

Now use the following table to note the ways in which these units contribute to key customers and collaborate with each other. This will produce an informal map of the horizontal groups in your organisation.

Operation model	Organisational Unit	Professional Disciplines in the Unit	Extent of collaboration with other functions (High, Medium, Low)	Contributions to Customers	Effectiveness of the Function as viewed by the customer (High, Medium, Low)
TQM/JIT					
Lean six sigma					
AGILE					
CIM					
Others					

Part 2: Identify Warning signs

Instructions: Assess your organisation on the following warning signs of haywire horizontal boundaries. Use the scale next to each statement to indicate the extent to which the statement characterise your organisation's behaviour, circling a number from 1 (not true at all) to 5 (very true). Also, make a note of an example that supports your assessment.

	NOT True at all				Very true
Organisational processes tend to be slow and sequential instead of fast and parallel.	1	2	3	4	5
Functional groups are more concerned with Protecting their turf than with serving the customer.	1	2	3	4	5
3. Functional groups and disciplines place greater Priority on meeting their own functional goals than On contributing to overall organisational achievements	1	2	3	4	5
4. Functional groups and disciplines regard each other with suspicion, blame each other for problems, and operate as though the enemy is within the organisation.	1	2	3	4	5
5. The customer needs to integrate our products and services.	1	2	3	4	5
6. Our organisation tends to swing back and forth between centralisation and decentralisation every few years.	1	2	3	4	5

Part 3: Assess Horizontal Harmony

Instructions: Identify the extent to which your organisation applies the five principles for creating horizontal harmony. Use the scale next to each statement to indicate the extent to which the statement

Characterises your organisation's behaviour, circling a number from 1 (not true at all) to 5 (very true).

	NOT True at all				Very true
1. The focus on attention is always on the customer.	1	2	3	4	5
2. The customer has a single point of contact with our organisation.	1	2	3	4	5
3.We form and re-form teams to serve the customer	1	2	3	4	5
4.We have an extensive pool of competence that we can draw upon for customer teams—and we keep that pool refreshed.	1	2	3	4	5
5.We have active and robust processes for sharing learning across customer teams and across functions.	1	2	3	4	5

Questionnaire#4: How Well Linked Is your organisation's Value Chain?

Instructions: Diagnose your company's progress toward a boundaryless relationship with customers and/or suppliers in your value train. Select a strategically important customer/supplier (or category of customer/supplier) in your value chain. Circle a number on each scale to reflect where your customer/supplier relationship now stands.

	Traditional									Boundaryless
1. Strategies/operating plans	Developed independently.					Shared. Coordinated				Developed jointly
• Marketing plans	1	2	3	4	5	6	7	8	9	10
• Product development plans	1	2	3	4	5	6	7	8	9	10
• Production/Inventory planning	1	2	3	4	5	6	7	8	9	10
• Distribution/Transportation planning	1	2	3	4	5	6	7	8	9	10
• Information systems planning	1	2	3	4	5	6	7	8	9	10
2. Information sharing/problem solving	Highly guarded			Selective sharing as needed.			Joint sharing/ Problem Solving.			Integrated data systems/ processes on common issues
• Cost structure	1	2	3	4	5	6	7	8	9	10
• Profit Margins	1	2	3	4	5	6	7	8	9	10
• Quality/Production problems	1	2	3	4	5	6	7	8	9	10
• Problem-solving methods	1	2	3	4	5	6	7	8	9	10
• Market information/feedback	1	2	3	4	5	6	7	8	9	10
3. Accounting, measurement, and reward systems	Related			Understood but unconnected			Consistent but separate			Interconnected
• Accounting Procedures	1	2	3	4	5	6	7	8	9	10
• Quality measures	1	2	3	4	5	6	7	8	9	10
• Costing systems	1	2	3	4	5	6	7	8	9	10
• Rewards and incentives	1	2	3	4	5	6	7	8	9	10
• Communication processes	1	2	3	4	5	6	7	8	9	10
4. Sales processes	Independent/ differing views			Selective Collaboration			Two-way understanding			Consultative partnership
• Establish sales goals/quotas	1	2	3	4	5	6	7	8	9	10
• Assessing customer needs	1	2	3	4	5	6	7	8	9	10
• Determining optimal product usage	1	2	3	4	5	6	7	8	9	10
• Providing product feedback	1	2	3	4	5	6	7	8	9	10
• Setting terms of the deal	1	2	3	4	5	6	7	8	9	10
5. Resources/Skills	Separate			Called upon In emergency			Transfer of knowledge			Shared resources/ co-located
• Technical expertise	1	2	3	4	5	6	7	8	9	10
• Financial expertise	1	2	3	4	5	6	7	8	9	10
• organisational/Management skills	1	2	3	4	5	6	7	8	9	10
• Information systems	1	2	3	4	5	6	7	8	9	10
• Training	1	2	3	4	5	6	7	8	9	10

Questionnaire#5: How Far along the Path to globalisation or world-class is your organisation?

Instruction: Assess your organisation's efforts to remove global boundaries and operate across space, time, and nationality. Use the scale to indicate the extent to which each of the following statements characterises your organisation, circling a number from 1 (not true at all) to 5 (very true).

	NOT True at all				Very true
1. Managers in our company have a global outlook.	1	2	3	4	5
2. Mangers in our company speak more than one language.	1	2	3	4	5
3. We have managers responsible for global products, Services, or customers.	1	2	3	4	5
4. We communicate well across borders.	1	2	3	4	5
5. We respect cultural differences in management styles.	1	2	3	4	5
6. Top management constantly stresses its desire to Become a global competitor.	1	2	3	4	5
7. We routinely engage in cross-border task forces on projects.	1	2	3	4	5
8. Top management's calendars (daily schedules) reflect their commitment to globalisation.	1	2	3	4	5
9. Training programs include significant exposure to global issue.	1	2	3	4	5
10. Leadership positions in our company include people from culturally diverse backgrounds.	1	2	3	4	5
11. Accepting international assignments is a stepping stone to future success.	1	2	3	4	5
12. Information about global competitors and customers is well known throughout the company.	1	2	3	4	5
13. Travel budgets enable us to take necessary international trips.	1	2	3	4	5

14.Our structure allows us to operate seamlessly across borders.	1	2	3	4	5
15. Our customers recognise our ability to operate across borders.	1	2	3	4	5
16. We operate across borders significantly better than our competitors.	1	2	3	4	5
17. We recruit in places where "globally minded" candidates can be easily found.	1	2	3	4	5
18. We have many examples of culturally diverse teams.	1	2	3	4	5
19. Our culturally diverse teams generally work together in a way that the whole is greater than the sum of the parts.	1	2	3	4	5
20. Other companies have, or could, benchmark our efforts to remove geographic boundaries.	1	2	3	4	5
21.Other companies have, or could, benchmark our efforts to remove operation management boundaries (lean,agile,TQM,JIT,CIM,sixsigma,other)	1	2	3	4	5

Questionnaire#6: How to build a boundaryless leadership In Your organisation?

Instructions: On each 1 to 10 scale, place an O where you think you need to be, or want to be, to move your organisation forward into the twenty-first century. Then place an X where you think you currently are on the scale. The difference between the two scores (O-X) is your gap score.

1. Leadership to break down vertical boundaries Gap Score (O-X)

You and your senior management team make most decisions.	1 2 3 4 5 6 7 8 9 10	Most decisions are made close to the action.	_____
You hold information close to the vest—and promote a need-to-know Approach to information sharing.	1 2 3 4 5 6 7 8 9 10	You share information about overall performance and business strategy with as broad a base of constituents as possible.	_____
Your recognition and reward system is based solely on individual contributions.	1 2 3 4 5 6 7 8 9 10	Your recognition and reward system is primarily team based.	_____

2. Leadership to break down Horizontal boundaries Gap Score (O-X)

Your people have narrowly defined roles, responsibilities, and skills.	1 2 3 4 5 6 7 8 9 10	You encourage people to develop multiple skills—so everyone feels ready to do what it takes to get the job done.	____
You have clear functional agendas that determine the way things get done and the pace of implementation.	1 2 3 4 5 6 7 8 9 10	You ensure everyone is focused on shared goals, across functions.	____
You have put in place strong controls—with multiple hand-offs and sign-offs—to get work done effectively.	1 2 3 4 5 6 7 8 9 10	You push for integrated end-to-end processes with a single point of accountability to get work done—streamlined, efficient, and value-added every step of the way.	____

3. Leadership to break down internal boundaries Gap Score (O-X)

You and your senior management team focus most of your attention on your own company's current performance.	1 2 3 4 5 6 7 8 9 10	You are focused primarily on maximizing value to the end-user.	____
You encourage a tough negotiating approach interacting with customers and suppliers.	1 2 3 4 5 6 7 8 9 10	You actually seek partnership and relationships of trust with customers and suppliers.	____
You spend a significant portion of your time in internal meetings and in running in-house committees.	1 2 3 4 5 6 7 8 9 10	You spend most of your time with customers, suppliers, and other outside constituents.	____
Your look for new business opportunities solely on the basis of your company's capabilities.	1 2 3 4 5 6 7 8 9 10	You formulate new business in partnership with your customers—based on their needs and changes in their markets.	____

4. Leadership to break down geographic boundaries Gap Score (O-X)

You promote a look-alike culture-hiring and promoting people who look like you.	1 2 3 4 5 6 7 8 9 10	You seek diversity in the people you hire and promote.	_____
To get a shot at the top positions, executives need to "punch their ticket" in a series of domestic positions.	1 2 3 4 5 6 7 8 9 10	Significant international experience is a prerequisite for top positions.	_____
Your try to apply the domestic model for doing business to each international market you are involved in.	1 2 3 4 5 6 7 8 9 10	You always start from the local market conditions and build your business practices around these—taking very little for granted.	_____

5. Overall Leadership to make it happen Gap Score (O-X)

You are preoccupied with task management—constantly trying to explain to your subordinates the steps they need to take.	1 2 3 4 5 6 7 8 9 10	You are focused on results—you clarify expectations about the desired end results and let your people figure out how to get there.	_____
You exercise a command and control model of leadership.	1 2 3 4 5 6 7 8 9 10	You lead through articulating clear goals, then coaching, counselling, and cheerleading people to achieve them.	_____
You prefer to wait for all the analyses, reports, and studies to come in before staking a position about the issues facing the organisation.	1 2 3 4 5 6 7 8 9 10	You are comfortable sketching out a rough-and-ready vision of where the organization needs to go and using actions as a way to test and refine the vision and the overall direction.	_____
You are constantly worried about giving people more than they can handle—considering everything else on their plate.	1 2 3 4 5 6 7 8 9 10	You are comfortable putting out exceptional challenges to people—even if you have no clue how people will deliver on them.	_____

You promote a keep-your-head-down policy—one mistake can derail a career.	1 2 3 4 5 6 7 8 9 10	You create an environment in which coming up with and exploring new ideas is encouraged and rewarded.	

APPENDIX 2: SURVEY QUESTIONNAIRES JUSTIFICATION:

USING ONE REPLY FROM UK BEST FACTORY AWARD COMPANIES--STANNAH STAIRLIFT LTD

Why I choose this Harvard business school designed boundaryless organization survey questionnaires?

The reason I choose this survey questionnaire because I want to design a boundaryless leagile manufacturing organizations, thus I need collect first hand real world data from those best innovation award firms in Japan, UK and USA. Another reason I choose this survey questionnaires because it is firstly been designed by Harvard business school <Ron Ashhenas(1998): Building a boundaryless organization: field guide. Jossey-Bass inc. publishing.> they defined four boundaries exist in modern manufacturing organization: vertical boundary and horizontal boundary and external boundary and geography boundary. Also they introduced how to explore these boundaries through highly integrating organization hierarchy, horizontal harmonies, world-class organization leadership building. Actually lean organization is a horizontal organization and agile organization is vertical organization through virtual enterprise design, the question is how to integrated this lean and agile principles and go to optimal leagile organization structure. Another merit of this Harvard business school designed boundaryless organization survey questionnaires are it can analysis the degree of organization boundaries through quantitative calculation and give some useful suggestion to those survey reply companies. I think it is fair for those survey reply companies, they can get some experts opinions on their future organization design.

What did I find from this survey reply?

I can give one example from the UK best factor award company: Stannah stairlift ltd

Questionnaire#1: How Boundaryless Is Your Organisation?

Instructions: The following sixteen statements describe the behaviour of boundaryless organisations. Assess the extent to which each statement characterises your current organisation, circling a number from1 (not true at all) to 5(very true)

	Speed	Flexibility	Integration	Innovation	Total Score
Vertical boundary	Most decisions are made on the spot by those closest to the work, and they are acted on in hours rather than weeks. 1 **3** 4 5	Mangers at all levels routinely take on frontline responsibilities as well as board strategic assignments. 1 2 3 **5**	Key problems are tackled by multilevel teams whose members operate with little regard to formal rank in the organisation. 1 2 **4** 5	New ideas are screened and decided on without fancy overheads and multiple rounds of approvals. 1 2 3 **5**	13
Horizontal boundary	New products or services are getting to market at an increasingly fast pace. **2** 3 4 5	Resources quickly, frequently, and effortlessly shift between centres of expertise and operating units. 1 2 3 **5**	Routine work gets done through end-to-end process teams; other work is handled by project teams drawn from shared centres of experience. 1 2 3 **5**	Ad hoc teams representing various stakeholders spontaneously form to explore new ideas. 1 2 3 4	14
External boundary	Customer requests, complaints, and needs are anticipated and responded to in real time. 1 2 3 4	Strategic resources and key managers are often "on loan" to customers and suppliers. 1 **3** 4 5	Supplier and customer reps are key players in teams tackling strategic initiatives. 1 2 3 **5**	Suppliers and customers are regular and prolific contributors of new product and process ideas. 1 **3** 4 5	13
Geographic boundary	Best practices are disseminated and leveraged quickly across country operations. 1 2 **4** 5	Business leaders rotate regularly between country operations. **2** 3 4 5	There are standard product platforms, common practices, and shared centre of experience across countries. 1 2 **4** 5	New product ideas are evaluated for viability beyond the country where they emerged. 1 2 **4** 5	10
Total score	11	11	14	14	50

Questionnaire Scoring:

1: Column scores represent your organisation's relative achievement of the new success factors. A score of 12 or less on any one factor suggests significant work

may be needed, especially if the factor will be critical in our industry or type of organisation. A score of 16 or higher suggests your organisation already has achieved significant strength in the factor. It will be important to build on that strength. Overall, your score can help you and your colleagues begin to think about the overall urgency for change facing your organisation.

2: Row scores represent your organisation's relative success at achieving permeability of the four boundaries. Again, a score of 12 or less on any one boundary suggests an opportunity for significant improvement, and a score of 16 or higher probably indicates an area of strength.

From questionnaire 1, I find this company has a good overall organization performance (score is 50 out of 80), its organization prefer using innovation and integrating organization strategy, (innovation and integration are high score 14 out of 20), but its flexibility and speed is weak (speed and flexibility score is 11 out of 20). Using its own explain is business leadership rotating frequently and new product or service getting to market at an increasing fast speed which trigger the decision making is not optimal. Thus it has horizontal, vertical, geography and external boundaries. The best way to solve above problem is integrated lean and agile manufacturing. For instance, using lean leadership at all the level operation to solve horizontal and vertical bounaries, using virtual technology solve the geography boundaries, using lean supply chain management consolidate supplier and buyer relationship to solve the external boundaries. In sum, I intend to obtain from question 1 is how many organization boundaries exist in those best factory award companies. Does it make sense that lean and agile principles can solve these organization boundaries?

Questionnaire#2: How Healthy Is Your organisation's Hierarchy?

Part1: Success Factors.

Instructions: Determine how critical the four new paradigm success factors are in your organisation, circling High, Medium, or Low for each factor.

1. Speed.	High	[redacted]	low.
2. Flexibility.	High	[redacted]	low
3.Integration.	[redacted]	Medium	low
4.Innovation.	[redacted]	Medium	low

Part 2: Red Flags

Instructions: Evaluate how often the following five danger signs appear in your organisation, circling a number from 1(too often) to 10 (seldom).

	Too often							Sometimes		Seldom
1.Slow response time.	1	2	3	4	5	6	7	8	9	■
2.Rigidity to change.	1	2	3	4	5	6	7	■	9	10
3. Underground activity.	1	2	3	4	5	6	7	8	■	10
4.Internal employee frustration.	1	2	3	4	5	6	7	■	9	10
5.Customer alienation.	1	2	3	4	5	6	7	8	9	■

Part3: Profile of Vertical Boundaries.

Instructions: Assess where your company stands today on the four dimensions of information, authority, competence, and rewards, circling a number from 1 (traditional) to 10 (healthy).

Traditional Hierarchy		Healthy Hierarchy
Information closely widely held at top.	1 2 3 4 5 6 7 8 9 ■	Information shared
Authority to make Decisions centralised distributed to the top.	1 2 3 4 5 6 7 ■ 9 10	Authority to make decisions wherever appropriate
Competence specialised widespread And focused—people do one job.	1 2 3 4 5 6 ■ 8 9 10	Competence --people do Multiple tasks as needs
Rewards based on position.	1 2 3 4 5 6 7 8 9 ■	Rewards based on skills and accomplishments and market place

Note: Questionnaire#2 will give you a baseline snapshot of your organisation and its hierarchy, use the first two sections to assesses the extent to which your company needs to be driven by the new paradigm success factors and to consider how often the warning signs of dysfunctional hierarchy appear in your organisation or unit. The third section allows you to assess your current vertical boundaries against the four dimensions of the healthy hierarchy in order to produce an organisation profile.

Questionnaire follow-up:

First discuss the following questions:

- How important is it to our organisation's success that we loosen our vertical boundaries? In other words, do we really need to operate faster and more flexibly?
- Are the red flags serious and recurrent? Which ones are most worrisome?
- To what extent is our current vertical profile dragging us down and causing us problems?
- In the current profile of our hierarchy, which dimensions are strongest? Where do we most need to change in order to be more successful?
- What is our desired profile of vertical boundaries? Where would we like to be on each of the four dimensions in the next year or two—that is, what profile do we need to compete successfully now and into the future?

Questionnaire#2 shows that how the loosening of vertical boundaries on four dimensions can create a more healthy hierarchy, that is, a process of authority and decision making that better meets the new success criteria of speed, flexibility, integration, and innovation. In order to create the permeable vertical boundaries that lead to a more healthy hierarchy, we recommend two sets of actions through a systemic process: wiring the system and tuning the system.

- Wiring the system involves putting in place components such as management commitment and alignment between organisational structure and business strategy that are prerequisites for permeable vertical boundaries.
- Turning the system involves calibrating four dimensions to permeate vertical boundaries. (Four dimensions are information, competence, authority, and rewards).

From questionnaire 2, I find this company has a healthy hierarchy, because it fits well with new paradigm success factors: speed, flexibility, integration and innovation and has no many warning red flags. But the weakest link is speed and flexibility due to frustrated decision-making. In my opinion, the best solution for this vertical boundary is highly integrated technology, organization and people

(HITOP) to obtain optimal decision-making in future fast changing manufacturing environment. In sum, I intend to obtain from question 2 is how many organization vertical boundaries exist in those best factory award companies. Does it make sense that HITOP method can solve this organization boundary?

Questionnaire#3: How Congruent Are Your Organisation's Horizontal Boundaries?

Part1: Map Relationships

Instructions: In the space below, identify five or more functional disciplines or specialities that exist as different units in your organisation.

Now use the following table to note the ways in which these units contribute to key customers and collaborate with each other. This will produce an informal map of the horizontal groups in your organisation.

Operation model	Organisational Unit	Professional Disciplines in the Unit	Extent of collaboration with other functions (High, Medium, Low)	Contributions to Customers	Effectiveness of the Function as viewed by the customer (High, Medium, Low)
TQM/JIT	Yes		High		High
Lean six sigma					
AGILE					
CIM					
Others					

Part 2: Identify Warning signs

Instructions: Assess your organisation on the following warning signs of haywire horizontal boundaries. Use the scale next to each statement to indicate the extent to which the statement characterise your organisation's behaviour, circling a number from 1 (not true at all) to 5 (very true). Also, make a note of an example that supports your assessment.

	NOT True at all				Very true
Organisational processes tend to be slow and sequential instead of fast and parallel.	1	2	▮	4	5
Functional groups are more concerned with Protecting their turf than with serving the customer.	▮	2	3	4	5
3. Functional groups and disciplines place greater Priority on meeting their own functional goals than On contributing to overall organisational achievements	1	▮	3	4	5
4. Functional groups and disciplines regard each other with suspicion, blame each other for problems, and operate as though the enemy is within the organisation.	1	▮	3	4	5
5. The customer needs to integrate our products and services.	1	2	3	▮	5
6. Our organisation tends to swing back and forth between centralisation and decentralisation every few years.	1	▮	3	4	5

Part 3: Assess Horizontal Harmony

Instructions: Identify the extent to which your organisation applies the five principles for creating horizontal harmony. Use the scale next to each statement to indicate the extent to which the statement characterises your organisation's behaviour, circling a number from 1 (not true at all) to 5 (very true).

NOT True at all Very true

1. The focus on attention is always on the customer.	1 2 3 4 ▮
2. The customer has a single point of contact with our organisation.	1 2 3 4 ▮
3.We form and re-form teams to serve the customer	1 2 3 4 ▮
4.We have an extensive pool of competence that we can draw upon for customer teams—and we keep that pool refreshed.	1 2 3 ▮ 5
5.We have active and robust processes for sharing learning across customer teams and across functions.	1 2 ▮ 4 5

Note: Questionnaire#3 can help you assess the extent to which such boundaries may be haywire and the extent to which your organisation already has processes to share resources. Part 1 of the questionnaire asks you to map your organisational functions according to importance to key customers and the degree of collaboration with other functions. Part 2 asks you to identify warning sign behaviours in your organisation. Part 3 asks you to identify the degree of horizontal harmony in your organisation.

Questionnaire follow-up:

In order to create boundaryless horizontal organisations, companies must integrate their resources to serve the customer. We provide five specific improve vehicles for facilitating harmonious behaviour across horizontal boundaries.

Improve vehicles for permeating horizontal boundaries:

- Orient work around core processes.
- Trackle processes through targeted teams.
- Turn vertical dimensions (information, competence, authority and rewards) sideways.
- Create shared services for support processes.
- Develop organisational learning capability.

From questionnaire 3, I find this company has harmony horizontal boundaries, because it satisfies the five principles for creating horizontal harmony. But the weakest link is the customer is not highly integrated into its product and service. In my opinion, the best solution for this horizontal boundary is highly integrated technology, organization and people (HITOP) to develop lean learning organization. In other words, lean socio-technology system will lead to more innovation lean practices even in different social culture environment, thus lean organization culture can satisfy different customer requirements in future business contest. In sum, I intend to obtain from question 3 is how many organization horizontal boundaries exist in those best factory award companies. Does it make sense that lean and agile principles can solve this organization boundary? In this case, this company wish to integrate customer into its product and service, lean organization culture can help them achieve this goal, because from the survey reply, I find they still use traditional JIT/TQM management.

Questionnaire#4: How Well Linked Is your organisation's Value Chain?

Instructions: Diagnose your company's progress toward a boundaryless relationship with customers and/or suppliers in your value train. Select a strategically important customer/supplier (or category of customer/supplier) in your value chain. Circle a number on each scale to reflect where your customer/supplier relationship now stands.

	Traditional								Boundaryless
1. Strategies/operating plans	Developed independently.					Shared, Coordinated			Developed jointly
• Marketing plans	1	2	■	4	5	6	7	8	9	10
• Product development plans	1	■	3	4	5	6	7	8	9	10
• Production/Inventory planning	1	2	3	4	■	6	7	8	9	10
• Distribution/Transportation planning	1	2	3	4	■	6	7	8	9	10
• Information systems planning	1	2	3	■	5	6	7	8	9	10
2. Information sharing/problem solving	Highly guarded			Selective sharing as needed.			Joint sharing/ Problem Solving.			Integrated data systems/ processes on common issues
• Cost structure	1	2	■	4	5	6	7	8	9	10
• Profit Margins	1	2	■	4	5	6	7	8	9	10
• Quality/Production problems	1	2	3	4	5	6	■	8	9	10
• Problem-solving methods	1	2	3	4	5	6	■	8	9	10
• Market information/feedback	1	2	3	4	5	6	■	8	9	10

3. Accounting, measurement, and reward systems	Related	Understood but unconnected	Consistent but separate	Interconnected
• Accounting Procedures	1 2 3	4 5 6 7	8 9 10	
• Quality measures	1 2 3 4	5 6 7	8 9 10	
• Costing systems	1 2 3	4 5 6 7	8 9 10	
• Rewards and incentives	1 2 3	4 5 6 7	8 9 10	
• Communication processes	1 2 3 4	5 6 7	8 9 10	

4. Sales processes	Independent/ differing views	Selective Collaboration	Two-way understanding	Consultative partnership
• Establish sales goals/quotas	1 2 3	4 5 6 7	8 9 10	
• Assessing customer needs	1 2 3	4 5 6 7	8 9 10	
• Determining optimal product usage	1 2 3	4 5 6 7	8 9 10	
• Providing product feedback	1 2 3	4 5 6 7	8 9 10	
• Setting terms of the deal	1 2 3 4	5 6 7	8 9 10	

5. Resources/Skills	Separate	Called upon In emergency	Transfer of knowledge	Shared resources/ co-located
• Technical expertise	1 2 3	4 5 6 7	8 9 10	
• Financial expertise	1 2 3	4 5 6 7	8 9 10	
• organisational/Management skills	1 2 3	4 5 6 7	8 9 10	
• Information systems	1 2 3	4 5 6 7	8 9 10	
• Training	1 2 3 4	5 6 7	8 9 10	

Questionnaire scoring:

Score on Value Chain	Appropriate Action
75 or Less	Getting Started Tune into customers and suppliers and figure out where the opportunities are • Arrange customer/supplier cameo appearance. • Take customer/supplier field trips. • Hold open-agenda dialogues with management teams. • Map customer/supplier needs. • Collect customer/supplier data.
75-150 Total score: 135	Building momentum Experiment with collaboration to experience success and learning:

	• Hold customer/supplier town meeting. • Organise cross-value chain task force. • Share technical services. • Teach sales people to be consultants.
Above 150	Sustaining progress Align/integrate systems, structures, and process to sustain gains in the long term. • Integrate information systems • Reconfigure roles and responsibilities.

Questionnaire Follow-up:

First discuss these follow-up questions:

- On which external dimensions have you made the most progress toward a boundaryless relationship? What have you done to make this progress? What has worked particularly well?
- On which dimensions are you lagging the most? Why are they the most difficult? What have your tried and what barriers have you run into?
- How far do you need to move on each continuum to successfully strengthen this part of the value chain and increase your competitive capability? Which dimensions are most critical to your progress? Where do you want to focus your efforts?
- Is the relationship with the chosen supplier or customer representative of your overall situation In your value chain? Are there ways to leverage learning from this relationship elsewhere, or vice versa? Are there more broadly based changes that need to occur?

In order to strength the value chain, we provide the actions for tuning your organisation's performance in relation to its external boundaries are divided into three categories: getting started actions, building momentum actions, and sustaining progress actions.

From questionnaire 4, I find this company's value chain is still in the building momentum (its overall score is 135 out of 150). From above table, I find this company organization has middle level strategy/operation plan and cross value chain operation. But the weakest link is information system has not been used to

highly integrate technical, financial and organizational experts to create a knowledge-based organization. In my opinion, the best solution for this organization value chain problem is to develop agile virtual enterprise information system. In other words, this virtual agile enterprise information system will lead to high value organization value chain through integrating those lean accounting, organization, technology experts for knowledge transfer across the lean organization. In sum, I intend to obtain from question 4 is how many value can be created in organization value chain from those best factory award companies. Does it make sense that lean and agile principles can solve this organization boundary? In this case, this company wish to obtain high value organization integration, agile enterprise information system can help them achieve this goal through highly integrated lean organization experts and technology experts and financial experts across the whole value chain for knowledge transfer in future business contest.

Questionnaire#5: How Far along the Path to globalisation or world-class is your organisation?

Instruction: Assess your organisation's efforts to remove global boundaries and operate across space, time, and nationality. Use the scale to indicate the extent to which each of the following statements characterises your organisation, circling a number from 1 (not true at all) to 5 (very true).

	NOT True at all			Very true
1. Managers in our company have a global outlook.	1	2	3	4
2. Mangers in our company speak more than one language.	1	2	4	5
3. We have managers responsible for global products, Services, or customers.	1	2	3	4
4. We communicate well across borders.	1	2	3	4
5. We respect cultural differences in management styles.	1	2	3	4
6. Top management constantly stresses its desire to Become a global competitor.	1	2	4	5
7. We routinely engage in cross-border task forces on projects.	1	2	4	5

8. Top management's calendars (daily schedules) reflect their commitment to globalisation.	1		3	4	5
9. Training programs include significant exposure to global issue.	1		3	4	5
10. Leadership positions in our company include people from culturally diverse backgrounds.	1	2	3	4	
11. Accepting international assignments is a stepping stone to future success.	1	2	3		5
12. Information about global competitors and customers is well known throughout the company.	1	2	3	4	
13. Travel budgets enable us to take necessary international trips.	1	2	3	4	
14.Our structure allows us to operate seamlessly across borders.	1	2	3	4	
15. Our customers recognise our ability to operate across borders.	1	2	3	4	
16. We operate across borders significantly better than our competitors.	1	2	3	4	
17. We recruit in places where "globally minded" candidates can be easily found.	1	2		4	5
18. We have many examples of culturally diverse teams.	1	2	3		5
19. Our culturally diverse teams generally work together in a way that the whole is greater than the sum of the parts.	1	2	3		5
20. Other companies have, or could, benchmark our efforts to remove geographic boundaries.	1	2	3		5
21.Other companies have, or could, benchmark our efforts to remove operation management boundaries (lean,agile,TQM,JIT,CIM,sixsigma,other)	1	2	3		5

Questionnaire Scoring:

Add all the numbers circled to figure your total score. You can also view your scores in four key areas: human resource practices, organisational structure, organisational processes and systems, and overall global mindset.

Total score: add scores for all items __86___

Human resource practices: add scores for items 2,9,10,11 and 17. ___17____

Organisational structure: add scores for items 3, 7,14,16 and 18. ____22___

Organisational processes and systems: add scores for items 4, 8, 12, 13 and 19. _21

Overall global mindset: add scores for items 1, 5, 6, 15 and 20.___22____

- Total score: 20 to 55. Your organisation is probably a Global learner, at the beginning stages of globalisation. At this time, many organisational supports are not developed, and resistance must be overcome.
- Total score: 56-75. Your organisation is probably a Global launcher. It has made considerable progress on the path toward removing global boundaries, but certain areas must be improved.
- Total score: 76 to 100. Your organisation is likely to be a Global leader. It has demonstrated a serious commitment to removing global boundaries and is probably in the midst of solidifying and institutionalising this way of operating.

A comparison of your total scores in the categories of human resource practices organisational structure, organisational processes and systems, and global mindset will show you which boundary-crossing characteristics are strongest and which are the weakest in your company. This secondary examination can help you determine if barriers to globalisation are equally in evidence across all the categories or if your company has conspicuous gaps primarily in one or two categories.

In order to actions from Global learners to launchers and leaders, we provide three categories actions:

- Human resource practices
- Organisational structures
- Organisational processes and systems

From Global learner to Global launcher:

Human resource practices
• Supply language/ cultural sensitivity training • Standardise forms and procedures • Set up an overseas presence via joint venture, modest acquisition, or establishment of a headquarters • Engage in extensive cross-broader relationship building
Organisational structures
• Arrange short-term visits and international assignments • Staff for more diversity in management and board to directors • Use email and videoconferencing to maintain day-to-day contact.
Organisational processes and systems
• Establish worldwide shared values, language, and operating principle. • Conduct fact-finding missions. • Design ad hoc trans-national teams. • Hold global town meeting and best-practice exchanges of information.

From Global launchers to Global leaders

Human resource practices
• Seek complete liquidity of human resource: recruit outside the domestic base; place foreign recruits within the domestic base; promote the best people to global assignments; rotate people internationally; use twinning • Aim for a global structure • Map global processes
Organisational structures
• Provide continuing global leadership training and regular trans-national training to reinforce the global mindset • Remove/minimise country mangers and replace with global managers and focus on global customers. • Routionize real-time global communications
Organisational processes and systems
• Use global reward systems

- Multiply ongoing trans-national project teams
- Work for global integration (for example, total global sourcing, global design, global engineering, and global purchasing).

From questionnaire 5, I find this company is likely to be global leader (its overall score is 86 out of 100 and its sub-score includes human resource practices is 17 and organisational structure score is 22 and organisational processes and systems is 21 and overall global mindset is 22). From above table, I find this company organization has high level overall global mindset due to its organization structure. But the weakest link is human resource practices and organizational processes and systems. In my opinion, the best solution for this organization human resource practices problem is to develop leagile knowledge-based system. In other words, this leagile organisation will lead to knowledge-based system through highly integrated technology, organization and people across the lean organization. In sum, I intend to obtain from question 5 is how far along the path to move to global leader from those best factory award companies. Does it make sense that lean and agile principles can help this organization become global leader in the future? In this case, this company is likely to be global leader in the future due to its highly integrated organization structure and overall global mindset, but its human resource practice will hold back the process, thus I recommend using leagile organization to create a knowledge-based system through HITOP method, in other words, building a complete liquidity human resource structure for global leader launch.

Questionnaire#6: How to build a boundaryless leadership In Your organisation?

Instructions: On each 1 to 10 scale, place an O where you think you need to be, or want to be, to move your organisation forward into the twenty-first century. Then place an X where you think you currently are on the scale. The difference between the two scores (O-X) is your gap score.

1. Leadership to break down vertical boundaries Gap Score (O-X)

You and your senior management team make most decisions.	1 2 3 4 5 ▮ 7 8 9 ■	Most decisions are made close to the action.	_4_
You hold information	1 2 3 4 5	You share information	

close to the vest—and promote a need-to-know Approach to information sharing.	6 7 8 ▮ ▮	about overall performance and business strategy with as broad a base of constituents as possible.	_1_
Your recognition and reward system is based solely on individual contributions.	1 2 3 4 ▮ 6 7 8 ▮ 10	Your recognition and reward system is primarily team based.	_4_

2. Leadership to break down Horizontal boundaries Gap Score (O-X)

Your people have narrowly defined roles, responsibilities, and skills.	1 2 3 4 5 6 ▮ 8 9 ▮	You encourage people to develop multiple skills—so everyone feels ready to do what it takes to get the job done.	3
You have clear functional agendas that determine the way things get done and the pace of implementation.	1 2 3 ▮ 5 6 7 8 9 10	You ensure everyone is focused on shared goals, across functions.	4
You have put in place strong controls—with multiple hand-offs and sign-offs—to get work done effectively.	1 2 3 ▮ 5 6 7 8 ▮ 10	You push for integrated end-to-end processes with a single point of accountability to get work done—streamlined, efficient, and value-added every step of the way.	5

3. Leadership to break down internal boundaries Gap Score (O-X)

You and your senior management team focus most of your attention on your own company's current performance.	1 2 3 4 5 6 ▮ 8 9 ▮	You are focused primarily on maximizing value to the end-user.	_3__
You encourage a tough negotiating approach interacting with customers and suppliers.	1 2 3 4 5 6 7 8 ▮ ▮	You actually seek partnership and relationships of trust with customers and suppliers.	1
You spend a significant portion of your time in	1 ▮ 3 4 5 6 7 8 9 ▮	You spend most of your time with customers,	

internal meetings and in running in-house committees.		suppliers, and other outside constituents.	8
Your look for new business opportunities solely on the basis of your company's capabilities.	1 2 ▮ 4 5 6 7 8 9 ■	You formulate new business in partnership with your customers—based on their needs and changes in their markets.	7

4. Leadership to break down geographic boundaries Gap Score (O-X)

You promote a look-alike culture-hiring and promoting people who look like you.	1 2 3 4 5 6 7 8 9 ■	You seek diversity in the people you hire and promote.	0
To get a shot at the top positions, executives need to "punch their ticket" in a series of domestic positions.	1 2 3 4 5 6 7 8 ▮ 10	Significant international experience is a prerequisite for top positions.	0
Your try to apply the domestic model for doing business to each international market you are involved in.	1 2 3 ▮ 5 6 7 8 9 10	You always start from the local market conditions and build your business practices around these—taking very little for granted.	0

5. Overall Leadership to make it happen Gap Score (O-X)

You are preoccupied with task management—constantly trying to explain to your subordinates the steps they need to take.	1 2 3 4 5 6 7 8 ▮ ■	You are focused on results—you clarify expectations about the desired end results and let your people figure out how to get there.	1
You exercise a command and control model of leadership.	1 2 3 4 5 6 7 8 ▮ ■	You lead through articulating clear goals, then coaching, counselling, and cheerleading people to achieve them.	1
You prefer to wait for all the analyses, reports, and studies to come in before staking a position	1 2 3 4 5 6 7 8 ▮ ■	You are comfortable sketching out a rough-and-ready vision of where the organization needs to go	

about the issues facing the organisation.		and using actions as a way to test and refine the vision and the overall direction.	_1_
You are constantly worried about giving people more than they can handle—considering everything else on their plate.	1 2 3 4 5 6 7 8 ▮ 10	You are comfortable putting out exceptional challenges to people—even if you have no clue how people will deliver on them.	_0_
You promote a keep-your-head-down policy—one mistake can derail a career.	1 2 3 4 5 ▮ 7 8 9 ▮	You create an environment in which coming up with and exploring new ideas is encouraged and rewarded.	_4_

Total Score: 47

Questionnaire Scoring:

Add your eighteen individual gap scores to find your overall score. Interpret the results as follows:

1: Gap of 25 or less. Either your expectations are very low, or you have achieved an exceptional level of boundaryless leadership. How far to the right-hand side of the scales are your O scores, your vision of the leadership needed in your organisation for the twenty-first century? If most of your O scores are 7 or lower, you might ask colleagues, customers, broad members, or subordinates where they would place the O's on the 18 scales. Do they share your view about the kid of leadership needed for the future? Be sure you are not simply extrapolating your current situation into the future rather than imaging possible new markets, technologies, competitive threats, and customer demands.

If your O scores are already over on the right-hand side, congratulations! You may be a model of the leadership needed in the next century. You may want to ask some of your leadership colleagues to assess themselves or even to assess you. Consider the value of having a dialogue with colleagues to confirm your sense of the leadership needed and where you and they are on the continuum from traditional to boundaryless leadership. If you are already a boundaryless leader, this dialogue is probably ongoing in your organisation, and perhaps the questionnaire can add talking points to that dialogue.

2: Gap of 26 to 75. You have begun the journey and made progress, but there is still a long way to go. A middle-range score probably means key boundary areas need your attention. Look through the questionnaires to see if any categories stand out as having larger gaps than others. For example, companies often make progress on braking down internal barriers before they see progress on external barriers. If some gaps are indeed bigger than others, you might consider targeting them, selecting from the preceding chapters strategies that apply specifically to closing the largest gaps.

Also consider whether the larger gaps are reflections of your own leadership challenges. Most executives, at all levels, have a range of skill sets and comfort levels. For example, you may be very effective in producing cross-functional team collaborations but still uncomfortable allowing your teams to "just do it" without checking in with you. Or perhaps you are successful at the hard work of developing successful partnerships with customers, but much less clear about how to provide global leadership. If one of these situations or a similar diagnosis rings true for you, you might ask some colleagues or close friends, people who can give you candid feedback, to discuss your findings with you. Remember that your own ability to break through self-imposed boundaries is one of the critical determinants of your company's ultimate success.

3:Gaps of 76 or more. You are just getting started, and there are lots of opportunities to pursue. If your gap score is above 75, then the fun is just beginning. It is probably time for you to pull together your management team, review the strategies we have discussed particularly those keyed to getting started, and have some concentrated work sessions. Remember, of course, that you cannot change everything at once. Pick your targets, create some successes, and get the process going. Return to this questionnaire and the previous questionnaires periodically and take stock of your progress. As long as you keep learning along the way and building your learning back into your organisation. You will make progress toward the boundaryles organization of the twenty-first century.

From questionnaire 6, I find this company is still in the middle journey of building a boundaryless leadership (its overall score is 47 out of 100 and its sub-

score includes vertical boundaries leadership gap score is 9 and Horizontal boundaries leadership gap score is 12 and external boundaries gap score is 19 and geographic boundaries leadership gap score is 0 and overall Leadership to make it happen gap Score is 7). From above table, I find this company organization has middle level overall gap score for future boundaryless leadership. But the weakest link is external and horizontal leadership boundaries due to the leadership rotation at different organization levels and unbalanced relationship between customer and suppliers. In my opinion, leagile organization can solve this leadership gaps. Because lean leadership can be consisted at all the organization levels and agile virtual enterprise can solve the uncertainty customer and supplier relationship using dynamic leagile supply chain management methods. In sum, I intend to obtain from question 6 is how far along the path to move to future boundaryless leadership from those best factory award companies. Does it make sense that lean and agile principles can help this organization achieve boundaryless leadership in the future? In this case, this company is in the middle journey to boundaryless leadership due to external and horizontal leadership gaps. Lean leadership can solve this problem, because it can work at all the organization levels. Also leagile supply chain management can solve the uncertainty customer and supplier relationship with flexible and dynamic reply.

Therefore, through this Harvard business school designed boundaryless organization survey questionnaires, I will find first hand organization performance data from those best factory award firms in Japan, Europe and USA. I find leagile organization can solve their current operation problem through HITOP method.

Reference:

Ron Ashhenas(1998): Building a boundaryless organization: field guide. Jossey-Bass inc. publishing. (Harvard Business School)