University of Hertfordshire

Faculty of Engineering and Information Sciences

School of Aerospace, Automotive and Design Engineering

Developing a model of sustainable learning appropriate to SMEs in the automotive supply sector

Eur. Ing. KEITH I BEVIS

A thesis submitted in partial fulfilment
of the requirements of the University of Hertfordshire
for the degree of

Engineering Doctorate in Automotive Engineering Management

September 2008

The programme of research was carried out in the School of Aerospace, Automotive and Design Engineering, University of Hertfordshire in part collaboration with the Automotive College.

Abstract

Evidence from national surveys conducted in 1995, 2002 and 2006 shows that, despite a variety of specific Government training initiatives, the UK automotive supply sector lags behind international competition and suffers from severe skills shortages. Long term recovery from this position will require improvements in education, careers guidance, recruitment and work related training. The aim of this research has been to design a model of work related training for the sector to help ensure that the learning involved delivers sustained changes in behaviour and skills.

A series of case studies have been reviewed to provide a context of work related training in the sector. Separate surveys were used

- to benchmark training performance in a World Class manufacturer to understand realistic norms of training output,
- to sample the sustainability of learning amongst SMEs engaged on similar training programmes and
- to determine the range of training needs across the automotive supply sector.

In total data was obtained from 833 individuals in 389 companies. The initial conclusions that defined the requirements for the model were that

- The outcomes of training across SMEs in the automotive supply sector were mostly unknown, unmeasured and often unpredictable. For reference, even in large organisations it is estimated that 60% of training budgets lack quantifiable targets.
- Learners themselves are unpredictable,
- Training initiatives, deriving from recommendations of the Leitch report and which are ‘employer led’ focus on “World Class Manufacturing” which, coming largely from the perspective of Automotive OEMs, means Lean Manufacturing.
- For smaller SMEs a constrained training offer can be an impediment to growth. Their needs are the more diverse.

The model was synthesised from the survey results and its concept tested and refined by a further survey of sixteen predominately automotive companies. Tamkin’s IES model from Human Resources was also used as a reference comparator.

On the input side the new model stresses company readiness and relevance of training. On the output side it adds organisational impact to the accepted but often overlooked measurable outputs. Beneath each of the ten elements of the model there are quantifiable indicators for use with diagnostic tools in either a company's HR plan, a training provider's delivery planning or a funding agency's grant criteria.

The companies most likely to meet these quantifiable criteria will be the competitive and innovative companies that operate as learning organisations. It is argued that training targeted on these companies will be cost effective to implement, provide measurable performance benefits and deliver sustainable learning.

Contents

List of Figures and Tables

Portfolio Contents

(Included as a CD after appendix)

P.4.9 **Bevis, K**. The Challenges for Sustainable Skills Development in the UK Automotive Supply Sector: Policy and Implementation (Abridged version), (submitted to Management Research News 23rd May 2008).
* Paper presented by other author.

P.5. University of Hertfordshire presentations
- P.5.1 Developing sustainable learning for the automotive supply company, (2003)
- P.5.2 Developing sustainable learning for the automotive supply company, (2004)
- P.5.3 Developing sustainable learning for the automotive supply company, (2005)
- P.5.3 The Challenges for skills development in the automotive supply sector, (2008)
- P5.4 Educational Research Network (UH) Poster Summary, (2002)

P.6. Presentations from Conference papers included in Appendix
- P.6.1 Training: an inhibitor of innovation in the automotive supply chain (2007)
- P.6.2 The Challenges for Sustainable Skills Development in the UK Automotive Supply Sector: Policy and Implementation (2008)

P.7 Translated Questionnaires for Project 3

P.8 Author's CV

Acknowledgements

It is always in season for old men to learn
Aeschylus in Agamemnon

My sincere thanks to Professor Peter Bullen for his encouragement and insightful commentary throughout this research programme and to Paul Findlay and other colleagues for their helpful inputs.

A particular thanks to the translators who assisted in Project III: Markus Schadt, Henk Pringels, Alain Engelschenschilt, Diana and Mark Bevis Sanabria.

I must acknowledge with gratitude the inputs of over eight hundred individuals who have anonymously provided much of the data on which this work is based.

Above all it is to Margaret, my wife, whose perseverance, determination, infuriation, understanding, patience, long suffering and love that have got me to this point, that I whisper my deepest thanks.

Keith Bevis

Prologue

This thesis is presented as the examinable component of a Professional Engineering Doctorate, EngD. The main differences between an EngD and the traditional PhD are that the EngD relates to professional activity, is closely coupled with industry and is constructed from a taught component, a series of related but distinct projects and an overarching thesis that brings the whole programme together. The EPSRC introduced the EngD to provide a doctoral qualification that would meet the needs of industry, enhance its knowledge base and generate partnerships between academia and industry. The Engineering Doctorate is identical in academic standing to a conventional PhD. Its outcome is a contribution to professional practice.

The thesis includes a summary of each project and the project reports are appended to the thesis. Along with those reports, the appendix includes other relevant papers and presentations that have been generated during the programme. There is also a portfolio of related material. This additional material presented on CD includes further papers written during the programme, presentations and support materials to demonstrate professional development.

During the programme the author has been working at the University of Hertfordshire, but in a specifically industry-facing role. His working objective has been to encourage business and academia to work together in particular to facilitate training initiatives in which academic staff engage directly with workers in industry. Initially this has been with SMEs in the automotive supply chain. After 2004, the mix of companies has diversified, partly as a result of broadening of job specification but partly too as a manifestation of SMEs increasing their client base in order to be less dependent on the volatile automotive marketplace.

Initially the Automotive College was the industrial sponsor for this Engineering Doctorate. In 2004 the Automotive College was subsumed into the Automotive Academy. As a direct result of a UK Government initiative that introduced a number of ‘Skills Academies’, in 2007 this too was subsumed into the National Skills Academy for Manufacturing. Each of these organisations has had as its core purpose skills development in the automotive supply sector and latterly in the manufacturing sector. The author has been involved with all three, but only the first was an official sponsor of this Engineering Doctorate.

The university has strategically enlarged its capacity to be business facing by absorbing the business support organisation, Exemplas Ltd. On behalf of the School of Aerospace, Automotive and Design Engineering, the author has worked closely with the consultancy and business development arm of Exemplas. On the wider European front, work on European Innova projects has provided access to automotive manufacturers and their local support services in France, Spain, Germany, Austria, Belgium and Italy.

Glossary

The scope of this research programme crosses a number of specialties and is therefore likely to introduce a large number of acronyms and abbreviations which have not necessarily transferred from one specialty to another. In the text of the thesis each is defined fully with its introduction, either in the text or as a footnote. In some cases the reader is referred to a detailed explanation in an Appendix. To assist the reader further each is included here in this glossary with a short description.

Term or abbreviation	Definition
5S	Set of techniques providing a standard approach to housekeeping within Lean Manufacturing. Showing its Japanese origin the "Ss" stand for **Seiri** (整理) – Sort, tidy; **Seiton** (整頓) – Set, order; **Seiso** (清掃) Shine, clean; Seiketsu (清潔) Standardisation and **Shitsuke** (躾) Sustain, sustaining discipline.
ADDE of UH-ADDE	The School of Aerospace, Automotive and Design Engineering at the University of Hertfordshire
AEU	The Amalgamated Engineering Union was previously the major engineering industry trade union, but in 1992 – following a merger with another trade union association – changed its name to Amicus the Union.
Andon system	On the production line the Andon system provides a direct connection between the operator, the production line automation, the conveyor systems and the factory wide enunciator. When a problem manifests itself, the operator can stop the line and call for support. This is a vital communications system for management of the human/machine interface.
APEL	**A**ccredited **P**rior **E**xperiential **L**earning, i.e. that learning from professional experience and other training that has been accepted as equivalent to the taught requirement of the EngD programme.
APL	**A**ccreditation of **P**rior **L**earning
APQP	Advanced Product Quality Planning
ASPEN	**A**utomotive **S**upport **P**rogramme for the **E**ast of E**n**gland is the mnemonic for a European funded project discussed in Chapter Three.
BeLCAR	**Be**nch **l**earning in **c**luster management for the **a**utomotive sector in European **r**egions, a transnational European project within the EU's Innova programme.
Beneficiary time	The full cost of employment of staff for their time devoted to the training. When a project is funded by the European Social Fund, the funding represents only a fraction of the total project cost. The remainder must come from other sources and the investment in time from the beneficiary organisations. This

Term or abbreviation	Definition
	method of accounting is intended to ensure that a project is delivering its committed outcomes.
BERR	The UK Government Department for Business, Enterprise and Regulatory Reform.
Bipartite dialogue	Bipartite dialogue at the European level is dialogue between the European employers and trade union organisations, the 'social partners'. See also tripartite dialogue.
BIT	Business Improvement Techniques - an NVQ pathway which focuses on aspects of Lean Manufacturing.
Basic Skills	The ability to read, write and speak in English / Welsh and to use mathematics at a level necessary to function and progress at work and in society in general. (www.basic-skills.co.uk) The reference to the Welsh language is because the Basic Skills Agency is a UK Government agency.
BRIC	Brazil, Russia, India and China
CAD	Computer aided design
CEO	Chief Executive Officer
CIPD	Chartered Institute of Personnel and Development, which is the professional body for Human Resources and Training in the UK.
CLEPA	European Association of Automotive Suppliers. The acronym stands for Comité de Liaison de la Construction d'Equipements et de Pièces d'Automobiles.
COGENT	A co-development initiative between Nissan and a selection of its suppliers.
DIUS	The UK Government Department for Innovation, Universities and Skills.
DTI	Department of Trade and Industry, now superseded by BERR and DIUS.
Delivery Schedule Achievement	Delivery Schedule Achievement (DSA) measures how well a supplier matches the planned delivery requirement of the customer. The DSA measures the actual delivery performance against the planned delivery schedule. Late and part deliveries are regarded as failures compared to the planned delivery schedule. Parts that do not conform to the specification are also regarded as a delivery failure, even if they can be reworked. The objective is to match the planned delivery schedule by preventing late deliveries, eliminating factors that contribute to part deliveries and parts that do not conform to the specification. (IndustryForum 2008f)
East of England	The East of England Development Agency (EEDA) is the regional development agency for the six counties of

Term or abbreviation	Definition
Development Agency	Bedfordshire, Cambridgeshire, Hertfordshire, Essex, Norfolk and Suffolk. It works with a variety of organisations in the region, including the East of England Regional Assembly, Government offices for the east of England, Go-East, and sub-regional economic partnerships. All RDAs are accountable to and receive funding from central government. In 2006 EEDA received just under 200 million pounds from Government and £50 million in European funds. It employs just under 200 staff.
EEDA	See East of England Development Agency
EEF	Engineering Employers' Federation
EFQM	European Foundation for Quality Management
End of Life Directive (ELV)	The End of Life Directive was passed into European law in October 2000 and transposed into the UK's End-of-Life Vehicles (Producer Responsibility) Regulations 2005. Ultimately this will place the financial burden of vehicle disposal back with the vehicle manufacturers.
EPSRC	Engineering And Physical Sciences Research Council
ESF	European Social Fund
EU27	The accession of Bulgaria and Romania to the European Union on 1 January 2007 brought the membership of the European Union to 27 countries
Eurozone	That part of the European Union whose currency is the Euro. It consists of the pre-enlargement 15 less Denmark, Sweden and the UK.
FAST 2015	A German foresight project about future automotive industry structure in 2015.
Five S	Set of techniques providing a standard approach to housekeeping within Lean Manufacturing. Showing its Japanese origin the "Ss" stand for **Seiri** (整理) – Sort, tidy; **Seiton** (整頓) – Set, order; **Seiso** (清掃) Shine, clean; Seiketsu (清潔) Standardisation and **Shitsuke** (躾) Sustain, sustaining discipline.
Floor Space Utilisation	Floor Space Utilisation (FSU) is a measure of the sales revenue generated per square metre of factory floor space.(IndustryForum 2008a)
GDP	Gross Domestic Product.
GERPISA	Permanent Group for Study of Automobile Industry and its Employees. It is run from Université d'Evry, Rue du Facteur Cheval, 91025 Evry Cedex, France
GM	General Motors
HEC	See Hethel Engineering Centre

Term or abbreviation	Definition
Hethel Engineering Centre	The Hethel Engineering Centre is a business incubator and training facility focusing on high performance engineering and manufacture. It is located adjacent to Group Lotus in Norfolk , UK
High Performance Working	The International Labour Organisation defines High Performance Working as 'the achievement of high levels of performance, profitability and customer satisfaction by enhancing skills and engaging the enthusiasm of employees'.
HMRC	Her Majesty's Revenue and Customs
HRM	Human Resource Management
HPW	See High Performance Working
i10	Network of universities and colleges in the East of England which are building stronger links with businesses in the region to help develop and exploit innovation opportunities. www.i10.org.uk . The innovation tool introduced in sections 4.4 and 5.2.5 is hosted on the i10 web site.
IBC Vehicles	Isuzu and Bedford Commercial (IBC) Vehicles was formed in 1987 as a joint venture between General Motors and Isuzu Motors of Japan. In 1998 IBC Vehicles became a 100% owned subsidiary of General Motors
ICT	Information and communication technology
IDBR	IDBR is the Inter-Departmental Business Register, a list of UK businesses maintained by the Office for National Statistics (ONS) and combines the former Central Statistical Office (CSO) VAT based business register and the former Employment Department (ED) employment statistics system. It complies with European Union regulation 2186/93 on harmonisation of business registers for statistical purposes.
IES	Institute of Employment Studies
IF	See Industry Forum
IGDS	Integrated Graduate Development Scheme MSc at the University of Hertfordshire entitled "MSc in Automotive Engineering: Design, Manufacture and Management" provides the taught modules for this Engineering Doctorate programme.
IiP	**Investors in People** Standard which provides a framework for staff development within an organisation. Companies attaining an IiP accreditation have demonstrated that they have systems in place to train and develop their staff.
Industry Forum	The Industry Forum, a division of the Society of Motor Manufacturers and Traders, SMMT, was established in 1996 with the aim of achieving sustainable world leading competitiveness in the UK based vehicle and components industry. Its engineers were trained by Master Engineers from the major players in the industry. These Industry Forum engineers would then transfer the skills, knowledge and

Term or abbreviation	Definition
	delivery techniques of the tools of process improvement into the companies with whom they worked. This was the essence of the "**Learning by doing**" programmes developed by the Industry Forum. (SMMT Industry Forum website)
Innovation Efficiency	Innovation Efficiency is the second output from the i10 Innovation tool. It reflects how well the enterprise converts innovative ideas into revenue.
Innovation Score	Innovation Score is the first output from the i10 Innovation tool. It is a measure of the enterprise's ability to innovate in comparison with others in the same industry sectors across the UK. As reference data it uses the Department of Trade and Industry 'UK Innovation Survey' (CIS3) for 6784 SMEs in the UK in the period 1998-2000.
JCP	See Jobcentre Plus
JIT	Just in Time. The JIT philosophy encourages the use of the minimum amount of resources (e.g. space, time, material, workers) necessary to add value to a product. Synchronous Suppliers deliver parts line-side only when they are required, therefore reducing the need to store large supplies of parts at great cost.
Jobcentre Plus	Jobcentre Plus is a government agency, responsible to the Department for Work and Pensions (DWP) and was designed to help meet the UK government's aim of providing 'work for those who can, security for those who cannot'. Jobcentre Plus provides a network of local offices which combine job finding and benefit services.
Kaizen	Kaizen is a Japanese word meaning 'Continuous Improvement'. Nissan, NMUK, encourages its entire workforce to seek out areas in which improvements, no matter how small, can be made to their working environment. There are Kaizen teams in every department. The emphasis is on small, manageable improvements.
KTP	A **K**nowledge **T**ransfer **P**artnership is a three-way project between a graduate, a company and an academic institution (University or college). Graduates are recruited to deliver strategic projects for the company partner, mentored by university staff.
Lean Manufacturing	Lean Manufacturing or Lean Production refer to a philosophy of manufacturing centred on removed waste (see seven wastes) and improving performance (see five S). Historically this is linked to the Toyota Production System.
LSC	Learning & Skills Council
Luton Vauxhall Partnership	On 13 December 2000, a day after the closure announcement at Vauxhall Luton, a number of concerned organisations, led by EEDA, were brought together to form the Luton Vauxhall Partnership. This was a partnership of the public and private sector encompassing the Vauxhall Company, trade unions, the Employment Service, regional supply network, the local

Term or abbreviation	Definition
	authorities and local University. Its purpose was to address job losses and the effects of the closure on the local economy. The partnership was chaired by EEDA who was responsible for meeting the project's objectives and for finding funding. EEDA was also itself a funding partner. Luton Borough Council helped write an ESF bid, provided match funding and gave personal support to displaced workers. Jobcentre Plus assisted with giving advice and guidance and tracking beneficiaries. Vauxhall Motors provided office space and equipment and also funded the Learning for Life team, which was based on site.
LVP	See Luton Vauxhall Partnership
MAS	The Manufacturing Advisory Service is jointly funded by BERR, the Department for Business, Enterprise & Regulatory Reform (formerly the DTI) and the Regional Development Agencies to provide manufacturing businesses with expert advice through hands-on support, training and events.
Microbusiness/ Microenterprise	For the expanded European Union, the EU-27, The term "small to medium sized enterprise" has been broken down into the following size-classes: 1-9 persons employed (micro enterprises), 10-49 persons employed (small enterprises), 50-249 persons employed (medium-sized enterprises) leaving large-sized enterprises for those with at least 250 persons employed. In particular, a micro business and has a turnover or balance sheet not exceeding EUR 2 million.
MIT	Massachusetts Institute of Technology
NIACE	National Institute of Adult Continuing Education, which exists to encourage wider adult participation in learning of all kinds. It began in 1921 as the British Institute for Adult Education: in 2007, it merged with the Basic Skills Agency (BSA) and in now part of the Alliance for Lifelong Learning.
NMUK	Nissan Motors UK
Not Right First Time (Not RFT)	Not Right First Time (Not RFT) is a measure of the product's ability to match a specification and is expressed in 'number of defect parts per million'.(IndustryForum 2008e)
NSA	National Skills Academy. The UK Government's white paper "Realising our Potential" in 2003 reinforced the notion that skills development needed to be "Demand Led". It set out a structure for Sector Skills Councils and Sector Skills Agreements. The political ambition was to grow this initiative to support twelve different skills academies.
NSA-M	The UK Government has planned to deliver twelve different skills academies. In 2007 funding was found for four academies of which the National Skills Academy for Manufacturing, NSA-M was one.
NVQ	National Vocational Qualification. These are work-related competence based qualifications. 'Level 1' represents the

Term or abbreviation	Definition
	competence to apply knowledge in varied but predictable work environments commensurate with GCSE grades D to G. 'Level 2' adds complexity and collaboration commensurate with GCSE grades A* to C. 'Level 3' takes that competence to handle some responsibility and guide or control other staff, commensurate with A levels.
OEE	**O**verall **E**quipment **E**ffectiveness is a total measure of performance that relates the availability of the process to the productivity and quality. (IndustryForum 2008b)
OEM	**O**riginal **E**quipment **M**anufacturer. In the automotive industry this is the vehicle manufacturer. The use of the term OEM allows for generalisations across sectors, but it is primarily the manufacturer who is supplying goods to the open market, even if this is through distributors.
Overall Equipment Effectiveness	**O**verall **E**quipment **E**ffectiveness (OEE) is a total measure of performance that relates the availability of the process to the productivity and quality. (IndustryForum 2008b)
PAC	**P**erformance **a**nd **C**ompetitiveness Analysis
People Productivity	People Productivity (PP) is a measure of the ratio between the number of units made and the number of direct operator hours associated with manufacture of those units.(IndustryForum 2008c)
Prince2	**PR**ojects **IN** **C**ontrolled **E**nvironments: a process-based approach for project management
Quality Cost and Delivery (QCD)	Quality, Cost and Delivery provide a set of benchmark measures which can be used to focus continuous improvement in any sector of manufacturing industry. The intention is to raise levels of customer satisfaction and greatly improve the management of production. Here the associated key performance measures known as the "Seven Measures" have been defined by SMMT – Industry Forum specifically for use with the automotive industry (IndustryForum 2008d). See Seven Measures.
Rapid Response Service	Government intervention, intended for organisations facing 'significant' redundancies, when existing provision does not meet the circumstances. Its provision might include on-site advice surgeries, links and referrals to other agencies, and information and advice about job vacancies and training opportunities. (formerly known as the Rapid Response Fund) See Jobcentre Plus.
RDA	Regional Development Agency
RRS	Rapid Response Service (formerly known as the Rapid Response Fund)
SEMTA	The Sector Skills Council for Science, Engineering,

Term or abbreviation	Definition
	Manufacturing and Technology.
Seven Measures	The seven measures are a series of standardised measures which can be applied to a manufacturing operation, in order to express its efficiency in a meaningful way. A brief description is available at http://www.autoindustry.co.uk/features/qcd . Appendix I (Project 1) includes the DTI Factsheet, which also points to the same DTI reference as used in the text. The DTI reference details each measurement and its use.
Seven Wastes	Taiichi Ohno defined the **Seven Wastes** defined as the Unnecessary **Transport** of materials, **Inventories** beyond the absolute minimum, **Motions** of employees, **Waiting** for the next process step, **Overproduction** ahead of demand, **Overprocessing** of parts and producing **Defective** parts.
SIC	The UK Standard Industrial Classification of Economic Activities is used to classify business establishments and other standard units by the type of economic activity in which they are engaged. The codes used here are from SIC(2003) which were current at the time of enquiry. Subsequently the SIC(2007) list has been issued in which there are significant differences.
SILS	Supply In Line Sequence. This involves just-in-time delivery of modules in the sequence that their vehicles are passing along the final manufacturer's production line, matching individual vehicle variation, e.g. required colour or required accessories.
Skills4Auto	A publicly funded organization that provides support to the Midlands Manufacturing and Engineering Automotive sector. It works with companies and individuals to identify business development needs and facilitate training based solutions. It has acted as the Midlands' spoke of the national Automotive Academy.
SME	Small to Medium sized Enterprise. The European Commission defines a Small to Medium sized Enterprise as an enterprise that employs fewer than 250 persons, has an annual turnover not exceeding EUR 25 million and/or a balance sheet total not exceeding EUR 43 million. For a small business these limits are 50 employees and EUR 10 million. A micro business employs fewer than ten people and has a turnover or balance sheet not exceeding EUR 2 million.
SMED	Single Minute Exchange of Die meaning reduction in changeover time
SMMT	The Society of Motor Manufacturers and Traders. This UK trade body has been in existence since the invention of the motor car and in 2008 has over 600 members spread across the automotive manufacturers, the components suppliers and distributors and after sales service.
Stock Turns	Stock Turns (ST) is a measure of how frequently the stock, raw material, work-in-progress and finished goods are turned over in relation to the sales revenue of a product.(IndustryForum

Term or abbreviation	Definition
	2008f)
Tripartite dialogue	Tripartite dialogue at the European level involves interaction between the 'social partners', the employers and trade unions, and the public authorities. See also bipartite dialogue.
Value Added per Person	Value Added per Person (VAPP) is a financial measure that relates the number of direct people involved in the conversion process to add value to the product.(IndustryForum 2008g)
World Class Manufacturer (WCM)	**World Class Manufacturing** is a holistic approach to productivity and quality improvement which is focused on the elimination of all forms of waste and non value adding activities in the organization. This is achieved through the creation of a culture of continuous improvement based on the involvement of the total work force. There is no formal definition of "World Class Manufacturer" but see informative discussion included in Chapter Two section 2.3.1.

Chapter One The Automotive and Manufacturing Context

Something is rotten in the state of Denmark
Shakespeare, Hamlet

1.1. Introduction

This thesis presents an overarching review of an Engineering Doctorate programme of research and learning. The focus of study has been the learning that is required within the automotive supply sector, at all levels of staff responsibility, to address skills needs. The gaps in skills relate closely to performance and competitiveness.

At the Lisbon Council in March 2000, European government leaders set themselves the target of making the European Union the "most competitive and dynamic knowledge-based economy in the world, capable of sustained economic growth …" within ten years (Leitch 2005).

The European Automotive industry is a key strategic player in the European Union with an estimated 10 million workers. The majority of these work in the supply chain (CLEPA 2005). As a major employer, the sector must work to maintain its competitive edge if it is to keep that workforce engaged.

Human resources are central to the creation and exploitation of knowledge and a determining factor in the European automotive industry's potential for innovation. Employees are increasingly required to demonstrate significant judgement and flexibility, while maximising performance and improving productivity. But to become more efficient and competitive, people need the right skills. Therefore they need to be better trained, more innovative, more customer focused and more determined (Leitch 2006).

The beginning of the twenty first century found parts of the UK Automotive Supply sector in a fragile and nervous state. Vauxhall and Rover had been the two most recent examples

of upheaval amongst the vehicle builders. There was already overcapacity in the market. Financially the sector was under pressure both from the distant markets and from within Eurozone[1]. Not only had globalisation brought more companies into the market, it had broken the tie between the customer and the natural local suppliers.

International comparisons show differences between automotive component suppliers in the UK and similar companies in Germany, Japan and the USA. Skills and productivity in the UK are lagging these other economies (Carr 1992; DTI 1998a). UK firms have been at a competitive disadvantage by a shortage of suitably qualified engineers. That need has been reiterated time and again.

The skills shortages and skill gaps at all levels within companies are a major factor in the UK's lack of competitiveness. Even the methods of tackling these shortages have come in for criticism. The view of the Automotive manufacturers themselves is one of losing competitiveness due to the lack of skilled labour to fill open positions (CLEPA 2005). The skills and competitiveness needs of the companies in the UK Automotive Supply Sector have been highlighted as a vital part of the industry's strategy for survival at national level (AndersonConsulting 1994; DTI 1998a) and at a more local regional level following upheavals in the industry (Bevis 2001).

Long term recovery would require improvements in education, careers guidance, recruitment and work-related training. However one remedy to tackle the issue of work-related training would be to ensure that the learning involved delivers sustained changes in behaviour and skills.

The research aim is to develop a model of sustainable learning appropriate to SMEs in the automotive supply sector. The research starts from the viewpoint that the most effective learning that can be delivered into an SME is unlikely to be a simple extension of other forms of learning. It seeks to uncover the context in which company based learning takes place and within that context to develop an appropriate learning model.

[1] That part of the European Union whose currency is the Euro. It consists of the pre-enlargement 15 less Denmark, Sweden and the UK.

1.2. Outline of Thesis Structure

This thesis has been presented as a series of seven chapters. The first chapter introduces the subject of the thesis; it outlines the structure and then provides a wide ranging introduction to the automotive industry from three perspectives: the geographical from European to regional, the scale from vehicle manufacturer to SME component supplier and the human resource perspective showing the importance of the social partners to the discussion of training in the sector.

Chapter Two sets out the academic and organisational background to the research programme. It explores the connection between associated learning and the context of the research. Links are made to both taught and APELed[2] subject areas. Most importantly it sets out the research problem at the heart of this programme and defines the research aims and objectives.

Chapter Three outlines the overall research methodology explaining how the three projects fit together. It details the particular methodology used in each stage of the research. Finally it reviews how these methodological steps fit together to assure the validity of the final conclusions.

Summaries of the three research projects are presented in Chapter Four. Within the programme these are the main components of the research. The projects are reported fully in Appendix A1. The first project has provided a current view of training within the East of England. The disparity between the intended outcomes of the training and the actual outcomes was demonstrated amongst a group of SMEs chosen from participants in a supplier development project. Each had been selected for Lean Manufacturing training and had reported encouragingly about the effects of the training immediately afterwards. However, in the longer term the effects of training on the business were in many cases masked by the 'noise' of the market and personnel activities.

[2] APEL is Accredited Prior Experiential Learning, i.e. that learning from professional experience and other training that has been accepted as equivalent to the taught requirement of the EngD programme.

The second research project examines in detail what owner/managers want from their investment in training and what skills and expertise the OEMs expect them to acquire. Partly this stage has been a gap analysis determining whether the voice of the SME is being heard by commercial providers and Government.

The final research project is presented at the end of chapter four. Building on the work of the first two projects, a model has been presented that can support sustainable training. Within the model specific criteria have been identified that could be used to target training resources more selectively. A further survey amongst a small sample of predominately automotive manufacturing companies was used to confirm this model. The ensuing analysis refined the model to show that sustainable learning takes place within a learning organisation. Measurable indicators are presented for the model, with recommendations of how these might form the basis of diagnostic tools for managers, purchasers and funding agencies.

In Chapter Five the results of the three projects are brought together and a model for sustainable learning in the workplace is proposed. This model which includes a set of measurement indicators could be used as the basis for a diagnostic tool that would test the viability of training programmes. Recommendations are made about the types of diagnostic tools that could be developed. Recommendations are also made for further research in answer to questions raised during the programme. There is a personal reflection by the author on the implementation of this research and the process of learning associated with it. This is a critical reflection on the learning achieved through the programme.

In Chapter Six the author reviews the contribution that this research programme has made to the profession. It identifies the practical interaction with University, industry and the various support organisations. The research has strengthened the professional link between engineering management and human resource development which is a positive contribution to manufacturing industry.

In Chapter Seven are the final conclusions of the research programme itself.

The thesis has also included a prologue and an epilogue. These have been included to cover material that is relevant to the subject but not part of the research. The prologue has set the structural scene for the thesis, by identifying the differences between the conventional PhD programme and that of an Engineering Doctorate. It has located the

author within the context of the industry and the support and training mechanisms around it. It has identified partner organisations with whom the author has worked.

In parallel to this research the National Skills Academy for Manufacturing has come into being. During May and June 2008, NSA-M has been promoting its Performance and Competitiveness or PAC service which has been designed with not dissimilar objectives to this research programme. Details are set out in the epilogue to provide an added point of reference.

Abbreviations and specialist terms are introduced on their first appearance in the text. For ease of location these definitions are also collected together in a glossary that has been located before chapter one.

1.3. Pressures on the International Automotive Industry

1.3.1. The scale of the national and regional automotive industry.

The European view

Despite a long period of unease in the European car industry, it has been the beginning of the twenty first century that has seen major turmoil with the European car market going through an extremely weak phase. This can be illustrated with a few examples. Historically, Belgium had attracted all the major car producers. However, during the period 1992-2001, the total number of jobs in Belgian car assembly fell by 30%, while the added value fell by 8%. Genk Ford lost 30% of its direct labour. The U.K. saw the break up of the Rover Group, accounting for around 2,500 voluntary redundancies in its successor companies. In May 2000, Ford ceased vehicle production in Dagenham. In December of the same year, General Motors, GM, closed Vauxhall's Luton plant. Fiat Auto's car sales dwindled both in Italy and in Europe. There the domestic drop in demand reached 6%. Employers have identified overcapacity in the European car market as the cause of price pressures on new cars. Those responsible for UK manufacturing plant have also

highlighted the issue of operating inside Europe but outside the 'Eurozone'[3], but this view ignores the wider European picture.

Further pressure on the car makers comes in the predictions for changes towards 2015. There is already a trend amongst vehicle manufacturers to concentrate on final assembly, sales and distribution, moving the responsibility for innovation and development back up the supply chain to specialist suppliers. FAST 2015[4] predicts a movement in employment from vehicle assembly to component manufacture with an anticipated ratio of 1:3 (Mercer 2005). In the UK in 2002 the ratio was around 2:3. Mercer also predicts an increase in the value of the component market of 70% whilst the vehicle market falls.

Aside from the market, there are also policy and technical challenges. These are the continuing demand for lower CO_2 emissions, increasing road safety and the "End of Life Directive"[5]. Each of these requires innovations amongst the suppliers. Both production volume and innovation accentuate the skills demanded of the companies in the automotive supply sector.

In a report on Industry trends across Western Europe, Kamp writes "Skills shortages do pose a problem for the smaller companies in the supply chain. These businesses find recruitment difficult and, with lean production, have little spare capacity to engage in training programmes. Also, as the skill demands on smaller sized and lower tier supplier companies in the business become ever more stringent, these companies encounter growing problems to attract or develop their human resources accordingly" (Kamp 2006).

The National picture

Vehicle manufacturers are a discrete subset of the manufacturing industry and their statistics can be reported with some confidence. When the automotive industry is viewed as a whole that clear distinction disappears and consequently the aggregated statistics for the industry become ambiguous. As will become apparent in a later section of this thesis, companies in the automotive supply chain, especially at Tier 2, tend to diversify into other

[3] Eurozone is that part of the European Union whose currency is the Euro. It consists of the pre-enlargement 15 less Denmark, Sweden and the UK.
[4] A German foresight project about future automotive industry structure in 2015
[5] The End of Life Directive was passed into European law in October 2000 and transposed into the UK's End-of-Life Vehicles (Producer Responsibility) Regulations 2005. Ultimately this will place the financial burden of vehicle disposal back with the vehicle manufacturers.

sectors. The more reliable statistics come from BERR[6] and the SMMT[7]. Even here the annual figures are quite volatile. Although basic statistics were collected at an early stage of the research the figures quoted here were revised during writing.

In 2008, the UK automotive industry represents about £9.5 billion in added value to economy. At over 1% of GDP[8] the industry produces the largest contribution to the UK's export of manufactured goods, 11%. £4.5 billion is generated by the components industry and another £22 billion comes from the retail and service sector.

The output of the sector is also variable, but in setting the scene for this research, which is conducted in the twenty first century, it is sufficient to record that in 1999 vehicle production in the UK reached 1.78 million units which is equivalent to the record levels reached in the early 1970s, but with a much reduced workforce (Wood 2006). Estimates of size of the workforce employed in design and manufacture of vehicles and their components vary between 194,000 and 200,000. Whilst vehicle manufacturers can be identified by their progressively decreasing list of brand names, the automotive supply sector has at least 2,600 companies in the UK.

The regional picture

Tightening the focus to a single region such as the East of England, the uncertainty in the figures becomes more apparent. At the beginning of this research programme, the clearest figures that anyone could provide were those available from IDBR[9]. In an attempt to derive a reasonable estimate against which to benchmark any findings in the research, the author started by collecting data first from practitioners whose views were conditioned by their working environment or by known interaction, moving out through the estimated data from regional advisers and finally to the robustness of IDBR. Even with these varied sources there is still uncertainty associated with what are the meaningful definitions with which to interpret the data.

---

[6] The UK Government Department for Business, Enterprise and Regulatory Reform, BERR, provides summary statistics on its website, which was reviewed on 8th August 2008: http://www.berr.gov.uk/sectors/automotive/index.html

[7] Taken from The Society of Motor Manufacturers and Traders, SMMT, website on 8th August 2008 http://www.smmt.co.uk/dataservices/indanalysis.cfm?sid=-2&catid=553&maincatid=551&fid=&fid1=&fid2=

[8] GDP – Gross Domestic Product.

[9] IDBR is the Inter-Departmental Business Register, a list of UK businesses maintained by the Office for National Statistics (ONS) and combines the former Central Statistical Office (CSO) VAT based business register and the former Employment Department (ED) employment statistics system. It complies with European Union regulation 2186/93 on harmonisation of business registers for statistical purposes.

Starting with vehicle manufacturers in the region, the General Motors view from Human resources is of 4500 employees distributed between IBC, GM's commercial vehicle plant in Luton and their Tier 1 suppliers. They indicate another 3000 indirect employees. Ford Motor Company's major site in the region is its R&D complex at Dunton, Basildon. Staff at Basildon Borough Council have a more parochial and Ford-centric view citing 5000 employees, principally being at Ford's Dunton site and therefore involved in R&D together with the Visteon operation which is a major Tier 1. These views give 7500 in Bedfordshire and 5000 in Essex. These two sources do not account for the Dagenham and Southend parts of Essex.

Within the Regional Development Agency, the view of EEDA's industrial advisers is that there are five major vehicle manufacturers, plus a dozen small sports motor companies. The five are Lola, Lotus, IBC, Marshall SPV and CNH. Perkins is a major engine manufacturer. Johnson Controls is a major Tier 1 company. More broadly EEDA estimates that the region has circa 600 automotive businesses in the region that act as elements of the vehicle supply chain. This is based on Findlay Publishing's database (dependent on returns from readers of the trade press) which in 2001 cited 900 companies together with EEDA's estimation that the sector is shrinking. Both the Luton Vauxhall Partnership research (Bevis 2001) and the subsequent ESF funded intervention (Bevis 2006) encountered a number of weakening companies. This fall away was not limited to small or micro businesses.

Staff at the DTI's Manufacturing Advisory Service, MAS[10], working in the region, advised use of the IDBR numbers. Here all reported businesses are classified by SIC code[11]. MAS focused on companies involved in *Motor Vehicles, trailers and semi-trailers* classification, i.e. SIC 34. This suggests 330 companies across the region, but that is a slightly more restricted view of the same data, as it excludes companies in the supply chain. Taking the wider picture, by adding *Manufacture of Fabricated Metal Products, Except Machinery and Equipment(28), Manufacture of Machinery and Equipment Not Elsewhere Classified (29), Manufacture of Other Transport Equipment (35)* and so using SIC codes 28, 29, 34,

[10] Manufacturing Advisory Service is jointly funded by BERR and the Regional Development Agencies to provide manufacturing businesses with expert advice through hands-on support, training and events.
[11] The UK Standard Industrial Classification of Economic Activities (SIC) is used to classify business establishments and other standard units by the type of economic activity in which they are engaged. The codes used here are from SIC(2003) which were current at the time of enquiry. Subsequently the SIC(2007) list has been issued in which there are significant differences.

35 the estimate rises to 5030 companies, which represents about a third of the region's manufacturing. A simple extrapolation from these numbers would indicate that the minimum number of employees in the sector across the region is 55670.

Even this set excludes SIC code 25, *Rubber and Plastic Products*, which would include at least two major manufacturers of automotive bumpers in the region. Performing the same employee extrapolation on just SIC 34 yields a minimum of 10,145 employees.

None of this points to a conclusive estimate of the number of companies or employees in either the Region or in the relevant sub-regions. So a combination of reviewed statistics and local knowledge would suggest a regional picture of some **600** companies plus or minus 100 employing around **20,000** people plus or minus 7,500. This is very much an estimate but comes after careful review of the preceding data. The current figure given on the AutoIndustry Website[12] is 700, but that will be restricted by the same problem of definition outlined above. Despite their uncertainty these numbers are sufficient to put the implementation of Government initiatives into perspective. During its two and half years of operation, the regional spoke of the Automotive Academy engaged with fourteen of those companies and recruited 263[13] staff onto NVQ Level 2 Business Improvement Techniques programmes.

1.3.2. The changing structure of the automotive industry

Traditionally the automotive industry's supply chain has been seen as a series of tiers, with the vehicle manufacturers themselves being **Tier 0**. In this model any discussion of the automotive supply chain would concentrate on tiers 1 to 3. Richard Lamming, who was part of the small team that wrote 'The machine that changed the world" adds two more significant categories of supplier: the *influential suppliers* and the *unrelated suppliers* (Lamming 1993). A revised model is set out in figure 1.1.

The role of **3rd** and **2nd tier** suppliers is clear from the diagram. The **tier 1** companies are producing substantial modules and assemblies which tend to be required in Supply In-Line Sequence (SILS). This involves just-in-time delivery of modules in the sequence that their

[12] The Auto Industry website is maintained by BERR's Automotive Unit, as an authoritative resource for all players in the industry. East of England information is available at http://www.autoindustry.co.uk/regions/eastofengland/2 .
[13] From management reports of the London and East of England Spoke of the Automotive Academy, LEESAA.

vehicles are passing along the final manufacturer's production line, matching individual vehicle variation, e.g. required colour or required accessories.

In the East of England there are manufacturing sites of at least three tier 1 suppliers in the world's top ten: Delphi, Johnson Controls and Visteon (Datamonitor, *Automotive Business Review2004 quoted in (Kamp 2006)).*

Tier 0 normally refers to the vehicle manufacturer, VM, or original equipment manufacturer, OEM. The use of the term OEM allows for generalisations across sectors, but it is primarily the manufacturer who is supplying goods to the open market, even if this is through distributors. This definition is now distorted by the appearance of **tier 0.5** suppliers. At present they only produce 2% of vehicle production but companies like Magna, Pininfarina and Matra are growing in importance. Magna builds BMW and Mercedes cars. Pininfarina builds the Ford StreetKa and Matra the Renault Espace. These tier 0.5 companies have the flexibility to produce the small niche market variations of standard mass market vehicles.

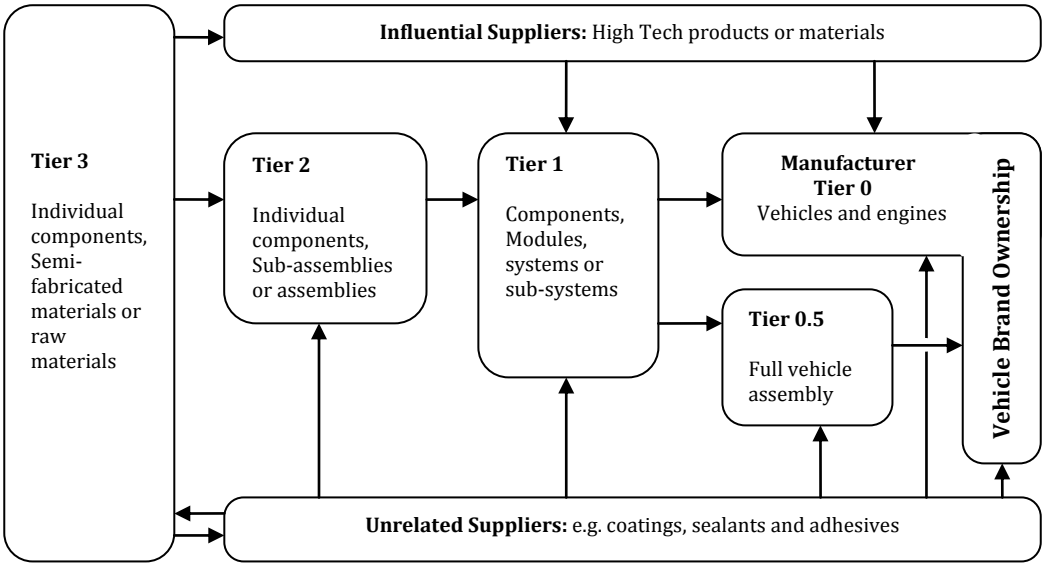

Figure 1.1 Supplier Classification

An **influential supplier** produces a product that must be purchased and modified before incorporation into a vehicle. A microprocessor is typical of these products. Work has to be done before the product can be used, but control of the product in terms of specification,

price and availability is firmly in the hands of the supplier. The Tier 1 company may well design a module to accommodate the product.

An **unrelated supplier** is not an insignificant supplier. Henkel Loctite is an example. They claim to be "the only company in the world that provides total systems encompassing all aspects of adhesive and sealant applications in automotive production" and, that in 1999, 454,000 tons of their specialty compounds were used in vehicle manufacture (Kamp 2006).

1.4. The role of Social Dialogue in promoting training initiatives

To understand the role of learning in the automotive supply sector, attention must first be given to the environment of the major players in the automotive industry. As indicated above, these major players work in a global market where the actions of competitors, governments and organised labour can affect performance.

Recognition that European employers, workforce and governments must work together was enshrined in Articles 138 and 139 of the Treaty of Rome[14]. The collective term used is European Social Dialogue, which encompasses formal meetings at the European level and the more localised discussions centred around an enterprise.

One of the key features of Social Dialogue is the primacy of Human Capital. People need to be developed in order to secure employment, to be productive in employment and to keep pace with developments in their employer's organisation and the industry around them.

> "Education and training are the key messages coming out of the social dialogue. This is not a generic request for training. The voice of industry and unions has been very precise in articulating their needs in terms of subject matter and form of learning. The providers need to respond in different ways to these needs. It is not simply a progression of qualifications. It is also about the role of learning in different situations. There are those who need training to gain employment. Businesses need staff trained to improve the competitiveness of their businesses. There is the need to capture the knowledge locked in older workers and to retrain those workers for new technologies. Above all in the new Knowledge Based

[14] The Treaty of Rome, 1958, amended by the Treaty of Maastricht, 1973, jointly known as the EC Treaty is the foundation stone of the European Union.

> Economy, routes for innovation must be found and staff trained to adjust to the changes that innovation will bring with it."(Automotive-Regions 2006)

Given the pressures on the international automotive industry as a whole, western countries cannot compete with low-wage countries on labour costs alone. The productivity and availability of employees are important as are geographical situation and logistic infrastructure. So too is the new desire to become Knowledge Based Economies. This is starting to take effect in the older EU states. It must be anticipated that this trend will follow across the whole of the EU, since at the Lisbon European Council in March 2000, government leaders set the EU a ten-year mission to become the most competitive and dynamic knowledge-based economy in the world, capable of sustained economic growth with more and better jobs and greater social cohesion.

In our complex society, effective government depends on the co-operation of other players and has to work with partners in the development and implementation of new policies and programmes to tackle economic and social problems. The shift from "power to partnership" opens up new opportunities but also poses difficult implementation issues.

Enterprises, too, are having to respond to structural change, reassess the skills they need and how production in general and work processes in particular should be organised. The challenge ahead is to maintain their competitiveness and improve their quality whilst positively managing all dimensions of change - economic, social and environmental – in order to ensure sustainable development and social cohesion. This can only be achieved by developing the full potential of both the present and future labour force.

The Community defines social dialogue as a "force for economic and social modernisation". Attainment of the strategic goals set in Lisbon depends largely on the action taken by the social partners. At a European level, both bipartite[15] and tripartite[16] dialogues have a contribution to make to employment, job training, modernisation and the adaptation of social protection systems.

[15] Bipartite dialogue at the European level is between the European employers and trade union organisations, the social partners.
[16] Tripartite dialogue at the European level involves interaction between the social partners and the public authorities.

Traditionally, sectors dominated by large companies are less inclined to develop a European social dialogue, since they tend to prefer collective agreements at enterprise level.

Within the Automotive Industry, Social Dialogue is the positive convergence of interests between social and institutional players to develop locally. Such convergence is crucial if the shared aims of socially sustainable growth and development are to be effectively achieved.

For the components of the European automotive sector to remain viable, their growth and development are essential. For this to be achieved, there is a need for greater responsiveness. This is not just a reference to lean manufacturing, but acknowledgement that companies who cannot keep up with the pace of change will suffer. The pressure for Lean manufacturing is an important part of this. The introduction of 'Lean' at both Ford and General Motors has created additional jobs at suppliers. It has also required a greater level of operational and management skills at these suppliers.

The pace of change is reflected in the case studies in section 1.5. The companies are different: British, American and Japanese. Their progress is different: demise, retraction and growth. Their approaches to the skills challenge differ. There is no "one case fits all" approach as a standard of good practice; there are illustrations that show how the various players can use social dialogue to their organisational, commercial and social advantage. There are also certainly some clear lessons about how not to engage.

1.4.1. Implication for Government and support agencies

There are good examples of agencies working well with industry and being able to take a long view uninhibited by regional or national prejudices. Government agencies have had to change, to take account of the changing global pattern. They have had to work with industry to develop strategically important partnerships. Two examples are the Fiat Auto Project in northern Italy and the Automotive Academy in the UK.

The Fiat Auto Project came into being as a result of the Programme Agreement signed by Fiat Auto Spa and the Italian government in December 2002, in which the company, considered to be strategically important for the Italian economy, undertook to support a

major training scheme, co-funded by the state. The project had to meet guidelines identified by the Ministry of Labour and Social Security and by the European Community.

The Automotive Academy was set up by the UK government under a predominately industrial board chaired by Jo Greenwell, CEO[17] of Jaguar Cars. At its launch in June 2003, the Trade and Industry Secretary, Patricia Hewitt, said: "The sector can't compete on the global stage on the basis of low wages and nor should it want to. It must compete on the basis of new technologies, new processes and skills - all key strands of the [UK] Government's manufacturing strategy."

In these partnerships governments are having to work with industry, both employers and unions, and very often are being guided by industry rather than providing standard solutions. Implicitly, these are social partnerships which cannot be controlled by one strong political partner.

The skills agenda has become important in most countries and there are examples where this has been worked out with input from the social partners.

Case Study I, in section 1.5., covers the period 1994 to 2006 of the Rover plant at Longbridge (abridged from (Davey 2006)). It concentrates on the training issues. The complex training scheme at Rover was intended to provide the workers with the specific know-how required to manufacture the proposed new Rover models, and to increase their basic skills. The scheme involved four levels of training:

1. basic skills;
2. job-related skills;
3. vocational training;
4. development of related skills (management, leadership, information technology).

Although the training was targeted at upskilling the company workforce there was also the intent to develop the trainees to create career opportunities for themselves outside Rover too, if the need arose for them to move. With transferable skills they would have improved levels of employability and adaptability.

[17] Chief Executive Officer

Case Study II covers the period during which the Vauxhall plant at Luton was closed down, again concentrating on the training and skills issues around that event (abridged from (Wood 2006)). The key initial task was to identify skills shortages in the local area, to map the skills of the Vauxhall workforce and then to consider the training and re-skilling requirements, which would enable them to be redeployed in the UK labour market. Particular reference was made to local labour shortages.

Case Study III illustrates the role that training has had in the planning and development of Nissan's very successful plant in Sunderland. The priority given to skills was demonstrated by the early plans and negotiations for the plant. Here the unions have played a positive role in creating a learning organisation.

Case Study IV illustrates examples of active partnerships within supply chains. Here the role of unions is less, but the strength is the host company working collaboratively with its suppliers rather than in an adversarial purchasing mode. There is still the same element of managing risk as in the other case studies.

The Fiat Auto Training Plan was formulated with the company's needs in mind and its aim is to assist the workers in developing their ability to adapt to the market. Along with the training plan, welfare services are implemented to aid groups of workers that would otherwise risk being dismissed from the labour market, taking action to improve their basic and technical skills.

As well as the use of training programmes, the move to a Knowledge Based Economy requires greater acknowledgement of innovation in its widest sense.

Governments' responses to social dialogue have also helped to shape their budgetary policy. The Challenge is how to use available budgets across similar but competing demands:

- Training to raise skills within the automotive and advanced engineering sectors, targeting acknowledged skill gaps.
- Training to improve employment prospects of those in the labour market, including basic skills.
- Training to prolong the working usefulness of older workers, enabling them to keep abreast of new technologies.

- Training to prepare the whole workforce to embrace the shift to a Knowledge Based Economy.

1.4.2. Implication for the vehicle manufacturers

For both employers and the unions engaged in large organisations there has been the realisation that a purely confrontational approach is no longer tenable. The details given in the case studies at Rover and Vauxhall show that the main preoccupation for unions had been to save members' jobs. Only more recently have there been examples of employers and unions working together to face the external competition. The supply chain examples show that progress is made once scepticism is overcome.

The challenge of a congested market with low cost competitors located nearer to the new growing markets has meant that the OEMs need an adaptable rather than a stable workforce. Companies have had to be prepared to be innovative in their approaches to recruitment, employment and training.

The training programmes that are presented here and in the case studies have been designed to do more than just increase operational skills. They have included basic and life skills. Companies have seen that access to European Funding is predicated on development plans that support competitiveness of industry and job security or job readiness of the population.

Both the Fiat and the Vauxhall training plans and welfare services are implemented to aid groups of workers that would otherwise risk being dismissed from the labour market, taking action to improve their basic and technical skills

The challenge for large companies and their union partners are:

- To engage with the challenges of over capacity in a moving global market. The Nissan example faces the transnational pressures.
- To develop a skilled, adaptable but fluid employee resource.
- To become agile innovative operations that can follow the market.

1.4.3. Implication for small to medium sized manufacturing enterprises

There is no homogeneity amongst SMEs. As the message about lifelong learning takes root, SMEs need to understand not the advantages or disadvantages of training, but the perils of missing the opportunities that are open to an SME with a well trained workforce. These companies, who form a significant part of the automotive supply chain, suffer from lack of skills. Recruitment is difficult as they rely on multi-skilled staff. If they have embraced lean production, they have little capacity to engage in training activities (Automotive-Regions 2006).

1.4.4. Implication for training providers and support agencies

Education and training are the key messages coming out of the social dialogue. This is not a generic request for training. The voice of industry and unions has been very precise in articulating their needs in terms of subject matter and form of learning. The courses mentioned in these case studies have ranged from computer networking, teacher training, LGV and forklift truck training, construction trades, PC maintenance, management studies and data cable installation project management using PRINCE 2 and various computer graphics courses from AutoCAD to Catia V. This voice will be articulated again in chapter 3, especially in section 3.2.

The providers need to respond in different ways to these needs. It is not simply a progression of qualifications. It is also about the role of learning in different situations. There are those who need training to gain employment. This might include counselling services to provide access to welfare and financial advice. Businesses need staff trained to improve the competitiveness of their businesses. There is the need to capture and acknowledge the knowledge locked in older workers and to retrain those workers for new technologies.

With the emergence of a highly flexible workforce, there is the need for skills and the evidence of skills to be transferable from one employment to another (Tolley et al. 2002). In the UK, National Vocational Qualifications, NVQs, which are awarded on demonstration of competence in the workplace, provide a good means to acknowledge learning. Accreditation of prior learning, APL, at Rover gave credence to the experience of the company's many well established staff before they found themselves in the job market.

The other challenge that permeates these case studies is that training providers themselves

need to be reactive to demand and flexible in delivery. Where short courses are required to handle a particular skills gap, they must deliver a product that meets the company need but also provides the employee with the component of a qualification that can be built into a recognised certificate or "passport" which will have credibility with other employers.

Above all in the new Knowledge based economy, routes for innovation must be found and staff trained to adjust to the changes that innovation will bring with it. This again calls for new ways of delivering training.

This section has used the concept of Social Dialogue to demonstrate the mixed role of learning in the major vehicle manufacturers in Western Europe. The four case studies provide evidence of diverse applications of training. Challenges have been gleaned from the experiences presented in the case studies. They are certainly not the definitive list of challenges facing participants in Social Dialogue, nor those involved in training, but they are manifold in more than one European country.

1.5. Case Studies

1.5.1. Case Study I - Rover Group Ltd, Longbridge

Once the biggest manufacturing plant in the world, the Longbridge Rover plant in the West Midlands has declined despite significant investment both financial and in the development of its human capital. It opened in 1894 as Austin. Its history and its financial traumas are well documented, for instance by Oliver, Holweg and Carver (Oliver 2008), but to consider it from the perspective of skills development, a good starting point is 1994 when the then Rover Group was taken over by BMW.

In the following year, the 30,000 strong staff were trained in the philosophies and tools of total quality. Within six years the still failing company was sold to the Phoenix Venture Holdings, PVH, in a management buyout.

Over 400 employees underwent a nine-week training programme. The "pilot production" facility in the Longbridge Methods Build Department was used for intensive five-day "hands-on" training modules. The training programme included a full strip-down and re-build of a Rover 75 to ensure each associate was familiar with the advanced components, processes and tools used to build the cars for the new company, MG Rover Holdings Limited.

In the period from 1999 to 2004, a training scheme for around 6,000 workers received funding of 15.6 million Euros from the European Commission. The scheme was intended to provide the workers with the specific know-how required to manufacture the new Rover model, to increase their basic skills and by using accredited training (NVQ), to ensure full transferability into the job market.

The scheme involved four levels of training:

1. basic skills;
2. job-related skills;
3. vocational training;
4. development of related skills (management, leadership, information technology).

However, the Phoenix Consortium had to put MG Rover Group into administration in 2005 at the cost of 6000 jobs in the plant and in the supply chain. Nanjing Automobile Corporation bought MG Rover with the hope of restarting production of some of MG Rover ranges by 2007, but with a smaller workforce. Full-scale production restarted in August 2008.

Public support to those people was provided through the 'Manufacturing Offer' delivered by the Learning & Skills Council, LSC, Job Centre Plus, JCP and Skills4Auto[18], supported by the Sector Skills Council, SEMTA, Society of Motor Manufacturers and Traders, SMMT, and the Engineering Employers Federation, EEF. The UK Government provided £150 million and the EU a further £68 million. The aim of the offer was to retain the much needed manufacturing skills of the workforce within the regional economy and provide an opportunity to enhance this skills base. Over 800 people have been successfully retained in a manufacturing/engineering role within the region. Skills4Auto worked with its partners to support companies' own recruitment activities.

Over 270 companies have participated in the offer, involving potentially over 800 ex-Rover, supply chain employees. 600 individuals have been referred to almost 40 different providers. Business Improvement Techniques, NVQ Level 2, was the main training

[18] Skills4Auto is a publicly funded organization that provides support to the Midlands Manufacturing and Engineering Automotive sector. It works with companies and individuals to identify business development needs and facilitate training based solutions. It has acted as the Midlands' spoke of the national Automotive Academy.

programme. Other training programmes included the Project Management Tool PRINCE 2 and various computer aided design courses from AutoCAD to Catia V.

This case study has been abridged directly from a report presented to Skills4Auto *(Davey 2006)*

1.5.2. Case Study II – Vauxhall Cars – Luton

The closure of Vauxhall in Luton was part of a wider restructuring programme announced by GM involving 10,000 job losses in North America and Europe over a period of 18 months. The Vauxhall Car Plant in Luton, which had opened in 1905, had been one of the area's major employers for almost a century. At the height of production, the plant employed around 25,000 people.

The plant finally closed in March 2002 with the direct loss of just over 2000 employees, with an average length of service of 17 years. 1000 jobs were transferred to the neighbouring IBC[19] van plant. It was also calculated that there was an indirect loss of a further 563 jobs. The impact on the wider supply chain was estimated at £85 million.

The potential impact of the closure of Vauxhall on Luton was such that it provoked an extremely fast response. A day after the closure announcement, a number of concerned organisations, led by EEDA, were brought together to form the 'Luton Vauxhall Partnership'. This was a partnership of the public and private sector encompassing the Vauxhall Company, trade unions, the Employment Service, regional supply network, the local authorities and local University. Its purpose was to address job losses and the effects of the closure on the local economy.

Despite initial hostility to the closure, the unions were instrumental in identifying a need for an accreditation of prior learning (APL) programme at the plant, and played an active role in delivering an NVQ programme. The Learning and Skills Council helped to identify training providers and supported the APL programme. A local Further Education College was the main provider of the training and re-skilling programme along with other private providers. The project was delivered by an ESF Project Management Team, whose remit

[19] IBC: Isuzu and Bedford Commercial (IBC) Vehicles was formed in 1987 as a joint venture between General Motors and Isuzu Motors of Japan. In 1998 IBC Vehicles became a 100% owned subsidiary of General Motors

was to 'tackle issues arising from the closure'. With matched funding the total budget for the project was £1.6 million.

A key initial task was to identify skills shortages in the local area, to map the skills of the Vauxhall workforce and then to consider the retraining and re-skilling requirements, which would enable them to be redeployed in the UK labour market, locally in particular. This was undertaken by the local Jobcentre Plus, who also provided initial advice and guidance to workers.

Workers were offered impartial guidance interviews with advice on their training needs, appropriate training/re-training courses, interview techniques, CV writing and Basic Skills. Training sessions were organised by the local college and private training providers on Friday, with some training taking place on Saturday morning, thus easing pressure on production.

The training provided included computer networking, teacher training, LGV and forklift truck training, construction trades, PC maintenance, management studies and data cable installation. An APL assessment scheme was initiated with extra funding from the LSC, Vauxhall and EEDA.

The partnership offered an enhanced business support package to a core of very skilled workers who wanted to set up their own smaller manufacturing businesses. It worked with them on a special programme, offering incubation space to build and grow businesses, on the basis that these could be the sort of businesses that might provide replacement jobs.

The project tracked the activities of each beneficiary through the various stages of support. 1,540 beneficiaries took part in the programme (27% more than had been expected at the start of the project). Vocational training was accessed by 1,214 workers with 105 workers attending Business Start-Up Courses organised by the Chamber of Commerce.

A key aspect was the focus on the supply chain. To enable the Partnership to support companies in the region, Vauxhall provided details of their supply chain. Here 66 companies and 452 individuals received support. Training was in terms of marketing, lean production, health & safety, upskilling, management training and ICT training. This intervention left the supply chain in better shape, more able to cope with change and seek new opportunities.

This case study has been abridged directly from a report presented to EEDA *(Amicus 2004; Parliament 2002a; Parliament 2002b; Wood 2006)*

1.5.3. Case Study III Nissan Motor Manufacturing (NMUK)

Nissan Motor Manufacturing (UK) Ltd or NMUK is the largest car plant in the United Kingdom, as well as the most productive in Europe, producing more 'cars per employee' than any other factory. There are 4,500 workers directly employed by NMUK, and approximately 500 contracted, indirect staff. NMUK employs a well developed lean manufacturing system which includes Kaizen[20], Just in Time[21] and Job Rotation[22].

In accordance with its Investors in People[23] responsibilities, NMUK has a very active training department and offers a wide range of on- and off-the-job training. The Flexible Learning Centre established on-site is open to all staff and allows them to taken part in over 300 courses.

Technical on-the-job training is available to all staff, and most of the courses are given on-site by qualified trainers. People development courses (e.g. Presentation Skills) are also provided. NMUK spends more per head on staff-development than the British industry average. NMUK has a Continuous Development Programme (CDP) whereby staff are given personal and professional objectives each year, and are appraised against these objects. This appraisal is linked to pay increases. This is also an opportunity for staff to identify where further training may be appropriate.

After vetting various sites in Europe, Nissan reached an agreement with the British Government in 1984 to set up its new plant to manufacture vehicles for the EC market in Sunderland. At that time, the North-East England had recently undergone a period of

[20] Kaizen is a Japanese word meaning 'Continuous Improvement'. NMUK encourages its entire workforce to seek out areas in which improvements, no matter how small, can be made to their working environment. The emphasis is on small, manageable improvements.
[21] The JIT philosophy encourages the use of the minimum amount of resources (e.g. space, time, material, workers) necessary to add value to a product. NMUK uses this management technique throughout the factory and beyond. Synchronous Suppliers deliver parts line-side only when they are required, therefore reducing the need to store large supplies of parts at great cost.
[22] In order to keep the workforce flexible, NMUK operates a policy of '1 man to 3 jobs, 3 men to 1 job'. In other words, a worker should be skilled in at least three different jobs, and at least three people should be capable of doing each job. This principle ensures that each job can be covered in the case of absence. It also means that jobs can be regularly rotated to prevent a worker from becoming bored in a particular role.
[23] Investors in People is a voluntary assessment scheme backed by the UK Department for Education and Skills. IiP was developed in 1990 through a partnership of businesses and other national organizations. The scheme aims to improve organisational performance through better planning, implementation and evaluation of learning and development programmes, across organisations of all sizes and sectors.

industrial decline, with the closure of most of its shipyards and coal mines. The full story is covered in great depth in "The Nissan Enigma"(Garrahan and Stewart 1992).

In the next year Nissan's management began talks with various trade unions, proposing a company organisation project that was not very hierarchical, devoid of job compartmentalisation, based on a workforce that was ***all*** highly skilled, on-going professional training programmes, working groups with a considerable level of autonomy, and marked interchangeability of roles. The importance of the flow of information between employees and management, as well as the attention that would be devoted to implementing and improving it was particularly stressed. An agreement was reached with the Amalgamated Engineering Union (AEU)[24].

This agreement was innovative and unprecedented in UK industry. Amongst the general principles of that agreement two objectives stand out:

- establish procedures to solve each issue connected with these *[industrial]* relations rapidly and effectively;
- recognise that all workers, at all levels, play a significant role in the company's success.

In this regard, the trade unions and the employer agreed on the need to (Art.1):

- create a team committed to achieving the highest levels of quality, productivity and skills, using modern technology and forms of work and prepared to make the changes necessary to maintain these levels of excellence;
- actively promote the workers' contribution to the pursuit of these objectives;

By 1986 the first 247 employees were selected. The workforce quadrupled in four years. In 1991 NMUK turned its first profit of £18.4 million and was awarded 'British Manufacturer' status by the Society of Motor Manufacturers and Traders (SMMT). That accolade was followed by the Micra being voted "European Car of the Year 1993".

[24] The AEU was then the major engineering industry trade union, which in 1992 – following a merger with another trade union association – changed its name to Amicus the Union.

NMUK increased both its productivity and its innovativeness. Its co-operation with Cranfield University which had started with *Customer Understanding Processes in Design* (CUPID) extended to the design of a number of components for the vehicles manufactured.

The Sunderland plant, with a production rate of 73 vehicles per employee, achieved first place in the classification of the most productive car manufacturing plants in the world. It subsequently retained this leadership reaching a record 101 vehicles manufactured per employee in 2000[25].

The Institute for Automotive and Manufacturing Advanced Practice was set up at Sunderland University and began operation, with the task of supplying scientific research and technical design work to the car industry and to enterprises supplying services to it, as well as training personnel to be employed by them.

This case study has been abridged with an emphasis on learning directly from a case study in a report to Automotive Regions Working GroupTW5*(Paoletti 2006)*

1.5.4. Case Study IV Supply Chain Groups

The UK Government set up its Supply Chain Groups Programme in 2004 to bolster the global competitiveness of the automotive and aerospace industries. Host companies, with a minimum of eight of their suppliers, work in partnership to identify potential business improvements. The Government has funded 50% of the costs of the necessary training and interventions. Sixty four groups have been supported with funds of £5.5 million. Ten of those groups were in the East of England. Three of these have been located with Visteon, Lotus and Flexible Lamps.

Visteon UK Limited is a multinational Tier one supplier, with170 facilities in 24 countries and 3000 staff in the UK. As it rationalises its supply base, it needs long term relationships with suppliers who like Visteon are lean, responsive and committed to continuous improvement. This means developing the suppliers.

[25] Figures from the 2002 press release by the World Markets Research Centre*, Nissan's Sunderland Car Plant once again sets European productivity standards.*

'We are not aiming to 'Visteonise' the suppliers… we want to work with them to develop their core competences to a point whereby when the programme ends they can continue to move forward and build on the foundations that have been laid.' *Jon Diss, Supply Chain Project Champion, Visteon UK.*

He had a team of internal experts delivering training and practical interventions to twelve of Visteon's long term suppliers. The focus was on eliminating waste. The team helped the suppliers to commit to improving the capabilities of their teams, individuals and their processes. Key to this was understanding and rectifying their skills deficiencies.

Tools tailored to the supplier's needs included Value Stream Mapping, Standardised Work SMED[26], Workplace Organisation, Visual Management, Advanced Product Quality Planning, APQP, and Six Sigma. Progress against an action plan was monitored on a balanced scorecard. Targets were set for overall equipment effectiveness, delivery rating, quality, stability and customer relations, value added per person, floor space utilisation and stock turns.

In the two year project which finished in November 2005, the team delivered 3000 hours of training. One supplier delivered a 40% productivity improvement to what had been a loss-making cell. Another found sufficient cost saving to be able to continue winning work from Visteon.

Lotus Cars Ltd started a Supply Chain Groups project in January 2004. With a focus on scheduling and communications, they achieved a 50% improvement in delivery performance in two years.

For its own car manufacture it receives over 2,800 parts from 200 suppliers, but with a shift towards more Tier 0.5 manufacturing with predictions of sales growth, Lotus needed to develop its supply chain to be reliable, flexible and lean.

'Through the Supply Chain Groups project we wanted to improve scheduling to give suppliers a very clear demand profile so that we could reduce shortages and also tackle the problem of obsolescence.' *Dan Parnell, Material Control Manager and Project Champion at Lotus*

[26] Single Minute Exchange of Die meaning reduction in changeover time.

Work included value stream mapping to simplify processes and supplier development activities including workshops with trained change agents. Both Lotus and nine of their suppliers implemented changes.

The results across the project were a 10% increase in delivery performance, a 50% drop in line shortages and a substantial drop in unnecessary inventory amounting to 20 stock turns per year. Now regular QCD reporting from suppliers is assisting the integration of the supply chain into Lotus' internal operations.

In 2003/2004 Flexible Lamps in Essex, a manufacturer of commercial vehicle lighting systems, had annual sales of £30 million. To grow it needed to address the ever evolving niche markets and for this it needed an efficient, flexible, design orientated supply chain. Nine of its suppliers, with turnovers of between £1 and £6 million, joined its supply chain project.

Early training activities and value stream mapping diagnostics provided a number of specific improvement projects. A Steering Group maintained commitment from all partners and co-ordinated training and improvement activities. Early scepticism from the suppliers was overcome once the commitment of Flexible Lamps was seen. The company analysed its own processes and improved its ordering to allow suppliers to reduce their stock holding.

In just the first year of the project, delivery performance had increased by 5% with eight of the nine suppliers reaching their target 95%. Productivity across the group had increased by 17% in value added per person. In particular suppliers, examples included a 41% rise in throughput and 70% reduction in set-up time. The improvements in the group's performance meant that Flexible Lamps' competitiveness increased and the suppliers saw increased sales.

This case study has been abridged with a deliberate emphasis on learning directly from the BERR website http://www.supplychaingroups.co.uk/case_studies ***together with discussion with EEDA advisers.***

1.6. Interlogue

Chapter 1 has started with a brief introduction to the subject of the thesis. To set the problem into its industrial context, the main purpose of this chapter has been to review the

state of the European automotive industry and show how training initiatives have interfaced with its challenges.

The first part of the chapter reviewed the industry in terms of its capacity and its market size. The second part of the chapter has discussed training activities in terms of social partnerships. This has been illustrated with four case studies, two giving a poor view of the industry and two showing positive improvements. These have centred on vehicle manufacturers and their major Tier 1 and Tier 2 suppliers.

The focus here has been on the wider industrial context for the research. Chapter 2 will focus on the academic context and introduce a research agenda.

Chapter Two The Research Context

You have something within you, Theaetetus, that you're bringing forth
Socrates, Theaetetus, 450BC

2.1. Introduction

In contrast to Chapter One's industrial context here in Chapter Two the professional and academic context is described and the research questions are posed. First the working role of the author is set out in relationship to the various organisations that relate to learning in the sector. The contribution of the taught and APL/APELed modules of the Engineering Doctorate to the research are then reviewed. Finally the research problem itself is expanded.

2.2. Professional development and connections

National support for training in the automotive supply sector has been provided by a number of training and support agencies, one of whom, the Automotive College was an initial industrial sponsor to this Engineering Doctorate programme.

2.2.1. Automotive College

The *virtual* Automotive College was set up in 1999 in an effort to address the skills shortages amongst manufacturers in the UK automotive supply chain. It was conceived in 1995 after a DTI report that highlighted the lack of competitiveness in the UK Automotive Components Sector (AndersonConsulting 1994). This had concluded that UK firms were being put at a competitive disadvantage by a shortage of suitably qualified engineers. It was formed as a partnership of universities, colleges and industry in the form of the SMMT Industry Forum, together with an ICT specialist with support and £1.2 million in funding

from the DTI[27]. See figure 2.1. Regional operations ran in the Northwest, the Midlands and the East of England.

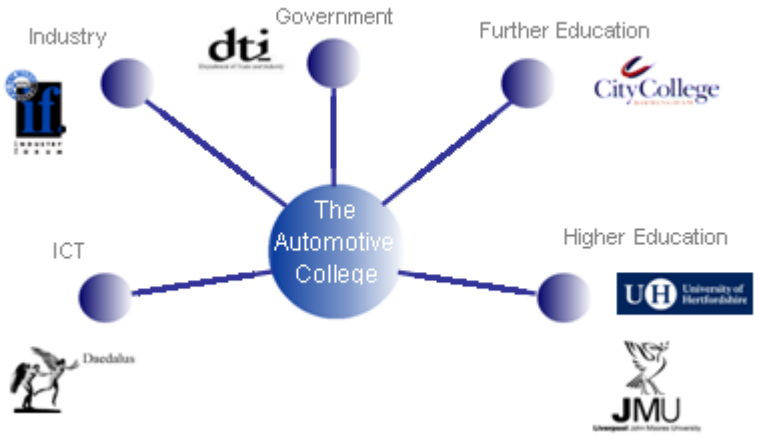

Figure 2.1 The Automotive College partnership

The College implemented its programmes in four key phases. The **diagnostic** visit defined the company needs, goals and benefits, and identified individual employee needs. Programmes of learning were **customised** to suit the specific needs of the participating company and individuals. The learning programmes were **delivered** in-house - where there is focus on company case studies and real company problem solving. The staff for these programmes were selected from the universities and FE Colleges in the partnership. Ongoing **support** was provided to aid implementation of improvements including the recording of achievements and access to the network of companies and an online network. Of the programmes on offer, it is unsurprising that the most popular has been "Lean Tools" (Barlow 1999).

The author was the Automotive College's regional manager for the East of England.

2.2.2. Automotive Academy

The work of the Automotive College and the Industry Forum were both recognised in the Automotive Innovation Growth Team report (Gibson 2002). The recommendations of that report included a proposal to build on their achievements by setting up an Automotive Academy.

[27] DTI the Department of Trade and Industry, now superseded by BERR and DIUS.

It was launched in 2003 with funding from the DTI of £15 million. The Academy was managed from a central hub in the West Midlands with delivery spokes in the nine English regions and the three devolved administrations.

To guarantee a strong "demand led" strategy at a senior level, senior members of industry were recruited to the board which was chaired by the CEO of Jaguar Cars. This foreshadowed The Leitch report which stressed both the need to drive up skills and the need to involve industry (Leitch 2005).

The Automotive Academy took the route of providing a training and monitoring scheme for upskilling the trainers and assessors working with the industry. In its last year, prior to being subsumed into the National Skills Academy for Manufacturing, its achievements included 178 additional automotive companies that have staff with Automotive Academy accredited qualifications and over 3,500 people starting on Automotive Academy training programmes. These trainees had initiated around 9000 improvement programmes in their own businesses (Darling 2006).

The author was seconded into the Automotive Academy's Launch Team and subsequently contributed to the Academy's Quality working group and project managed the East of England spoke of the Academy.

2.2.3. National Skills Academy for Manufacturing

As a response to the Leitch report, from 2005, the UK Government began to launch a series of National Skills Academies of which the National Skills Academy for Manufacturing was in the first batch along with Construction, Financial Services and Food and Drink manufacture.

As indicated above, its organisation subsumed the activities of the existing Automotive Academy but with a larger brief to cover all manufacturing. This has meant that from its "official" launch in January 2007 it has been able to achieve the validation of the skills of over 350 trainers and assessors, and worked with companies across the sector to select and employ programmes for improving the skills of over 700 employees.

Bob Gibbon, Managing Director of the National Skills Academy for Manufacturing, said: "We have achieved a great deal at the National Skills Academy for Manufacturing in a year. We have gone direct to over 250 businesses, throughout England and Northern

Ireland, to develop the training that industry needs to prosper economically on the world stage. We have identified, championed and begun integrating examples of quality manufacturing training." (MWPonline 2008)

Like the Automotive academy before it, it has a team of managers set up in each of the UK's regions and administrations. These are now supplemented with administration support and regional advisory groups chaired by key industrialists in each region. In the East of England work started with Lotus Group under the Automotive Academy is being continued with NSA-M.

The author represents the Association of Universities in the East of England, AUEE, on the Regional Advisory Group of the East of England Spoke of NSA-M.

2.2.4. Comparison of the initiatives

All three of these initiatives have had similar objectives. The major differences have been in their scale, their funding and their historical position. The performance of the immediate predecessor has influenced the decision to fund both the Automotive Academy and the National Skills Academy for Manufacturing (Gibson 2002; Leitch 2005). All three have been heavily supported by SMMT Industry Forum.

With its limited resources the Automotive College tested the principle of work-related training using Further and Higher Education staff. Its particular strength was running a lean and virtual organisation (Barlow 2002).

The Automotive Academy built on that experience with larger resources and a greater reach across the country. However it lost flexibility by reducing the offering to lean and business improvement techniques and by not continuing the development of pre-course diagnostic tools. This is covered in Project II which is introduced in Chapter Four section 4.3. It made progress with over 400 NVQs in the East of England but it could only achieve this by targeting the larger SMEs.

NSA-M has a similar structure and resources to Automotive Academy, but a larger remit to cover all manufacturing. Its initial plans were to continue the work of the Automotive Academy. Its launch has coincided with Project II, making it too early to judge the success or otherwise of this third initiative. The indications are that being positioned within

SEMTA[28] it will have stronger skills leadership than its predecessor. Industry has had an input into all three. This is an essential ingredient highlighted by Leitch but the experience here shows that industry's voice must be balanced by expertise in training and skills.

2.2.5. Career progression in relationship to learning in the automotive sector

Before joining the University of Hertfordshire, the author had moved from manufacturing industry to become an independent management consultant in 1995 and has worked with companies and educational institutions across the country and with staff ranging from apprentice to director. He has also been an associate lecturer with the Open University since 1991. Combining these two activities led him to work on the development, management and delivery of a number of postgraduate programmes including an MBA(Technology Management) and an MSc in Automotive Engineering.

He was a key member of the Luton/Cranfield/Hertfordshire team that provided the underpinning research to support the ESF funded ASPEN project aimed at supporting the automotive supply sector in the region during 2000 to 2001 (Bevis 2001).

Since 2000 he has been the Business Development Manager within the School of Aerospace, Automotive and Design Engineering, AADE, at the University of Hertfordshire. Currently he works to develop sustainable business links with industry, through student activity, consultancy, training and Knowledge Transfer Partnerships.

In partnership with **i10**[29], this has included mentoring, problem solving and finding the right expert to assist in an SME's development. He has worked on a major **i10** project, MAPSme, to identify and service the operational and strategic innovation needs of a group of manufacturing companies in the East of England. The survey has now reached over 200 companies.

Particular projects related to the automotive industry have included developing sustainable learning processes within SMEs in the Automotive Supply chain, as Regional Manager in the **Automotive College** project. The author was seconded to support the DTI in the **Automotive Academy** Launch Team. (2003-2004) and within UH-AADE has run the

[28] Sector Skills Council for Scientific, Engineering, Manufacturing and Technology.
[29] **i10** is the network of universities and colleges in the East of England which are building stronger links with businesses in the region to help develop and exploit innovation opportunities. www.i10.org.uk

London and East of England Regional Spoke project for the Academy (£500,000 project over 2005 -2007).

Other network activity has included the Interreg IIIc Automotive Regions programme and the BeLCAR[30] programme. Each of these programmes is aimed at developing understanding and linkages between organisations across a number of European regions.

The author has been on the Board of Governors of Enfield College since 1997 as a Business Governor, where he chairs the Quality and Self Assessment Committee of the Board. This position has deepened his understanding of the Further Education sector and National Vocational Qualifications.

He now sits on the Engineering Advisory Group of the Hethel Engineering Centre, HEC[31], in Norfolk, and on the East of England's Regional Advisory Group for the National Skills Academy for Manufacturing, representing the Association of Universities in the East of England. In both of these positions he is able to influence policy around the delivery of training for the manufacturing sector.

He supports the Masters' programmes in the School. To develop an understanding of taught modules mentioned below in section 2.3.3 the author has designed, written and marked eight integrating examinations for students on the IGDS[32] MSc programme. He also continues as an associate lecturer on the Open University Masters programme for manufacturing.

2.3. Academic context

2.3.1. The Developing Role of Quality in the Automotive Industry

Quality in manufacturing at the turn of the century cannot be studied without reference to the Japanese phenomenon and the roll out of lean manufacturing across western manufacturing industry and first of all across the automotive sector.

[30] BeLCAR is a European project, Bench learning in cluster management for the automotive sector in European regions, run from Stuttgart.
[31] HEC is a business incubator and training facility focusing on high performance engineering and manufacture. It is located adjacent to Group Lotus in Norfolk , UK.
[32] The Integrated Graduate Development Scheme MSc at the University of Hertfordshire entitled "MSc in Automotive Engineering: Design, Manufacture and Management" provides the taught modules for this Engineering Doctorate programme.

Having been developed by Toyota over a period of some thirty years, Lean manufacturing is widely considered as the best performing production paradigm. The term "Lean" was first coined by John F. Krafcik at MIT[33] as a contrast to buffered systems (Westkämper E.; Barthel 2007). Now the term is more closely associated with the Toyota Production System described by Taiichi Ohno and Shingo Shigeo, (Ohno 1988), (Shigeo 1985). Lean can however be a two edged sword. Despite the doubt he raises about companies becoming less innovative, Lewis still reports that "Lean is seen as specifically supporting the company's ambition to be competitive" (Lewis 2000). However, innovation supports competitiveness. This conundrum is picked up in Project II which is reported in Chapter Four.

To understand the success of the Japanese, examinations had to go deeper than just the approach to "lean". Krafcik and MacDuffie looked at the social relations in the workplace. Their study monitored factory practice – a measure of "leanness", work systems – a measure of team working and quality responsibility and HRM[34] policy – a measure of recruitment and training policies. Whilst each contributed equally to productivity, the HRM policy had a direct effect on quality. They concluded that "this analysis … supports our argument that all three of these components of production system management are important determinants of world class manufacturing performance."(Krafcik 1989) This again highlights the importance of the human capital in manufacturing industry.

No course or learning programme on the automotive industry would be complete without reference to "The Machine that changed the World". This seminal study of vehicle assembly plant performance, the International Motor Vehicle Programme, IMVP, revealed the gap in productivity between Japanese and European vehicle manufacturers. The average time to build a standard car was 36.7 hours in Europe compared to only 13.2 hours in Japan (Womack 1991). Whilst it is acknowledged that the Japanese carmakers are more efficient than their European counterparts, the comparison may not be so stark. By the late 1980s Toyota was already assembling its cars from larger subassemblies than its European rivals. The smaller part count contributed in some part to the differences shown. Differing manufacturing practices have meant that this was not a like for like comparison. This type of measurement has continued to feature as a "league table entry" when comparing nations. More recently the difference in productivity between the UK and its European partners was used as justification for the National Skills Academy for Manufacturing (Whiteman 2005).

[33] Massachusetts Institute of Technology
[34] Human Resource Management

The role of Nissan Motor Manufacturing UK (NMUK) in the implementation and promotion of lean manufacturing in the UK has already been alluded to in Chapter One's case studies. The overall implementation of lean is not without its problems. Peter Wickens, a senior HR professional at Nissan published a review of Lean Manufacturing, highlighting both its achievements and pitfalls. He recalled how the Japanese Auto Workers Union (JAWU), had at a conference in 1992, emphasised the 'triple sufferings' of the Japanese automobile industry:

> "*….the employees are exhausted, the companies make little profit and the automobile industry is always being bashed from overseas*."

A second study by Lloyd, Dale and Burnes, investigated Nissan's performance on supplier development. Most of the suppliers studied recognised that to become long term partners of NMUK they would need some form of cultural change. A number of issues were identified including the need to improve training at all levels, the need to make better use of supervisors and team leaders and the need to introduce various aspects of lean manufacturing (Lloyd 1994). These points run through the developments of the support mechanisms in the UK and the three research projects reported in Chapter 4.

In presenting an historical perspective to Quality and the human actors in this field, an early reference had to be Taylor and his scientific management approach (Taylor 1923). Taylor's ideas affected the early automotive manufacturers and interestingly, Stalin's drive for industrial efficiency in the Soviet vision for Russia. Much of the quality initiatives of the latter part of the twentieth century can be seen as reversing the simplifications of Taylor's approach (Dankbaar 1997). In Chapter 4, Project II reflects of the Taylorist approach and questions whether too high an emphasis on Lean can be detrimental to the smaller SMEs.

A major report picked up at various points in this thesis and used as justification for change by major players in Government and the OEMs was that produced by Anderson Consulting and researchers from Cardiff Business School and the University of Cambridge (AndersonConsulting 1994). The work began in 1992. They started by comparing automotive component manufacturers in the UK and Japan, using performance and quality as their criteria. Using nine companies in each country, they identified just five as being "world-class". As the definition of "world-class" is not an accepted standard, it is useful

here to record their particular view determined from this sample. The characteristics of the "world-class manufacturers" in comparison with the remainder were that they:

- had made more use of automation
- had higher production volumes
- had less than one third of the rework
- had one seventh of the inventory
- had more active structures of problem solving and improvement on the shop-floor
- held one quarter of the finished stock
- held only one quarter of incoming parts
- received noticeably fewer non-conforming items from their suppliers
- worked more closely with both their customers and their suppliers.

Five of these characteristics; inventory, problem solving and improvements, quantity of stock, quantity of parts and relationships through the supply chain can be seen as underpinning much of the company and supply chain development work promoted and funded by Government in the UK across the turn of the century, from Industry Forum and National Supply Chains Group through to Automotive Academy and National Skills Academy for Manufacturing.

These findings were verified by a larger study of seventy one companies across eight countries. Pertinent to this research is that the UK was listed after Japan, Spain, France and USA/Canada (AndersonConsulting 1994) as shown in table 2.1.

Table 2.1 Country Performance Comparison

Countries	No. of plant participating	No of world-class plants	Productivity	Labour costs per unit	Incoming defects	Internal defects	Customer complaints	Stock Turns
Japan	9	5	●	⊙	●	●	●	●
Spain	4	2	●	●	●	●	⊙	⊙
France	11	3	⊙	●	⊙	⊙	⊙	○
US/Canada	14	3	⊙	⊙	○	⊙	●	●
UK	12	-	○	○	⊙	⊙	○	⊙
Italy	8	-	⊙	⊙	○	○	○	⊙
Germany	9	-	○	○	⊙	○	⊙	○
Mexico	4	-	(Seat manufacturers only. No further information given.)					

● ranked 1 or 2 ⊙ ranked 3, 4 or 5 ○ ranked 6 or 7

Source: (AndersonConsulting 1994)

The final comment on how the study of quality has supported this research must be a mention of Joseph M. Juran, one of the fathers of the late twentieth century quality movement. He distinguished between quality control, quality improvement and quality planning. By separating out the different aspects of quality, he assured the importance of "improvement" as a key characteristic (Juran 1980).

2.3.2. The integrated nature of the Automotive Supply Chain and its development

The separate study of supply chain management, undertaken as part of this programme supports the concepts introduced in section 1.3.2 of this thesis – the changing Tier structure in the automotive industry.

An example of the advantage of a systems approach would be the Automotive Industry's response to complexity. Whilst car manufacture had been built into the mass production line (Hounshell 1984), the increasing demands for "different" models has increased the variations of each product running down the one line. Although offline assembly of the various subsystems could manage this, there is pressure on the space. The second pressure is that of expecting the same operators to work on a number of similar but different feeder lines, thus increasing the complexity and potential risk of error for each operator and the system as a whole. By pushing these major subsystems back down the supply chain to the Tier 1 suppliers, the OEM becomes an assembler of a smaller number of components. It is the systems approach that allows the OEM to manage the risk.

The disadvantage of this type of approach is that one player in the chain can become dominant to the detriment of the others. According to the American service sector guru Quinn it is likely that "within manufacturing, 75 to 85% of all value added, and a similar percentage of costs are due to service activities. The major value added to a product is typically due less to its basic commodity value than to styling features, perceived quality, etc added by 'services' activities inside or outside the producing company "(den Hertog 1997). Brand value is a particular example of this. This also supports the expectations of FAST 2015 reported in section 1.3.1.

A naïve view of the supply chain would assume that the Tier 3 or 4 supplier is smaller and more at the mercy of the OEM. Going upstream, we would find major players like Corus, who can bargain in terms of their technological capability in specialist steels and just their

size – the influential suppliers of section 1.3.2. Whilst this is not an option for the SMEs in the chain, there is a way to gain the advantage of a partnership. In high technology industries innovations tend to be realized by the bringing together of a number of players. What is key is that the combined strength of the offering is more than the capacities on offer within each of the potential players.

In the case of the automotive industry, the supporting factors for these developments are EDI and JIT:

EDI, electronic data interface – The greater use of electronic communication between OEM and suppliers, with the consequent availability of requirements data. Not only is the numerical information being shared, but with initiatives such as COGENT from Nissan, there is a greater sharing of electronic product data rather than paper drawings and specification. There is an expectation that modern component suppliers can manufacture from the customer's CAD[35] data packages.

JIT, Just in time – Stemming from the Toyota experience, JIT means producing only what is needed, as nearly as possible to when it is needed, and delivering it `just in time' to be used , (Monden 1994) and (Oliver and. 1992) quoted in (Hampson 1999). This certainly involves suppliers working very closely and even establishing plant or warehousing adjacent to the OEM. Linpac Automotive, a manufacturer of car bumpers based in the East of England has introduced what is effectively a transportable injection moulding plant, installed in leased premises next to the vehicle customers.

Together these two techniques support the notion of keeping prices down, driving out waste and the benefits of working in partnership.

Closer examination of the supply chain reveals that supplier development is not the only requirement for greater efficiency. One example of where the downstream buyer can maximize the advantages of partnership is to follow the Japanese example in the American automotive sector. Japanese OEMs who have set up manufacturing sites in the USA have outperformed their American counterparts. Although the US manufacturers seemed at least publicly to have adopted the same lean philosophy, there appeared to be fundamental differences. The Japanese OEMs worked with their suppliers to develop their own lean

[35] Computer aided design

practices at least where the relevant materials were being produced. The OEMs smoothed their own lines to present less variability in demand. More especially they developed versatile transportation systems that could handle loads that were mixed in terms of type and quantity. (Liker 2000) All in all this represented a more proactive approach to supplier development.

For those well-organised manufacturers in the automotive components markets who have a systems approach, there are stable contracts in place that span more than simply a single component. They refer to the supply of a commodity range over a period of time. For the "full-service supplier", it is the whole of the design, production and delivery of the major component including the lower reaches of the supply chain. Effectively the Tier 1 supplier becomes the equivalent of an OEM to the Tier 2 and 3 suppliers below.

2.3.3. Wider Learning that has supported the research programme

As part of the total Engineering Doctorate programme a number of taught or APEL/APLed modules are included. These are listed in the accompanying portfolio within item P.1, the Research Proposal. Their contribution to the understanding of the research subject is reviewed here. Module titles are emboldened in the text.

The automotive industry has had to adapt its design and manufacturing activities to enable it to produce the cars that the customers and regulatory bodies require at the speed and price that customers will tolerate. In doing so the majority of the industry has adopted various versions of the Toyota System in manufacture and advanced techniques in new product. This has placed constraints on the Tier 1 and Tier 2 suppliers. The implications for their training plans have been identified previously in looking at forecasts for the international industry and are substantiated in the findings of the individual research projects within this programme.

The modules **International Motor Industry** and **Automotive Product Engineering** are at the core of the programme, yet more than any other taught course in the programme the material is subject to change with time. Sections 1.3 through to 1.5 in Chapter 1 have revisited that material since the last delivery of the modules. The traumas within the industry and the place of training have provided the perspective for this thesis. The rise of

the BRIC[36] economies, epitomised by the Tata Motors purchase of Jaguar, has not been included. The technological aspects of alternative fuels have a strong impact on the long term skills requirements in the industry but they too have not been explicitly included in this thesis. In addition in the portfolio section P4 contains examples of the IGDS examination papers and a conference paper about them.

Although the biggest environmental influence on the industry will be the search for renewable sources of energy, in the short term the need to recycle and economise on the use of raw materials is a bigger constraint. The two components of **Enterprise and the Environment** that have been included are the drives for lower CO_2 emissions and the introduction of the "End of Life" directive. Both of these increase the demand for skills in the supply chain. Firstly the vehicle manufacturers are demanding modules and components of a higher technology. Secondly there is increasing pressure on suppliers to design products to meet these requirements.

There are three fundamental components to **Project Management**: the management of time, the management of risk and resources and the motivation of teams. It is the latter two components that have supported the research. Learning activity in the workplace represents a risk to the employer. Non-productive time is used in the hope of subsequent improved performance. The notion of risk management has informed the structure of the final learning model. Testing the relevance of a learning programme and checking the focus of the content begin to mitigate the risk of poor training investment. This theme is developed throughout the three projects.

In developing the final model in Project III, it became clear that learning could not be sustained unless the individual was sufficiently motivated by the team around him or her. Any training activity needed to fit into an overall training plan for the organisation. Training thus becomes a project relevant to a manufacturer's targets and aspirations rather than a purely individual investment. There are also the wider projects related to the funding and provisioning of training. As with any other major project, training and skills development is more than financial control and timing. The softer skills of project management also have their place.

[36] Brazil, Russia, India and China

The **Lean Enterprise** module emphasises the role of lean manufacturing in the development of a manufacturing SME. Project I has reviewed the effectiveness of lean training in a number of different situations. Project II has questioned the pre-eminence of lean in the menu of training possibilities. The application of the techniques has to be in the working context of the enterprise.

Technology and Innovation Management removes innovation from a discussion of inventiveness and sets it clearly as a differentiator for business performance. Examples were found in earlier research (Bevis 2001). Later discussion in Project III uses innovation as a proxy indicator for competitiveness. The role of innovation, of both new products and more efficient processes is key to the development and sustainability of companies in the automotive supply chain. The ability to innovate is dependent partly on the levels of skills within those companies.

Quality Methods has developed the structures in which lean manufacturing operates including cellular manufacturing and the role of continuous improvement. Although these are accepted practices in the automotive industry, their use in the SMEs of the supply chain is less prevalent. The major contribution from this area of study has been presented in section 2.3.1 above - the developing role of quality in the automotive industry.

The material in **Supply Chain Innovation, Strategy and Management** interfaces with a number of other areas, e.g. the implementation of lean practices down a supply chain. The major contributions from this area of study have been presented in section 2.3 above - the integrated nature of the automotive supply chain and its development - and have reinforced the discussion in section 1.3.2 of chapter 1, which described the changing nature of automotive industry.

2.4. The Research Agenda

2.4.1. Initial Perception of a problem with training.

The initial practical problem, the root of the investigation, is that the performance of UK manufacturing industry lags behind its international competitors and there appears to be a strong correlation between skills and performance. Considerable efforts, in terms of public

funding and policy initiatives, have been put into closing the gap but successive reports have continued to reiterate a similar view of low skills and less than competitive performance (AndersonConsulting 1994; DTI 1998a; Gibson 2002). This is not just about training. Long term recovery would require improvements in education, careers guidance, recruitment and workplace training. However one remedy to tackle the issue of workplace training would be to ensure that the learning involved delivers sustained changes in behaviour and skills.

Anecdotal evidence gathered from company visits in the author's role as regional manager for Automotive College indicated that seemingly good quality training was not implanting a sustained change in behaviour. The research starts from the hypothesis that the most effective learning that can be delivered into an SME is unlikely to be a simple extension of other forms of learning. At the beginning of the programme this was seen primarily as a function of the learners and their situation. These are adult learners in a small and possibly close knit working environment. The research programme has looked at the context in which company based learning takes place and within that context to develop an appropriate learning model. The work has subsequently been framed into three projects, but before that level of project definition can be reached it is necessary to analyse the problem.

2.4.2. Secondary research

The secondary research for this programme has covered a wide range of relevant literature from the educational theorists, the training practitioners and policy makers to business commentators. The educational theorists range from Lindeman, Dewey, Kolb and Knowles to the more contemporary Keep and Eraut (Dewey 1938; Eraut 2007; Keep 1999; Keep 2002; Knowles 1998; Kolb 1984; Lindeman 1926). A useful and much cited starting point is an early critique of available adult education in general:

> "The approach to adult education will be via the route of situations not subjects. Our academic system has grown in reverse order: subjects and teachers constitute the starting point, students are secondary. In conventional education the student is required to adjust himself to an established curriculum; in adult education the curriculum is built around the student's needs and interests. Every adult person finds himself in specific situations with respect to his work, his recreation, his

> family life, his community life, etc. - situations which call for adjustments. Adult education begins at this point. Subject matter is brought into the situation, is put to work, when needed."(Lindeman 1926)

The research is concerned with that learning which takes place in, or in connection with, the workplace. Whilst individuals may be involved in learning they are not operating in isolation. There are two extreme starting points of individual learning (Kolb, 1984) and the organisational learning of Argyris and Schön (Schön 1978).These could be the opposite ends of an axis in which the different but similar language of Argyris, Friere, and Habermann move from "single loop" to "double loop", from conformist to innovative reflective, from banking learning to problem posing, from technical and practical to emancipatory or innovatory (Jarvis 1983). At the Kolb extreme there is learning-by-doing but it is restricted to tightly defined learning outcomes. The competences involved are for prescribed skills. This is single loop learning.

At the opposite extreme, learning involves the investigation of unknown problems and innovation developments. This results in changes to the learning programme itself. This is double loop learning.

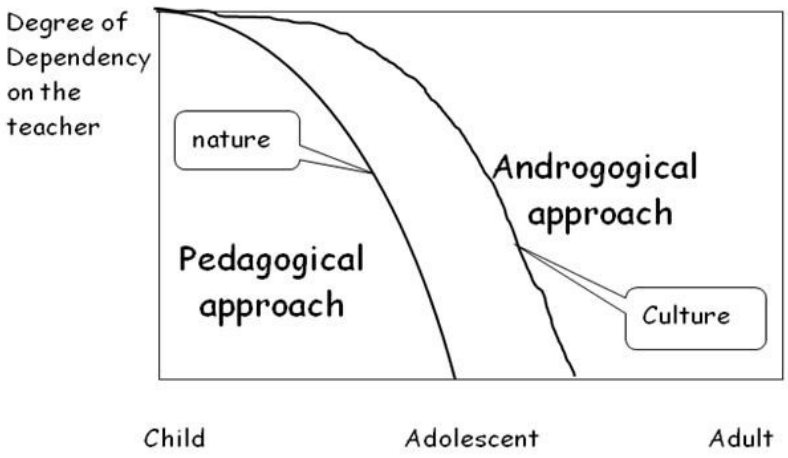

Figure 2.2 Maturation towards self directed learning

Source (Knowles 1998)

Along a second axis based loosely on the age of the learner, Knowles (1988) draws a continuum on which the assumptions about learning may be placed. He separates out "Pedagogy" into pedagogy and andragogy, child centred to adult centred education,

illustrated in figure 2.2. This reflects our maturation as individuals, either naturally or as our culture permits.

These two axes of learning can be combined into a single diagram. This illustrates that as learners mature from 'learning how to do....' to 'learning how to solve and change....', within an organisation, the organisation can grow and innovate. This simplification is presented to place the theoretical frameworks into perspective. The reality of any learning is likely to spread across the spectrum.

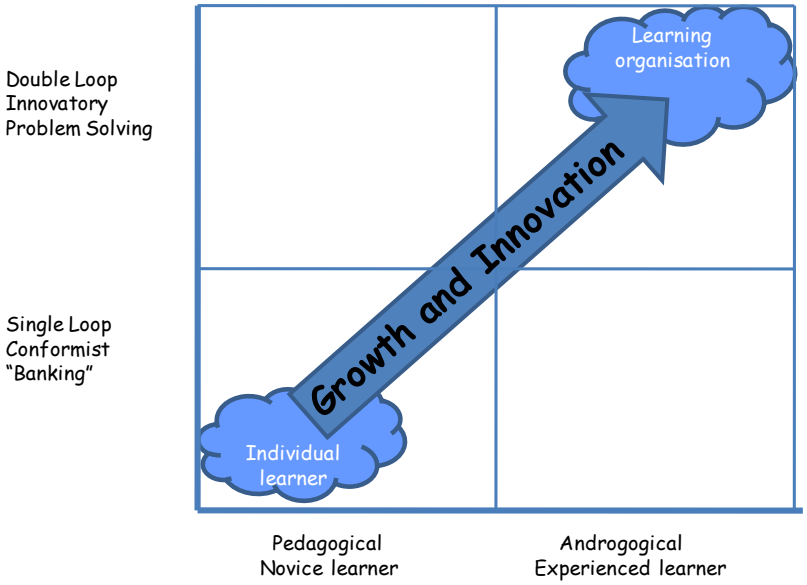

Figure 2.3 Axes of Learning

In the light of statements from twenty first century policy makers, the progress of change will be shown to have been lamentably slow. As the research programme encompasses the role of adult learning in industry, learning is broadened to consider its organisational context, with key contributions from Schön and Drucker (Drucker 1968; Schön 1978). The view of industry ranges from the internal implementation of lean manufacturing to the wider view of innovation and competitiveness.

The UK Government's thinking on Lifelong Learning and Widening Participation and its interaction with the Lisbon Agenda are further informed by evidence of development of industry specific agencies such as the SMMT Industry Forum, Automotive College and Automotive Academy and the more generic agencies such as the Learning and Skills Council and SEMTA.

It is against that broader picture of the learner, the industry, its environment, the training providers and the sources of funding that the research problem can be better articulated.

2.4.3. The research problem

The problem has both a theoretical and a practical component. Theoretically any good learning activity, designed to benefit SMEs or selected teams within those SMEs, must understand the "Sustainable Learning Style of the SME" which will be distinct from that of an individual.

At a very practical level all learning that takes place within the working environment will tend to be driven by practical drivers and environmental constraints. It will also be curbed by timing and funding issues. At best it is a compromise, at worst an ineffectual exercise. The problem is how to make any training relevant so that the learning and its consequential changes in behaviour are sustained. Only in this way can the investment in training be demonstrated as being cost-effective.

With this in mind the research problem reduces to the need to design a learning model for the SME environment that has:

1. a theoretical basis that recognises the differences between individual, team, organisation and SME styles,
2. a rationale attractive to delivery organisations and funding agencies
3. identification of the skills, expertise and location of possible delivery staff,
4. benefits for the individual participants,
5. benefits for the SMEs
6. benefits for the economy

Having formally set out the research problem, the next step is to generate a wide range of suitable research questions.

2.4.4. The research questions

A variety of questions arise from the statement of the research problem. Each of these could take the course of enquiry in a different direction. There are a number of potential questions. The list here is not exhaustive, but does give an indication of the possible range.

- To what extent does current provision of learning experiences provide sustainable outcomes?
- What do SMEs require in terms of training?
- Who and where are the SMEs as subjects for this research?
- Who constitute the available pool of educators and trainers and to what style are they most suited?
- To what extent might ICT assist the new learning process?
- What are the effects of the environment on the learning process for adults?
- What effect does a constrained team have on team learning?
- In this context, what is meant by sustainability?
- How do skills in the supply sector affect performance in the automotive industry as a whole?

To move to the conceptual design of the research, a subset of these questions are chosen and a possible research project defined. The questions act as a link between research problem and research project. As each project is outlined it is tested iteratively against the questions and the research problem itself.

It will be apparent in section 2.4.5 when the three projects have been defined that, of the list given above, questions about ICT and trainer style have been deselected. These have been valid questions but at the conceptual design stage they would add more complexity to the programme. So, not all these questions are taken forward into the research projects.

2.4.5. Conceptual design of the research

At the conceptual level the research problem is tackled in a series of three separate projects. The first has been to survey current training provision and the sustainability of the outcomes. This has been to confirm the validity of anecdotal perceptions and general reviews for the cluster of automotive SMEs in the East of England. The second project has been to gain a better understanding of the requirements for learning and innovation amongst SMEs. This is compared to the drivers for and providers of training. The final project sets out to design a learning model for SMEs that could identify constraints and so could facilitate more sustainable learning. This model was tested and refined after surveying views on training from amongst SMEs.

Project I: surveying the current state of training outcomes in industry.

The first project seeks to look at current training and educational provision across the region in terms of sustainability. It questions the extent to which current provision of learning experiences provides sustainable outcomes. Whilst the data collection is not trivial, the basic premise is to investigate companies that have received training a year ago and measure the extent to which that training is currently having an impact on the business.

Project II: identifying the general training requirements and the drivers.

The second project looks in detail at what owner/managers want from their investment in training and what skills and expertise the vehicle manufacturers expect them to acquire. Partly this project is a gap analysis determining whether the voice of the SME is being heard by commercial providers and Government.

Project III: design of a learning model tested against views in industry

The final project in this programme looks at the conceptual basis for the method of supported learning, particularly in those teams that are constrained by their very existence not to be ideally suited to traditional learning or even to co-operative activities.

The final project puts together these pieces into a design of a model that can be tested using the available resources of the Automotive College. Based on the findings of projects one and two of this research programme and the surrounding secondary research, the third and final project determines a set of conditions that is necessary for training to be sustainable. Concentrating on the organisational and human aspects, the project generates a model of sustainable learning.

2.5. Interlogue

Chapter Two has provided an academic context for the research. The professional and academic developments of the actors have been outlined. The subject of the research has been refined to a specific research problem that has been taken through conceptually to three projects. The methodology for the research will now be set out in chapter three.

Chapter Three Methodology

Proceed by process
Shakespeare, Coriolanus

3.1. Introduction

By its very nature the research component of the Engineering Doctorate is made up of discrete research activities which have been presented by the author as individual reports at stages during the programme. Here within this overarching thesis it is necessary to show how they relate together and to bring them into a unified whole. This chapter first presents the methodology for the research as a whole and then it introduces the methods used in each individual project. Finally it reviews the methodological approach running throughout the programme, identifying specific learning gained through the application and review of the projects.

3.2. Research methodology in general

A research project will employ one of the four main methods of experiment, case study, survey or review. Whilst experiments which are practical tests of theory can be performed in the field of training, typically by using action research, their timescale and complexity are beyond the scope of this research programme.

Case studies are appropriate for studies of training activity. They are especially useful as the phenomena being investigated are embedded in a contextual situation (Yin 2002). Exemplar case studies have been used as insets in Project 2 and in Chapter One, section 1.5. However, the general use of the case study approach would be limiting since the aim is to support the manufacturing and training community.

A survey involves the systematic collection of data from a particular sample of actors in the field (Thomas 1996). For the results to be practical and relevant, this is seen as a preferred method of approach. Thomas outlines the four stages of a survey as:

- sample selection from a defined population
- designing and testing a standardised measurement for the sample
- application of the measurement
- inferences about the population.

This programme makes use of cross-sectional surveys targeted at SME manufacturers predominately in the automotive supply sector. The surveys were conducted according to the University's research ethics protocol.

Interpretive Reviews are re-assessments of previous work in the field or re-evaluations of that work in the light of new or different insights (OU 2005). This differs from literature reviews that are intended for understanding the current "state-of-the-art". In the research sense, a review is intended to generate something new from existing knowledge.

A number of surveys exist, including some designed by the author, where for this programme, access has been made available to the raw survey data. This has enabled a new analysis based on different research objectives, producing a subset of findings which is relevant to this research programme or its constituent projects. As this involves work on existing data, not existing knowledge, the process can be termed a deconstructive review rather than a re-interpretive review. In this programme all three methods of using a survey have been employed, i.e. directly, through interpretive review across existing surveys and through deconstructive review to generate new results.

3.3. Programme methodology

The methodology discussed here is that for the research as a whole, rather than the individual projects. The interconnectedness of the projects is set out in the research map of figure 3.1. The explanation of its components is set out in the following sub-sections. The research map is based a research project map generated for Open University students (Hughes c.1995), but modified here to account for all the aspects of the Engineering Doctorate programme.

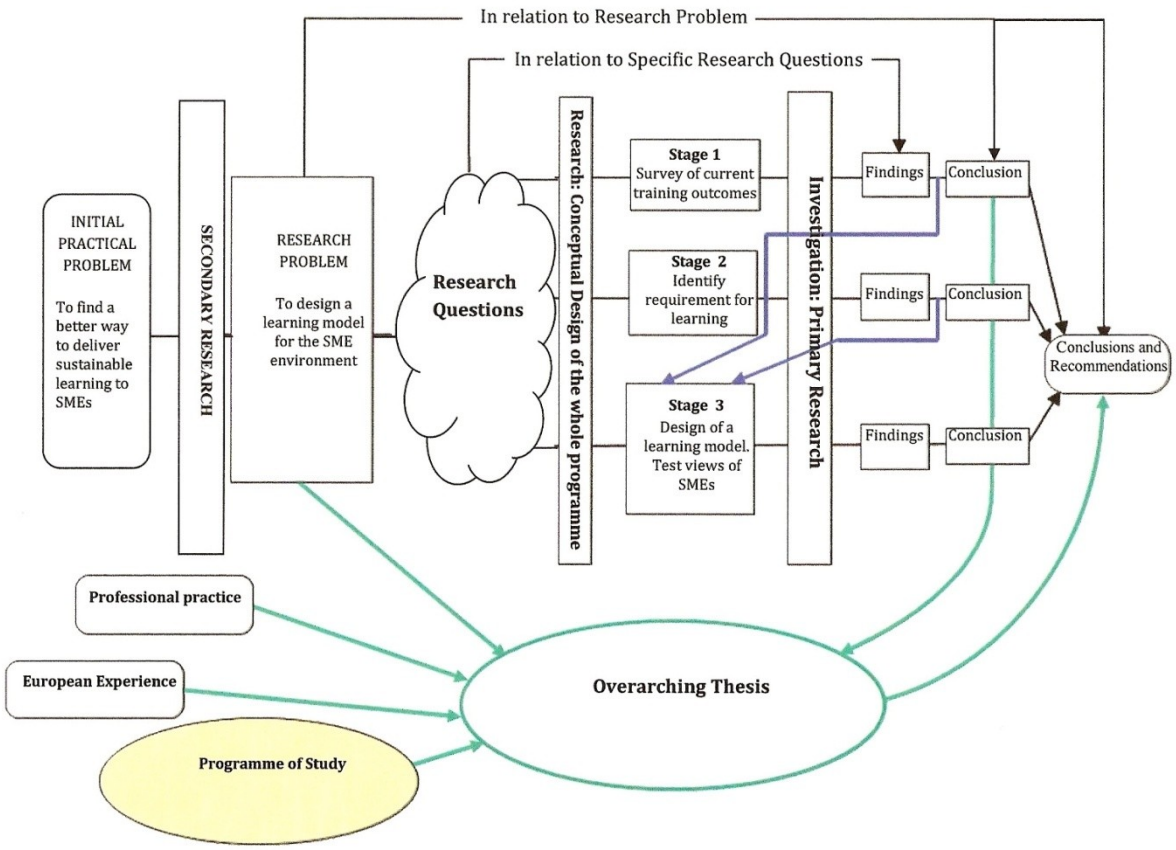

Figure 3.1 Research map for programme

The research passes through four broad phases identified by the three vertical bars in the diagram and the green oval. Whilst the model is presented here for the doctoral programme as a whole, the first three phases are repeated implicitly within each of the three individual projects.

The starting point for any new research is a poorly defined question. From practical experience in the industry, from anecdotal evidence, from conversations with managers, training providers and academics, an idea forms. Without any systematic research an *initial practical problem* or an *emergent research question* evolves. It is the secondary research phase that informs the discussion, adds structure and validity and enables the definition of the research objectives. The problem that has been presented is transformed with clear practical and theoretical aspects into a research problem to be tackled. From here a number of research questions arise and from these a subset of specific questions is taken forward into the research.

The second phase is the conceptual design of the whole research programme. Despite the Engineering Doctorate being a portfolio of research projects, this central process ensures

that they are complimentary and, as a set of research projects, they address the research problem.

The third phase is the primary research conducted within each of the constituent projects, or stages of the research itself. Each has its own findings, analysis and conclusions, but as shown in figure 3.1, the findings of stages one and two form part of the input to stage three. This phase concludes with a set of conclusions and recommendations that derive from the work of the three separate stages.

The final phase brings the research reflectively together with the underlying professional experience and the tailored learning contracted as part of the programme.

The initial practical problem

The initial practical problem, the root of the investigation, the emergent research question, to find a better way to deliver sustainable learning to SMEs in the automotive supply sector has been the starting point for this research. It is the unresearched statement of a perceived problem. The secondary research that follows enables its development into a structured research problem.

Secondary research

The secondary research for this programme has covered a wide range of relevant literature from the educational theorists, the training practitioners and policy makers to business commentators. It is a broad ranging literature review distributed across the projects and the knowledge from the taught and APLed modules of the programme.

The research problem

The research problem has been formulated from the initial practical problem together with input from the secondary research. During this stage, it is useful to separate out the theoretical and practical aspects of the problem.

The research questions

Once the research problem has been formulated it is possible to generate a plethora of related questions. The purpose of the research is not to answer all possible questions but a subset of questions that can be taken forward into the design of a coherent piece of

research that truly addresses the research problem. It is this final clear statement of the research problem that can be used both at the conceptual design phase and at the conclusion to keep the research on track.

Conceptual design of the research

The conceptual design of the research has converted the research problem and the key set of its resultant questions into three realisable projects. The first was to test the underlying assumptions of low effectiveness of training, the second to collect data from relevant actors in the field and the final to design a model and review it against performance of current learning activity.

The first project, surveying the current state of training outcomes in industry, sought to look at current training and educational provision across the East of England region in terms of sustainability. In particular it addressed medium term sustainability.

The second project, identifying the general training requirements and the drivers, was a *gap* analysis comparing provision and funding of training with the perceived needs of SMEs operating on differing scales.

The final project, design of a learning model tested against views in industry, involved the synthesis of a model, a survey to review that model against practice and a final revision of the model.

Findings, analysis and conclusions

The final phase of a research project, having collected the raw data, is to produce the findings based on that data, conduct the analysis and draw the conclusions. In this programme, as set out in figure 3.1, the findings and conclusions of Project I and Project II constituted inputs into the final Project III.

The conclusions of the research programme are the sum of the conclusions of all three projects.

3.4. Methodology for Project I

The area of Lean Manufacturing has been shown to provide the largest contribution to improved productivity and hence competitiveness in the Automotive Industry. Whilst the

majority of the literature on training, skills and the transfer of training is generic, this project is focused on training that is specifically designed to support the implementation and maintenance of lean manufacturing. In order to investigate the effectiveness of training in this area, two sources of primary data have been chosen, one to suggest a benchmark and the second to test that experience.

Benchmarking Reference

Benchmarking is defined here in its relative form as used by the HMRC[37]/Cabinet Office website:

> *"Benchmarking is simply about making comparisons with other organisations and then learning the lessons that those comparisons throw up".*
>
> ***Source: The European Benchmarking Code of Conduct***

The choice of benchmarking reference has been based on available criteria of good training practice in the academic literature, i.e. management commitment, supportive culture, simulations of the work environment and opportunity for practice. An OEM with an internationally established training programme for its manufacturing cell staff was chosen.

Pre-training and post-training surveys were compared with delayed surveys to analyse the degree of "perceived learning" and the degree of "perceived transfer" to the workplace.

The SME Group

By contrast the second source of primary data was a sample of eleven companies chosen from within those who participated in the European Social Fund funded support for automotive companies in the East of England over the past three years. Each participating company had engaged in a lean manufacturing training programme.

The method was a review of the independent "end of project" report followed by more focused telephone interviews with companies' senior management. These were semi-structured interviews where the respondents were encouraged to provide further detail about this training experience.

[37] HMRC – Her Majesty's Revenue and Customs

The purpose of the interviews was to unearth the reasons why particular training experiences in the SME environment have differing outcomes, i.e. to determine the contributory factors for successful training. The starting point for structuring this outline was Kirkpatrick's four levels of reaction, learning, behaviour and results (Kirkpatrick 1994). This has been further informed by work with companies, survey results and reading in the areas of Government initiatives, learning organisations and motivation.

3.5. Methodology for Project II

To understand how training can affect the automotive industry, it is necessary to collect views from a number of different perspectives. Decisions about training are supported by three sources: funding initiatives, training providers and clients. The method has been to interview key players in the training arena and review data from a number of surveys of manufacturers' training needs. In both the interviews and the reviews the primary research question has been about the training that would be the most appropriate in order to develop the competitiveness of the sector.

For the funding initiatives, the interviews were with representatives of the main sources of Government funding for industrial training. The selection of interviewees was determined to ensure that a knowledgeable source had been chosen with access to the necessary policy information – in all cases, managers with executive responsibility.

For the provider view, the interviewee chosen was a director of a training company who has a strong background in all three routes to provision: private provider, further education college and vehicle manufacturer's in-house provision.

The third perspective has to be that of the manufacturers themselves. The selected method here was a deconstructed review of three surveys with 356 records, each of which gave some space to questions about training. The primary research question focuses on training and competitiveness within the sector. The surveys present pre-existing data. The deconstruction enables the review to reflect the extent to which the respondents consider training needs.

3.6. Methodology for Project III

Given its position in this research programme, the chosen methodology for this project is a combination of review and survey. The first step in this project was to generate a model for sustainable learning. This model was synthesised from the earlier two projects and the associated research amongst relevant secondary sources.

The second step was a cross-sectional survey to test the model against the experience of a subset of manufacturers predominately in the automotive supply sector. The survey was designed around the research questions developed in the project and presented as an online questionnaire.

The final step was a re-evaluation the model in the light of the survey evidence. In addition to the survey, the model was discussed at a seminar and a conference providing feedback from academics and researchers with interests in the automotive industry. As a parallel exercise, both iterations of the model were compared to a known HR reference using its design methodology.

3.7. Questionnaire design

3.7.1. General aspects of question design

Survey questions can be open or closed. Open questions allow respondents to express opinions in their own words. Whilst these are useful in an interview, for clarity and ease of data analysis the questionnaire has been designed with a majority of closed questions (Sharp 1996).

Attitudinal questions have also been avoided. Where questions do have a limited range of possible responses these are concerned with frequency or significance, not attitudes. Where an opinion is requested the author used a simplified Likert scale. A normal Likert scale would have included individual statements with usually a five position response ranging from strongly agree to strongly disagree (Likert 1932). Here significance of an action has been graded “not at all”, “marginally” and “significantly”.

3.7.2. Piloting

There are two methods for piloting a questionnaire. The norm is to issue the questionnaire to a small sample of known respondents and collect their feedback on the questionnaire. A second less popular technique is by back translation (Sharp 1996). This involves the translation of the questionnaire into a second language by one individual and then the translation back into the original by another. The versions are compared with any inconsistencies highlighting difficulties in interpretation of the questions. Both methods have been used in this programme.

3.7.3. Distribution and response rates.

Typical response rate to commercial questionnaires are small e.g. 2-4% (OU 2005). For this reason special attention was paid to the introductory letter and news item. When mass distribution was available, filtering by SIC code was used to implement selection criteria.

With these systems of filtering and selection, the one element of positive bias is that only companies that engage with the manufacturing community have been contacted. Those that focus entirely on business to business activity in the service sector have been screened out.

When response rates were very low, personal invitations, made according to the same selection criteria, and structured interviews based strictly on the questionnaires were used.

3.8. Review of methodology

In reviewing the methodology for the programme there are two concerns, construct validity and external validity (OU 2005). Construct validity is an indication that the research method is appropriate to the research problem and therefore capable of delivering a successful result. Application of the research design model in figure 3.1 across the programme and again within each project has addressed the issue of construct validity.

External validity is an indication of whether the conclusions drawn from the research can be generalised beyond the samples investigated during the research. The concern here is that the final survey sample was relatively small. Personal interviews with selected respondents were used to compensate for this. The final model produced by this

programme is related to responses from surveys in each of the projects. In total, 833 respondents from 389 companies have contributed data to this programme.

3.9. Interlogue

Chapter Three has outlined the research methodology used at the level of the programme and within each of the individual projects. The implementation of the initial phase of research definition has been reported in Chapter Two section 2.4. The implementation of the individual research projects is reported in summary in Chapter Four. The complete project reports are included in Appendix A.1.

Chapter Four The Research Projects

I keep six honest serving men. They taught me all I knew. Their names are What and Why and When and How and Where and Who.
Rudyard Kipling, The elephant child.

4.1. Introduction

This chapter presents the three projects that make up the research component of this Engineering Doctorate in Automotive Engineering Management programme.

At the Lisbon Council in March 2000, European government leaders set themselves the target of making the European Union the "most competitive and dynamic knowledge-based economy in the world, capable of sustained economic growth …" within ten years. Human resources are central to the creation and exploitation of knowledge and a determining factor in the European automotive industry's potential for innovation.

The first of the two exploratory projects, (section 4.2, appendix A1.1, (Bevis 2006)) looked at current training and educational provision across the region in terms of their sustainability. It questioned the extent to which the current provision of learning experiences provides for sustainable outcomes.

The second project (section 4.3, appendix A1.2, (Bevis 2008) looked in detail at training needs and drivers. Partly it has been a gap analysis determining whether the voice of the SME is being heard by commercial providers and Government. Partly it has compared the suitability of provision to the wider international competitiveness agenda.

These first two have provided the evidence to support the developments in the third project, which develops a model for sustainable learning (section 4.4, appendix A1.3).

The research agenda has been discussed in chapter two. This requires a clear statement of the research problem:

The need to design a learning model for the SME environment that has:

1. *a theoretical basis that recognises the differences between individual, team, organisation and SME styles,*
2. *a rationale attractive to delivery organisations and funding agencies*
3. *identification of the skills, expertise and location of possible delivery staff,*
4. *benefits for the individual participants,*
5. *benefits for the SMEs*
6. *benefits for the economy.*

The projects that follow are a response to the specific research problem in the light of the challenge of Lisbon.

4.2. Project I A review of the current state and sustainability of in-company training in the Automotive Supply

Anecdotal evidence and Government sponsored research (AndersonConsulting 1994; DTI 1998b; Gibson 2002) indicate a continuing severe problem with UK manufacturing in general and UK automotive manufacture in particular. Performance is consistently behind the competition and there is evidence of low skills.

Research results are mixed on the connection between training and performance. A review of literature in the area shows that on an international scale UK performance is below that of the USA and Continental Europe, whereas in skills both the United Sates and the UK are below Continental Europe. Separate UK studies reported at the same time are inconsistent on whether training improves performance or has negligible effect (Keep 2002).

The indications from the literature are that 60% of large organisations embark on training without any contemplation of measures of effectiveness – more driven by the accepted wisdom that "training is beneficial" (Kearns 2005; Reid 2004). To review this assertion from the perspective of SMEs in the automotive sector, this project seeks to provide a snapshot of training within the East of England.

Before sampling a selection of automotive SMEs, a reference benchmark was set up, with which to compare the sampled SMEs' training performance. This was to prevent

comparisons being made to an idealistic "training is beneficial" image of training. The benchmark was developed from an investigation into a major manufacturer's in-house training which prepared staff for working in small production teams. Although the manufacturer was available and its staff co-operative, it was still subject to selection criteria: management commitment, supportive culture, simulations of the work environment and opportunity for practice. A survey of 322 staff compared the understanding of the importance of lean manufacturing principles before the training, immediately after the training and after a further three months in the normal working environment (vehicle assembly line, working in small teams).

The resulting qualitative benchmark indicated that, while their training might be reinforced by workplace practice, only 40% of the trainees surveyed could comment meaningfully on the training and only 30% showed long term engagement resulting from their training. Of those that did, their degree of engagement was not related to their individual level of knowledge gained during the training.

This disparity between the intended outcomes of the training and the actual outcomes was emphasised even more amongst the group of chosen SMEs. The selection criteria for the group established that they had a common business area, regional location, training experience and declared reaction to training. The SMEs were automotive suppliers, in the East of England. They had all taken part in lean manufacturing training within the last two years. Each had been selected for Lean Manufacturing training and had reported encouragingly about the effects of the training immediately afterwards. (Working within the same support project they all had similar funding for their training.) However, in the longer term the effects of training on the business were in many cases masked by the 'noise' of the market and personnel activities. In the economic environment of the early 2000s, any longitudinal study risks lack of background stability in other variables and potential loss of a number of its respondents.

The particular findings from this research are that there was no evidence of use or usefulness of Kirkpatrick's level four evaluation in the SME environment; that funded training needs to take greater cognisance of the aptitude and attitude of potential trainees; that the role of an in-company champion is pivotal for the successful implementation of training in the company context; that the effectiveness of training is grossly over-exaggerated. Nonetheless there is evidence to show that even the

apparently ineffective training does impinge on the organisational culture and prepare staff for changes.

4.3. Project II Training: an inhibitor of innovation in the automotive supply chain?

The second project is endeavouring to understand the drivers for training in the automotive sector. Perceiving that there could be a difference between supply, demand and funding support, the subject of Project II has been couched in a potentially controversial question, "Have training programmes become the new Taylorism: allowing OEMs to exercise control over their smaller suppliers and unconsciously preventing these SMEs from innovating, diversifying and growing to become competitive rivals"

Project II seeks to clarify whether the new skills that are being promoted across the supply chain are truly enablers for competitiveness and innovation. As currently practised they may be providing a less effective response to the Lisbon Agenda, i.e. increasing the distribution of skills without the depth that allows companies to become potentially innovative.

A previous survey of SMEs in the automotive supply chain based in the East of England region showed a marked difference between the stagnant or declining companies and those that were competitive and growing - most significantly in management attitude towards innovation and the evidence of innovative practice (Bevis 2001). Associated research has demonstrated that the outcomes of training across this segment of the industry were mostly unknown, unmeasured and often unpredictable. This result was in keeping with wider research reviewed in Project I which has indicated that even in large enterprises some 60% of training budgets lack quantifiable targets.

The questions raised by this previous research concern how training is commissioned for SMEs and what determines the nature and expected outcomes of that training; whether training is focused on the organisation or the individual; whether the objectives are remedial or aspirational. The pressing question is whether or not training is being deployed to improve the competitiveness of the SMEs. The inference from earlier work in the region is that for training to support the drive for competitiveness it must nurture innovation within those SMEs.

Decisions about training are supported by three sources: funding initiatives; the promotional drive from the training providers themselves, both public and private; and management drivers including customers and in some instances human resource professionals. There is, of course, additional advice and guidance available from research projects and brokerage agencies that may or may not be associated with one of the three groups listed.

To represent the public funding initiatives the three UK schemes pertinent to the automotive industry were chosen. These were the Automotive Academy, the newly launched National Manufacturing Skills Academy and the national "Train to Gain" Scheme. Interviews with senior managers questioned the strategic objectives for these nationally funded programmes. The key driver for the first two was the concept of a nationally agreed view of "World Class Manufacturing"[38] which, coming largely from the perspective of Automotive OEMs, was based on Lean Manufacturing. For "Train to Gain" the strategic objective at present is to raise the base level of qualification of the UK workforce. Within manufacturing this has been interpreted as basic operations or lean principles. Regional initiatives such as "Towards 2010" in the East of England have allowed more flexibility but at the price of lower funding per individual.

The provider sampled in this research had a track record of servicing the needs of the automotive and advanced engineering industry and experience in Further Education colleges and private providers. Within this sector the connection between funding initiative and training provider has polarised the training available to SMEs to be either business focused management development or workplace lean manufacturing. This supports the industry sector as a whole in line with the American experience of rolling out process innovation (in this case lean manufacturing) across company and supply chain, but does not equip SMEs to innovate in order to be able to diversify into new markets at a time when the automotive market is under pressure. What is a process innovation for an OEM may indeed be an external control for a supplier, however beneficial it might be.

Insight into the SME management views on training requirements has been collected from a number of surveys aimed at manufacturing SMEs in general and the automotive and advanced engineering SMEs in particular. These have included region and sub-region

[38] There is no clear definition of "World Class Manufacturer" but informative discussion is included in Chapter Two section 2.3.1.

cohorts of manufacturers. The surveys were from projects co-designed by the author or surveys where the raw data had been made available for a deconstructive review. Whilst the companies surveyed all reside in one European region and work in the same sector, for the most part they cannot be represented as members of a cluster or network.

Four distinct themes emerge from the data.

1. Specialist technical training is a key requirement, is peculiar to each individual SME and has to be seen outside any provision of generic training.
2. Supervisory training is the closest match with the two Academies' agendas; highly skilled supervisors are needed to support both the implementation of process innovation driven by the customer and the introduction of innovations for the sole benefit of the SME itself. There are records of good commercial benefits accruing from both lean manufacturing and supervisory training, but these appear within a stable manufacturing environment.

The next two move away from the comfort of the more stable manufacturing environments in the larger SMEs.

3. Breadth of experience for apprenticeships is needed as young staff require a range of knowledge and experience to engage in innovation.
4. Training in marketing has been the strongest requirement amongst the micro and small enterprises – again a skill required when a company produces a new product or service or attempts to penetrate a new market.

For SMEs to be encouraged to grow, to be innovative and so be truly competitive, they need training support. The training may be designed just to tackle short term skills needs. It may be designed to instil the demonstrable best practice of its customer and lean manufacturing is an eminent example of this type. Training must also be designed in the context of where the SME aspires to be, to allow it to mature and develop. Project II has highlighted the risk when externally promoted and funded training potentially constrains the potential for innovation and the Lisbon goals.

There are effective programmes available, laudably promoting lean manufacturing, provided by National agencies with good policy intentions. Not all SMEs need or want them. For some they offer a mechanism for growth; for others they inhibit growth (Lewis 2000).

Training programmes for SMEs need to reflect the context of the SME's aspirations. The view here is one shared by European SMEs (CLEPA 2005) that national programmes can be part of the problem as much as the solution.

An earlier paper (Bevis 2007b) based on Project II, has been presented at the International Society for Professional Innovation Management XVIIIth International Conference: Networks for Innovation in Warsaw. Its conclusions have also been discussed with colleagues at SMMT Industry Forum. This discussion added further authoritative insight into the role of Government and SEMTA (Bates 2008), which enabled a refinement of the project report. See Appendix A1.2.

4.4. Project III Necessary conditions for effective training leading to greater competitiveness amongst SMEs in the automotive supply chain

Insight into the SME management views on training requirements has been collected from a number of surveys aimed at manufacturing SMEs in general and the automotive and advanced engineering SMEs in particular. In its snapshot of the automotive supply chain based in the East of England region, Project I has demonstrated that the outcomes of training across this segment of the industry were mostly unknown, unmeasured and often unpredictable. The output of Project II showed a potential mismatch between policy driven funding for training and the training needs of SMEs.

Based on this research into the state of training amongst the automotive supply SME community, their training needs and the external drivers for training, a model has been devised that can support sustainable training. Within the model specific criteria have been identified that could be used to target training resources more selectively. If an enterprise is ready, motivated and receptive; if training is only given to selected suitable staff whose achievement is subsequently recognised; if the training is relevant and focused; then there should be measureable outcomes that relate to the enterprise's goals.

The companies most likely to meet these criteria will be the competitive companies. Competitiveness is key to meeting the Lisbon targets as set out in 2000. The problem raised here is that in policy terms, competition is defined as a national characteristic. Since at the level of the individual company, competition is a function of the company's performance and the environment of its market, in Project III innovation, or rather innovativeness, has been used as a proxy for competitiveness.

Innovativeness is still a difficult concept but there are predictive tools available to benchmark companies. A mechanistic innovation tool was incorporated into the research method to identify the more innovative companies and by implication those more likely to be competitive within their market.

It is argued that training targeted on these companies will be sustainable. It will provide measurable performance benefits to them and be cost effective to implement, thus satisfying both business and political criteria. To develop the sector, support must be focused on these companies.

A further survey amongst a small sample of predominately automotive manufacturing companies was used to confirm this model. The ensuing analysis refined the model to show the sequence of engaging in training and the expected outputs in terms of recognised achievements for the learner, measurable outcomes directly from the implementation of new skills and the organisational impacts to benefit the business. These all work together to demonstrate that sustainable learning takes place within a learning organisation. Measurable indicators are presented for the model. These can form the basis of diagnostic tools for managers, purchasers and funding agencies intent on enabling sustainable training to drive competitive growth.

The Institute of Employment Studies Model relates skills to business performance in a Human Resources sense (Tamkin 2005). This has provided a suitable reference guide to demonstrate the holistic approach of the model devised in this research programme. A mapping to the IES model helped to identify the improvements in the revised model.

The initial model developed in Project III has been presented in a paper entitled "The Challenges for Sustainable Skills Development in the UK Automotive Supply Sector: Policy and Implementation" presented at the 16th GERPISA International Colloquium

"The automobile industry and sustainable development: concepts and doctrines, public policies and company strategies" in June 2008.

4.5. Interlogue

In this chapter the three research projects of the programme have been presented in summary form. The full text of each project is included in the Appendix, in section A1, and the papers derived from Project II and Project III are included in Appendix A2. The results of these projects are discussed in chapter 5 along with the recommendations that can be taken forward and the author's reflections on the learning in the programme.

Chapter Five Results; Recommendations and Reflections

See first that the design is wise and just: that ascertained, pursue it resolutely; do not for one repulse forego the purpose that you resolved to effect.

Shakespeare

5.1. Introduction

The aim of this thesis has been to develop a model for sustainable learning. Chapter four discussed the three research projects in the programme. Here in chapter five the results of those projects are brought together and a model is proposed. Recommendations are made for use of the model and for further research. There is then a reflection on the implementation of this research and the process of learning associated with it.

5.2. Results of the research programme

5.2.1. The outcome of Project I

The aim of Project I was to test the current state of training activity amongst automotive SMEs in the East of England. The project used the established programme of training in a well performing OEM as a benchmark of learning effectiveness that can be achieved in the workplace.

At the individual level, with the limited sample available, three themes deserve note.

- When training is imposed there is a strong possibility that at least half of the learners will not engage. This suggests the risk that a major proportion of an SME's training budget, or even Governmental funding to support SME training is likely to be wasted, unless other specific safeguards are brought in. The general safeguards common to the use of Public Funds are only sufficient to ensure open and transparent financial dealings. Any definitions of "Value for money" are short term. The notion that much of the expense on training is currently wasted is the least

attractive conclusion of this project and so has needed to be addressed in the subsequent projects of this research programme. In his catalogue of learning responses to experience, Jarvis defines three "non-learning" categories: presumption, non-consideration and rejection (Jarvis 1983).

- There is a need for follow-on training to refresh knowledge and keep the subject alive. However, the engagement at this point may be more difficult. Here again presumption and non-consideration are possibly having an effect.
- There is also evidence of training providing a trickle effect, developing a background understanding that can be harnessed to support other change initiatives. Here both senses of trickle are implied; first that only a fraction of the intended outcome is achieved, secondly that if the message is being constantly repeated in small and different ways apart from the explicit training, the learning eventually takes root.

At the company level there are three basic themes.

- SMEs may be using third party training as an independent staff appraisal tool. This points to the need for Human Resources support, not just training needs analysis based on Company need. This theme recurs in Project III.
- There is a reluctance to engage in meaningful measurement of longer-term outcomes. This is due, in part, to a lack of understanding of what could be obtained from quantative measurement and lack of knowledge of measurement systems. Perhaps more importantly, the volatile nature of the business environment makes the accuracy or meaning of any measurements suspect. This suggests that any training is less effective than advertised.
- This leads on to a question about the usefulness of Kirkpatrick's level 4 evaluation, there having been no evidence of any attempt to collect data in this area. At best SME managers were recognising the need for performance measures in their companies and that these measures would need to be more than just the routine financial reports.

The one positive theme was that when training is based within a supportive regime with an in-company champion at hand, there is the potential for double loop learning. (Schön 1978) This also requires the training provider to be very aware of the company situation.

The recommendation from this project is that training for SMEs needs to be planned and customised not just for the company but also to take into account the particular staff development needs. There are a number of diagnostic tools available for determining the state of a company and assisting in the selection of appropriate interventions including training. These range from the EFQM[39] Business Excellence Model to BusinessLink's Gross Value Added Model.

The role of the HR view of a company is taken up in the later projects. The observation drawn from the interviews in Project I is certainly that amongst the sampled automotive SMEs, staff development is not viewed in a holistic way.

5.2.2. The outcome of Project II

Project II set out to view training from the standpoint of policy and its implementation – is the policy delivering relevant sustainable training to automotive SMEs.

The research found that there is a marked difference between the intent and desire of the major companies and government agencies on the one hand and the perceived needs of SMEs on the other.

There is a clear national policy for the SME community and this has been implemented in part through the two Academies. With the changes of Academies from "Automotive Academy" to "National Skills Academy for Manufacturing" that policy is developing further and impacting on the wider manufacturing SME community. The primary links to policy are the promotion of lean manufacturing and the raising of the minimum skills level of all workers.

The level of provision of skills development amongst both the private and public providers appears more diverse than national policy. Further Education provision for manufacturing work-based learning was significantly poorer than that supplied by private and company providers. Although there exist funding drivers to steer that provision, those mechanisms are new and their effect may not yet be visible (at the time of writing in May 2007).

Project II also aimed to determine the declared skills development needs amongst manufacturing SMEs in the East of England. Various sources of data on SMEs in the East

[39] EFQM: ***European Foundation for Quality Management***

of England have been mined for the companies' views on their skills needs. Each example shows a closer connection to the needs of the individual and less emphasis on the national policy issues.

For SMEs to be encouraged to grow, to be innovative and so be truly competitive, they need training support. Training must also be designed in the context of where the SME aspires to be, to allow the SME to mature and develop. There is a great risk that externally promoted and funded training might constrain the potential for innovation and the Lisbon goals. European manufacturers have also seen that national programmes are currently part of the problem (CLEPA 2005).

5.2.3. The outcome of Project III

The aim of this final project has been to build on the findings in the first two projects and define a set of conditions that are necessary for training to be both effective and sustainable. By sustainable training, the author means training that causes a significant change in behaviour in or increase in knowledge of an organisation's staff that can continue to promote the organisation's growth.

A model was designed that set out the eight key elements thought to influence sustainability. The one perceived weakness was the lack of clarity in an element entitled 'receptive organisation'.

Based on this initial model, an online questionnaire was used to review attitudes to training amongst both competitive and less competitive companies in the industry. This would test the concept especially amongst manufacturers who are committed to getting training results. The online questionnaire was made available in four European languages.

Despite circulation to over 1200 people, responses were limited. Finally using a direct approach a total of sixteen companies provided detailed responses. This has caused an inevitable bias in the results towards companies with an interest in training.

From the results seven of the sixteen companies were identified as significantly more likely to innovate and, therefore by implication, be more actively competitive than the others. All results were stratified on that basis. The sample size was small which means

that the results cannot be extrapolated to the general case. However, the detail of the questions and the interview nature of some responses did allow the results to be used as commentary on the proposed model of conditions of sustainable training.

Having reflected on these results, the model was revised to the form presented in section 5.2.5 below. The significant change to the model was the introduction of the concept of 'learning organisation' which removed the earlier ambiguity about how the organisation should be treated in the model. This is followed by 'organisational impact' as a measurable indicator of the business that is expected to improve as a consequence of the intended learning. It is not to be confused with the measured outcomes which relate directly to the implementation of new skills.

Both the initial model and this final model were compared to the IES[40] (Skills to Business Performance) model (Tamkin 2005), allowing for a difference in emphasis from HR to training. The final model mapped more consistently onto the IES model. This final model can be used to advise on policy, guide training providers and support manufacturers who wish to improve the sustainability of their training activity, as the constraints that the model identifies are consistent with a view of the linkage between skills and business performance.

The model and its associated set of measurement indicators could now be used for a diagnostic stage of any funded training programme. Such a diagnostic tool would require other content pertinent to the specific programme, but the inclusion of these elements as a common core would provide a safeguard against wasting funding on unsustainable training programmes. The model itself will be presented to staff at the National Skills Academy for Manufacturing and to SMMT Industry Forum for their consideration.

5.2.4. Synthesis of programme research results

Although the model of sustainable learning mentioned in 5.2.3 above as an output of Project III, and to be discussed in section 5.2.5, is the major output of one project, it is, in fact, a function of every part of this programme.

[40] IES: Institute of Employment Studies

The author's professional experience has raised the question of sustainability and provides examples of training activity that do not meet the requirements set out in the model. One example found in Italy in November 2007 involved Politecnico di Torino designing courses specifically for the automotive industry in a project entitled SAFI. Although the SAFI project team had worked closely with a number of companies to design appropriate, needed and 'relevant' courses, take up was still low. Even FIAT and Pininfarina found that time constraints inhibited participation. This is just one more example of the importance of 'tuned delivery'.

From the experiential background and the taught component on the supply chain, it is still anticipated that 'relevant' and 'focused' content will still tend towards lean manufacturing. Yet amongst the smaller SMEs, as indicated in Project II, lean is not the first requirement.

A very useful adage incorporated in the Quality course which vividly sets out the importance of measurement is:

> To *manage* we must *control*
> To *control* we must *measure*
> To *measure* we must *define*
> In *defining* we must *quantify*.
> (Dane 1982)

Project I had stressed the reluctance to measure training outputs. Since Project III also recorded a strong tendency amongst all respondents to use informal training techniques it is not surprising to find a lack of formal performance measurement. The model therefore is in line with other initiatives, in particular those of SMMT Industry Forum, which stress the need to measure.

Whilst definitive measurement provides a sound basis for management, not all management objectives can be quantified. The risk of Dane's advice is that some areas of concern can be missed. The model has the benefit of including a wider range of outputs. There are the direct measureable outcomes but also the learner achievement and the organisational impact.

5.2.5. The proposed model

Building on the outcomes of Project I and Project II and the experience and learning associated with this programme, a model of sustainable learning has been designed. The

final step in the mechanism of design was a related survey about the practice of training in the automotive industry. Sixteen companies provided a deeper view of their training aspirations and activities than was possible in the earlier projects.

The model is made up of ten elements that are described in this section. The elements that bear directly on the learning are shown in figure 5.1. With each element, a set of possible measurement indicators is proposed to facilitate a pragmatic but factually objective assessment of a company's ability to sustain its training, i.e. to generate permanent and beneficial changes in behaviour in its workforce. The particular measurements that are used will be a function of the implementation of the model and the particular skills area in question.

Figure 5.1 Indicators for sustainable learning

The complete thematic structure of the model is introduced in the latter part of this section after all the elements have been set out.

Company readiness

All the companies surveyed had clear ideas about their training needs, but readiness goes beyond need. It contains the notion of being strongly competitive or having the drive to be so. A definition of company readiness is presented as:

- being highly competitive or highly innovative or clearly understanding the need for greater innovation;
- being able to commit adequate time to training activity;
- having business and training plans with strategic aims.

Training plans would be part of a Human resource activity that is necessary here and in later subsections of this analysis.

Measurement Indicators:

- Innovation Score;
- Innovation Efficiency;
- training days per annum;
- proportion of workforce receiving training;
- existence of training plans;
- existence of IiP[41] certification.

Using the i10 Innovation Tool, the actual Innovation Score and Innovation Efficiency are compared with sector norms based on UK wide statistics. The tool's output report indicates whether the score is above or below the sector average. Low scores here could be compensated by evidence of clear strategic intent to develop skills related to innovation. In the research these indicators were obtained from the questionnaire. In practice, it is possible to obtain the figures directly from the on-line i10 Innovation Tool at www.i10.org.uk .)

In Manufacturing industry the average number of training days per person per year is two (EEF 2005). In the Aerospace industry this rises to three. The National Skills Survey shows that 61% of employees have received some training in last twelve months (LSC 2008). These national statistics provide a useful benchmark for the quantitative measurement indicators.

Learner Readiness

To avoid the potential that a significant number of learners might not engage with the training activity, a definition of learner readiness is presented as:

- selected by line manager as being ready for the learning involved;

[41] **IiP** represents the **Investors in People Standard** which provides a framework for staff development within an organisation. Companies attaining an IiP accreditation have demonstrated that they have systems in place to train and develop their staff.

- track record of personal development within the organisation, evidenced by previous formal learning or by informal participative learning either as learner or "coach".

Measurement Indicators:

- record of continuous staff development ;
- IiP certification;
- proportion of staff with personal development plans, PDP, or development objectives.

There is no benchmark figure for the proportion of staff with personal development plans. Manufacturing companies appear to be equally divided between those where all their staff have some form of PDP, those where no-one has a PDP and those where just some have a PDP (Tamkin 2008).

Relevance

A definition of the Relevance of any proposed training activity is presented as:

- directly relevant to the learners involved;
- providing skills that will be used;
- providing the potential to move the company forward;
- quantifiable contributions to the company's business strategy.

Measurement Indicators:

- specific entry requirements of pre-qualifications for a course;
- fit with training or business development strategy;
- planned business outcomes.

Measured Outcomes

Measured outcomes may include some or all of the DTI's seven measures of QCD[42] but also extend beyond the list. Of the companies surveyed value added per person seemed the clearest amongst the larger more innovative companies. Although profitability was

[42] The seven measures are a series of standardised measures which can be applied to a manufacturing operation, in order to express its efficiency in a meaningful way. A brief description is available at http://www.autoindustry.co.uk/features/qcd . Appendix I (Project 1) includes the DTI Factsheet, which also points to the same DTI reference as used in the text. The DTI reference details each measurement and its use.

mentioned in most cases this is better utilised in the definition of Organisational Impact that follows later in this section.

A definition of Measured Outcomes is presented as:

- One or more of the Seven Measures directly attributable to this training activity
- The proportion of evidenced competent staff rising as a direct result of this training activity, e.g. NVQs awarded.

This is the reason for including a reference to Human Resource planning in the subsection on company readiness.

Measurement Indicators:

- the seven measures or a selection of them.
- NVQ achievements

The DTI Factsheet[42] on the seven measures details each measurement and its use. On these measures the levels are dependent on the company's activity. The indicator is the relative increase in the chosen measure.

Recognised Achievement

Recognition is important even for courses or activities that do not carry qualifications.

A definition of Recognised Achievement can therefore be presented as:

- The response to the learner's involvement in a training activity and their achievement of its learning objectives should be sufficiently permanent and public so as to encourage both the learners and other potential learners.

The CLEPA White Paper on 'Education, Training and Learning to Increase Competitiveness in the Automotive Industry', argues for a stronger focus on vocational training, but also specifically for "more initiatives and incentives for on-the-job learning, in order to create a culture where lifelong learning is not only a guiding principle, but also an attractive part of life" (CLEPA 2005).

Measurement Indicators:

- Proportion of staff with NVQ Level 2
- Proportion of staff with NVQ Level 3
- Proportion of staff with a higher level of qualification than NVQ Level 3
- Existence of publicity of internal awards or achievements

The Leitch targets for 2020 are 90% of workforce reaching NVQ level 2 as a minimum and 40% reaching NVQ Level 4. As a guide in 2005, of adults in the East of England, 62.9% had reached level 2 and 26.4% had reached level 4[43]. More importantly Leitch has stressed the level 2 target is a baseline and there needs to be a move towards more Level 3 qualifications. The level 3 is important for team leaders and supervisors.

Focused Content

Focused Content measures the practical implementation of the training activity, whereas the previous element of 'Relevance' was a measure of the strategic alignment of the activity to the company's goals. A definition of Focused Content is presented as:

- In line with the relevance decided before the training activity commenced, the style of presentation and the material content of the activity must focus on the learner and their working situation.

Measurement Indicators:

- existence of training objectives;
- proportion of objectives rated as essential.

Where relevance is used to manage risk strategically by assessing whether investment is training is sufficiently in line with company objectives, focused content is a measure of whether the actual training is fit for purpose. If the proportion of learning objectives that are rated as essential is too low, questions should be asked about whether the right course has been selected. The strength of this model is that the questions are asked not in isolation but in the context of relevance and organisational impact.

Tuned Delivery

[43] http://www.eescp.org.uk/doclib/Leitch_Targets_in_the_East_of_England_baselined_1.pdf

The experience of the survey respondents covered a range of training delivery, including the participative forms such as competence evidence collection (NVQ) as well as the more structured classroom activity. The actual experience varied across the sample with more external course presentations for the smaller less innovative companies and more in-house formal training for the larger more innovative.

A definition of Tuned Delivery is presented as:

- Delivery that can be varied in accordance with the working patterns of the business.

Measurement Indicators:

- Efficiency of training delivery expressed as (hours of learning activity)/(hours lost from direct productive activity). For on-the-job-training the value could exceed 100%. For an off-site one day course it could reduce to less than 50%.

Organisational Impact

The more immediate effects on the business's strategic goals were included under Measured Outcomes. Here Organisational Impact is addressing the longer term items such as profitability, staff retention, customer complaints record.

A definition of Organisational Impact is presented as:

- impact on the profitability of the business, the ethos of the business or the customer perception of the business as a whole that can be attributed to culture of training and learning of which this particular learning is a part.

Measurement Indicators:

- Pre-Tax Profit/Turnover – to indicate level of cost control;
- return on capital employed, ROCE, suitable for larger organisation with significant shareholder funds in the financial system;
- return on net assets, RONA, to indicate operation efficiency;
- level of performance related pay;

- absenteeism expressed as (total hours lost due to sickness or otherwise unexplained)/(total hours available excluding holidays);
- Bradford Factor expressed as (number of incidences of absence)^2 × total number of days lost (Using this method five individual days becomes 125 i.e. 5 × 5 × 5, whereas five continuous days becomes 5 i.e. 1 × 1 × 5);
- customer complaints per reporting period;
- Innovation Score
- Innovation Efficiency.

If a policy of sustainable training is in place the anticipated consequence is improved profitability and competitiveness, in which case these last two scores should remain high. All the measures for organisational impact are relative. Like those for measured outcomes, the training strategy must include measurements before and after the learning activity.

The Learning Organisation

The Learning Organisation is a well developed concept, presaged by Drucker (1968) and Schön (1971) and recognised in 1990 by the work of Senge (1990) in the USA and Handy (1995) in the UK. A learning organisation is one that is flexible and able to adapt to changing conditions. Both the organisation and its staff are learning so as to foster continuous improvement and so the concept of a Learning Organisation is fundamental to sustainable learning. Employer expectations in general were beyond the normal measurable outcomes.

A definition of the Learning Organisation in this context is presented as:

- An organisation that is ready as described in company readiness, has intentions as described in organisational impact and facilitates its staff in learning activity.

The further refined definitions of a learning organisation would serve to complement this set.

Measurement Indicators:

- proportion of staff involved in continuous improvement activities;
- evidence of active communication throughout organisation, e.g. notices, briefings, meetings;

- proportion of multiskilled staff.

The Nissan model for multiskilling is a job rotation policy of '1 man to 3 jobs, 3 men to 1 job'. In other words, a worker should be skilled in at least three different jobs, and at least three people should be capable of doing each job. This appeared in Chapter One section 1.5.3. Multiskilling is included here under learning organisation since to achieve the Nissan ideal staff must engage in coaching colleagues in new skills.

The interrelationships within the model

The diagram in figure 5.1 depicts the interrelatedness of the model's elements. The thin lines have indicated the relatedness of those elements. An alternative view of the elements is to set them into three thematic pathways shown by the wide blue arrows in figure 5.2. The central pathway is the learner's journey from preparation through to achievement. The upper pathway considers the role of training provision showing that relevant training is aimed at producing measurable outcomes. The lower pathway develops the company experience to show that sustainable training first enables a cultural move to a learning organisation and beneficial impact on the organisation.

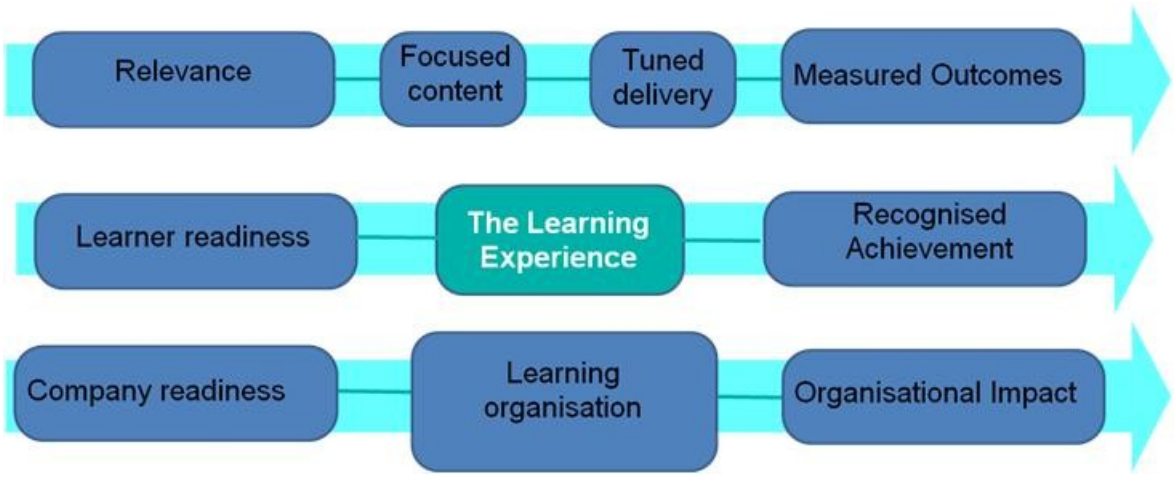

Figure 5.2 Thematic pathways for model

These elements and pathways are brought together into the final model. Together with the interrelationships, there are a set of causal links (indicated by ➡) through the elements from company readiness to organisational impact. Here it is apparent that in this model the learning organisation emerges from the successful interaction of the other

elements. The complete model is presented in figure 5.3. In this way the model sets out the necessary elements for sustainable learning to take root.

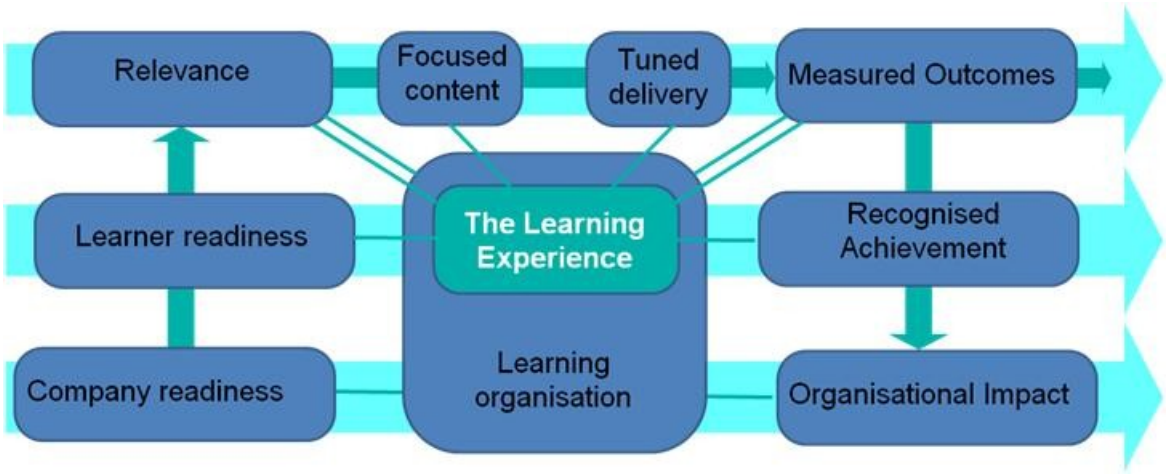

Figure 5.3 Revised Model of Sustainable Learning

At the strategic level, the model can be used to support a business manager's decision making. In drafting an HR policy it demonstrates to the manager how future training could affect staff, productivity, profitability and competitiveness. It could then be used to assess the performance of an HR/training policy.

5.3. Recommendations for further work

In addition to their conclusions, each of the research projects generated a limited number of recommendations. The main recommendation from Project I was that training should be planned and customised to suit company and trainee needs. This is in line with Automotive College aims and objectives but not in line with later university business objectives.

A weakness in Project II was the time allocated to public and private provision outside lean manufacturing. The final outcome of that project showed the diverse range of requirements especially amongst the smaller SMEs. There is a wide range of provision but national policies and funding prioritise business improvement techniques. More needs to be done to understand the capacity of training providers to support all skills needs. The current changes in further education funding and the slow growth of Train-to-Gain mean that this is a difficult area to research.

The strength of the model produced in Project III, is that it can be used in a number of different applications. It could be used by an SME's limited HR function, to assess the

suitability of a training provider. It could be used by a funding agency as a way of assessing applicants for training funding. Depending on the application, a different subset of the measurement indicators would be used in a diagnostic tool. The recommendation from Project III is that suitable diagnostic tools could be formulated with the model. This is picked up in Chapter Six that assesses the contribution that the research brings to professional activity. There is the potential for an analytic use to review the realistic return on Government investments in automotive sector skills initiatives. There is the stronger potential for the diagnostic tools emanating from this model to optimise the impact of skills funding.

In the latter part of Project III the design of the model as set out in section 5.2 above, was refined with input from a number of companies, thus partially validating the framework of the model. The data used concerned those companies' experience of training and the outcomes of their expectations. The strength of the model is that it can support planning activities. To validate this aspect of the model, it is recommended that a follow-on project uses the methodology of Project I, enhanced by the model. The criteria would be replaced by those set out in the model. Ideally the reference company should be another OEM that has implemented the Simulated Work Environment and the SMEs could be selected from EEDA's "Beyond 2010" programme of funded training. It has already been explained that the model may be used in a number of ways. In a follow-on project, the model could be used both to test the efficacy of the funding and the appropriateness of the selected interventions. This is also discussed further in section 6.2.

A conclusion of the research that needs further testing is that the companies most likely to meet these quantifiable criteria will be the competitive and innovative companies that operate as learning organisations. It is argued that training targeted on these companies will be cost effective to implement, provide measurable performance benefits and deliver sustainable learning.

5.4. Reflections on the learning

Moving away from the accepted convention used in engineering research, this one subsection of the thesis is presented in the first, not the third person. This is a critical reflection on the learning achieved through the programme. It is a critical appraisal on how I, the author, have practised and reflected on that practice (Schön 1983). These reflections

cover professional development, the subject, the technical aspects of research, knowledge in the area of the learning process itself, inquiry, presentation and self criticism.

Each of my professional activities has supported my development within the programme. Close involvement with Automotive College, Automotive Academy and National Skills Academy for Manufacturing alongside my work with SMEs in the East of England have provided insight into the research problem and the difficulties of engaging with the sector. Interreg III and BeLCAR have provided comparisons with experiences across Europe and the opportunity to manage a European project. Even the involvement with Further Education governing bodies has deepened my understanding of National Vocational Qualifications and The Learning and Skills Councils funding mechanisms.

A paper found during the early literature search was entitled "A learning process model to achieve continuous improvement and innovation" (Buckler 1996). The critical question to answer here is what does an Engineering Doctoral thesis entitled "Developing a model of sustainable learning appropriate to SMEs in the automotive supply sector" have to offer that has not already been covered. Authors like Buckler and Sölderquist, Chanaron and Birchall (Sölderquist 2001) have focused on the need for SMEs to innovate new product, partly with the move of design responsibility from OEM to Tier One. Their understanding of learning is totally at the level of the learning organisation, i.e. the organisation must learn new processes including New Product Development, NPD, in order to operate in a new environment.

The difference between that approach and the course of this research is that the innovation and organisational learning (used here as a parallel phrase to learning organisation) are a layer above the learning associated with skills. The notion that has been developed in this research programme is that the acquisition of knowledge and skills and the changes of behaviour, the elements of learning, are the more likely to be sustained if they take place in an environment where organisational learning is an expectation.

The technical aspects of the research have necessitated use of Endnote for library maintenance and referencing, Bristol Online Survey tool for web based questionnaires and SPSS for statistical data handling. The first two are efficient tools that have been employed to good effect reducing the non productive time on the research. Although SPSS training was undertaken at the beginning of the research programme, the low number of responses

to Project III's questionnaire meant that an Excel spreadsheet was more than capable of handling the data.

The programme has provided an opportunity for a deeper understanding of the learning process itself. By working on a series of three projects, each successive project has been more clearly defined, executed and criticised. The immersion in project based inquiry has yielded a better and more informed approach to my own support for ongoing MSc students.

The learning process itself has been researched, but it has made less of a contribution to the overall research than expected. Elements of Jarvis and Kolb have surfaced in the model. Less attention has been given to Knowles and his specific theme of androgogy where adult learners

- Are self directing
- Already have a pool of experience that can be built into the learning
- Are more likely to learn when they see the need to gain a skill for a specific purpose.
- Are motivated by their own needs for self esteem, recognition and fulfilment.(Knowles 1998)

The reason is that the research has not focused down onto one area of skill improvement. In fact the nature of the findings in Project I and Project II has meant that the skills have become more diverse rather than less. As the range of skills implied in the research is wide, so too must be the range of appropriate learning processes. Hence for the most part the research focuses on the learning environment.

From its inception, the Automotive College had emphasised *learning* rather than *training*. The people assisted by its programmes were learners, not students, trainees or delegates. This construct was especially important in an organisation that brought together Further Education, Higher Education and Industry. It limited any polarisation that might occur in discussion about training and education. Based on that initial experience the intention during this research programme has been to use learning as the focus. However, much of the language in the workplace is tied to training and to communicate a mixed vocabulary has been employed. Even Government initiatives have kept the word, e.g. "Train to Gain".

The language is changing. This can be seen amongst authors in the Human Resources field. In 1997, Holden relies on a the Manpower Services Commission definition of 1981 that defines training as

> "A planned process to modify attitude, knowledge or skill behaviour through a learning experience to achieve effective performance in an activity or range of activities. Its purpose, in the work situation, is to develop the abilities of the individual and to satisfy the current and future needs of the organisation."(Beardwell 1997; Manpower_Services_Commission 1981).

This was the time when the Training and Enterprise Councils existed to promote locally based training.

When describing HR Development in 2004, Reid et al. emphasise a shift in thinking. The older pedagogical view was of the teacher or trainer analysing the inputs to training. In the context of work based activity, the emphasis they suggest is on the learner's ability to control and monitor their own learning (Reid 2004). The trainer becomes a learning facilitator. This recognised Knowles' principles of androgogy.

By 2005, Torrington was describing "changed or new behaviour resulting from new or reinterpreted knowledge that has been gained from an external or internal experience" as the results of learning (Torrington 2005). In a 2006 text on contemporary HR management, Pilbeam and Corbridge found it unnecessary to offer any definition of learning or training (Pilbeam 2006).

The level of enquiry required in this research has formalised the ability to challenge 'received wisdom'. In asking 'why' iteratively it has been possible to unearth the reasoning behind actions of Automotive Academy in particular. The result is an understanding of the importance of NVQ in Business Improvement Techniques as an appropriate training intervention in the quest for more lean manufacturing, but not the acceptance of Business Improvement Techniques and the seven measures of QCD as the only route to a competitive existence for all SMEs.

Working with SMEs, either as an engineer or consultant, any presentations tend to be short, pictorial and output orientated. The discipline of the Engineering Doctorate involving annual presentations to students and the encouragement to publish in journals

and conference proceedings has provided ample experience of presenting complete arguments to wider audiences.

The learning has also increased my ability in self-criticism in terms of identifying the weaknesses in my own arguments in anticipation of supervisor feedback.

Despite some mitigating circumstances during the programme, I would admit to letting projects slip at the beginning. In contrast the stages of the final project were under more control. The Automotive Regions booklet (Bevis 2007a) (See portfolio P4.8), a project that ran in parallel during the latter part of 2007,was delivered on time, to budget, despite the client sliding their 'go' decision, thus reducing the project run time from four months to two months. It was the self assessment of the task structure of the project that kept it on time.

An Engineering Doctoral programme works on three levels. On the personal level, the study has been intense albeit part-time. In this case part-time has necessarily been a series of short periods of saturation rather than a continuous stream of additional work. I have learnt much about the process of learning and the implementation of training within the automotive supply sector.

Academically, a doctoral thesis has been produced. A number of conference papers have been presented. These have begun to open up opportunities to engage in further work at the intersection between industrial management, learning and innovation.

Professionally, it has increased the accessible research in an area of relevance to manufacturing, strengthened my position to work with the public agencies engaged in training and development for the automotive and manufacturing sector.

Individually the practice of research with clearly defined endpoints has strengthened my skills in data collection and analysis and my ability to deliver on time.

5.5. Interlogue

The integrated set of three research projects have been summarised in chapter four. The full text of those projects is included in Appendix 1. Here in chapter five, the results have been brought together to show their interconnection in developing the final model of sustainable learning. A number of recommendations for further work have been listed.

Finally at this point in the Engineering Doctorate programme, the author has reflected on the associated learning.

It remains to discuss the contribution the research makes to the automotive industry and to the profession in chapter six and to summarise the conclusions of the whole programme in the final chapter seven.

Chapter Six Contribution to the Profession

Expect performance from your promises
Shakespeare, Henry VI

6.1. Introduction

The purpose of this chapter is to put the work of the research programme and its associated learning into an active industrial or professional context. It asks the question, what effect will this research have had on learning within the automotive supply sector.

6.2. The Professional contribution

The context in which this research programme sits is at the conjunction of the automotive and manufacturing industries, higher education, further education, and the support agencies. This is similar to the context of the late Automotive College, the original industrial sponsor of the programme that was presented in chapter two, section 2.2.1. The research has strengthened the author's position to maintain a role for the university in that context despite the varied fortunes of the other organisations.

A number of models are available in the field of engineering and manufacturing management. Some like Porter's Five Forces (Porter 1979), Salaman and Mabey's training stakeholders (Mabey 1995) or the generalised product life cycle (Hill 1993) provide a specific view that can facilitate analysis. They provide a systematised picture of a complex situation. These pictures can assist managers in their strategic planning. Others such as the EFQM Business Excellence model (Osseo-Asare 2005) provide the basis for a diagnostic tool that can be used to assess status and measure improvement.

The model produced within this programme is in this second category. Its main purpose is not to explain a situation, but rather to test whether a learning activity or programme has the potential to produce a sustainable outcome.

Before moving on to the practical ways in which the model can contribute to producing sustainable outcomes, there is one retrospective benefit. Two of the national initiatives mentioned in this thesis no longer exist, the Automotive College and the Automotive Academy. There is no published account of their overall performance. By looking at the measured outputs and organisational impact of the companies with whom they interacted, the model would provide an analysis tool to measure the realistic return on the Government's investment.

There are four practical ways in which the research contributes to the profession. These are at the interface with School, University, support organisations and the regional development agencies.

In the School of Aerospace, Automotive and Design Engineering, the research has increased the School's expertise in work-related learning at a time when the trend in national funding policy is towards greater employer engagement. In 2008 the Learning and Skills Council, LSC, has already announced changes to Further Education funding. A higher proportion of the LSC grant is to be allocated to the partial support of employer placed learners. The Higher Education Funding Council for England, HEFCE, is making money available in the form of employer engagement funding and co-funded Additional Student Numbers, ASNs. These are student places sponsored by their employers. The risk for the School is that this opportunity be viewed as a need to change only the registration and delivery mechanisms and not to recognise the potential for strengthening measurable outputs and organisational impacts for participating employers. The potential of the model is its ability to raise the added value of a course and hence its achievement without raising the entry bar for a particular student.

As a business facing university, business support and training are provided through its commercial division, Exemplas Limited. For these two parts to work together effectively it is necessary for the university to have expertise in the area of work-related learning. There is potential here to reinforce the model with a further longitudinal study on the companies supported through Exemplas.

In the automotive sector specifically, the author has previous experience of working with the support organisations SMMT Industry Forum and National Skills Academy for Manufacturing and with the industry itself. Discussions with staff in these organisations

have provided additional perspectives, for example the input into Project II, see Chapter Four, section 4.3. The model has already been used within a funding bid for regional supply chain development.

The model is to be presented to these two organisations to assist them in the critical assessment of their support activities. Having completed the research component of the programme, the model can be presented in its most developed form to members of the senior management.

Finally the research is to be presented to colleagues in the regional development agency, EEDA. It is the regional development agency that sets its funding strategy for industrial support. EEDA's Regional Economic Strategy, RES, sets out the priorities for support and the levels of finance available. This is converted into substantial tenders for delivery. Where those tenders involve training, the model could inform the requirement statement and the award criteria.

6.3. Interlogue

Having summarised the outputs of the research and reflections on the process in chapter five, here the focus has been on the contribution that this research programme has and can have on the professions that relate to learning in the work-place. The research has strengthened the professional link between engineering management and human resource development which is a positive contribution to manufacturing industry.

Having covered all the outputs and potential outcomes of this programme, the next and final chapter will conclude the thesis by identifying all the necessary conclusions for the doctoral programme and confirming that the conclusions of the research match the original aims.

Chapter Seven Programme conclusions

He that questioneth much shall learn much and content much; but especially if he apply his questions to the skill of the persons whom he asketh; for he shall give them occasion to please themselves in speaking, and himself shall continually gather knowledge; but let his questions not be troublesome, for that is fit for a poser; and let him be sure to let other men their turn to speak.

Francis Bacon

7.1. Introduction

The purpose of this overarching thesis has been to bring the Engineering Doctorate programme together, to present the whole as an integrated unit revealing how the parts fit together, how the learning has informed the research and how the research projects interrelate. To complete the picture this concluding chapter has three distinct roles. Implicitly it brings the thesis to an end and confirms that the programme has been completed. Secondly it concludes the programme, confirming the extent to which the learning aims of the programme have been met. Finally it concludes the research. It confirms that the aim of the research has been met, results achieved and recommendations made.

7.2. Learning conclusions

The programme has eight specific learning objectives, each of which has been met with a combination of accredited experiential learning, accredited prior learning, learning on approved courses, the process of research and the overarching narrative of this thesis. Each learning objective (i to viii) is itemised in this section together with a key feature of the programme that has addressed its requirement.

To demonstrate increased expertise in key areas of automotive technology (i) and increased understanding of the automotive engineering business, its processes and infrastructure (iii), the author has during the life of the Integrated Graduate Development Scheme MSc in Automotive Engineering: Design, Management and Manufacturing at the University of Hertfordshire, written and marked eight integrating examinations. These were devised to assess the students' ability to integrate their learning across the range of compulsory and

optional subjects in the taught part of that course. Section 4.7 of the accompanying portfolio contains four examples of the case studies and examination papers together with a conference paper which explains the methodology. Chapter one of this thesis has demonstrated an updating of knowledge about the industry.

To demonstrate increased skills and knowledge in management theory and practice (ii), The Open University course Supply Chain Innovation, Strategy and Management, T882, has been completed successfully in 2003. See section P1 of the portfolio.

To demonstrate increased critical analysis and knowledge and research skills (iv), three research projects have been completed culminating in the model of sustainable learning presented in this thesis. Conference papers have been presented to enable wider engagement in the critical discussion of this research programme. This thesis has provided the opportunity to reflect critically on that acquired knowledge and skill.

The conference papers have demonstrated increased communication skills (v). As well as those associated directly with this research programme, the portfolio includes a number of other papers. During the span of this programme, these have progressed from contributions to papers, through co-authored papers with a lead author to co-authored papers as the lead author and solo papers.

The next two objectives are problematic for an academically placed researcher. Whilst not achieving a short term placement with an OEM, the author was seconded to the Automotive Academy Launch Team led by Nick Barter, previously of Ford. Subsequently, the author supervised the implementation of the East of England Spoke of the Automotive Academy which ran until the Academy was subsumed within the National Skills Academy for Manufacturing. Both of these roles demonstrated the ability to deal with complex issues including managing innovation and change (vi). (See portfolio section P8 for author's CV.)

The Automotive Regions Book (Bevis 2007a) does demonstrate the ability to manage a multidisciplinary globally dispersed team (vii). For this final report for a European project spanning the Western states of Europe, the participants were engineers, economists, sociologists and civil servants within seventeen different regions providing information about their respective automotive manufacturing facilities in six languages. The final book

which is available in the portfolio in section P4 was produced to time and to budget in two months despite a proposed project plan of four months.

Finally significant contribution has been made to the professional context (viii) through the role of Automotive College Regional Manager, through the regional spokes of both the Automotive Academy and the National Skills Academy for Manufacturing. The learning model itself is being presented as a valid contribution to policy discussions in NSA-M and SMMT Industry Forum.

7.3. Research conclusions

The aim of the research programme has been to develop a learning model for the SME environment that has:

1. a theoretical basis that recognises the differences between individual, team, organisation and SME styles,
2. a rationale attractive to delivery organisations and funding agencies
3. identification of the skills, expertise and location of possible delivery staff,
4. benefits for the individual participants,
5. benefits for the SMEs
6. benefits for the economy.

All three national initiatives discussed in this thesis have had a regional focus. The SMEs that have co-operated with this research are based predominately in the East of England.

It has been shown that the environment in which the model would have to operate is one of poorly monitored training and often unknown outcomes. Despite the well advertised benefits of training through *Train to Gain* and SMMT Industry Forum programmes, the evidence has supported wider research which points to poor sustainability of training and lack of measurement.

Where training is planned and assistance is provided to establish measurement regimes, performance is improved, but the major hurdle appears to be the recognition of performance measurement as an aid to improvement.

As the demand for training was unravelled, a distinct pattern emerged which has affected the model design. The benefits of lean manufacturing are clearly evident and measureable

for the larger SMEs with direct links into lean supply networks. There are benefits for both the SME and its customer.

For smaller SMEs, lean does not have the same level of priority. Sustainability of the business requires additional diverse skills including marketing skills to access new revenue streams and particular technical skills to develop and produce innovative products. The conclusion is that size and aspiration have a strong effect on skills needs. This has not been reflected in the specific training provision for the sector.

A model for sustainable learning has been developed and refined with input from sixteen companies. It is presented with a number of measurement parameters that can be incorporated into the design of a range of diagnostic tools. The model has a sound basis but now needs to be evaluated further with a wider range of companies.

Of the ten elements of the final model there are four that cater for variation in demand. *Company Readiness* ensures the SME has explicit aims. It provides delivery organisations and funding agencies an indicator of potential effectiveness. The potentially more attractive prospects can be prioritised. *Relevance* forces a check between training provision and those explicit aims of the SME. *Measured Outcomes* are an element of the model, but so too are the larger *Organisational Impacts*.

The detail of training activity is monitored through *Focused Content* and flexibility, a constant request from SMEs through *Tuned Delivery*. In this way elements of the model have catered for the training activity and the organisational change.

The individual learner is recognised through *Learner Readiness* to ensure only motivated and able staff are selected and *Recognised Achievement* to facilitate self and team motivation. The *Learning Experience* itself is defined by its interrelationship with the other elements. If all the elements of the model contribute positively the result is the *Learning Organisation* and the benefits that brings in terms of innovation and competitiveness.

A diagnostic tool designed from the model could be used in the HR practices within a company to plan training expenditure and select provision. It could be used in the initial stages of a training provider's offering. It could be used in a funding agency's

methodology for maximising the effectiveness of its grants. The structure and the measureable indicators are all set out clearly in the model.

A conclusion of the research that needs further testing is that the companies most likely to meet these quantifiable criteria will be the competitive and innovative companies that operate as learning organisations. It is argued that training targeted on these companies will be cost effective to implement, provide measurable performance benefits and deliver sustainable learning.

The theoretical aspect of the learning process has been an important part of the research. The reflection in Chapter Five, section 5.4 above indicated that the diverse nature of the skills demand in automotive manufacturing made that part of the research less prominent. However, the final model of sustainable learning includes the learning organisation which does recognise the difference between individual, team and SME styles of learning and developing.

Individual participants will benefit if their achievements are recognised. SMEs will benefit if the outcomes are measured and monitored and their organisational impact is taken into account.

Taking the final requirement, the economy as a whole would benefit if workplace learning was provided in a sustainable way. This model is proposed as a mechanism to help achieve that sustainability.

Epilogue

Quite separately, but in parallel with the closing stages of this research programme, NSA-M has, working with SMMT Industry Forum, developed and launched its 'Productivity and Competitiveness' framework, PAC, (Caffrey 2008). This has similar aims to the current research but has a different focus to achieve sustainability. It is reported here in an epilogue to indicate that it is not part of the research programme, but should be considered as part of the same development within the automotive sector.

PAC uses the NVQ in Business Improvement Techniques for the training, the seven measures of QCD for measurement and staff from the Manufacturing Advisory Service, MAS, to stimulate change by adding direct interventions.

The company scenario begins with a trained PAC analyst benchmarking the performance on the seven measures against data on similar competitors provided by SMMT Industry Forum. Areas of weak performance are identified, factually. Improvements are managed by targeted training of key staff and an MAS intervention to begin the process of improvement. Further NVQ BIT training is provided to gain 'buy-in' from staff and to support the roll out of improvement projects across the company. At the time of its launch the PAC framework benefitted from the existence of funding streams to support the MAS interventions and a proportion of the training.

The PAC analyst has a continuing role to co-ordinate the activities and report on the impact. The seven measures are applied and the 'bottom line' benefits recorded. The PAC framework starts with four days of diagnostic and co-ordinating activity. During the following six months MAS interventions and company led business improvement projects run in parallel to staff gaining their NVQs.

Comparing the PAC framework to the model presented in the thesis:

PAC is dependent on funding support	Model is presented independent of funding
PAC requires trained professional staff interventions for diagnostic and improvement activity	Model can run with or without support
PAC focuses on seven measures	Model includes seven measures but includes a number of other indicators for measuring impact.
PAC focuses on Business Improvement Techniques	In its development the research for the Model has concluded that Business Improvement Techniques are not the only skills necessary and indeed for smaller SMEs they may be secondary.
PAC has been piloted	Model is presented as a tool that could be used in more that one way.

The PAC framework is a stand alone product that at a given cost can be implemented across a number of companies. The funding available at launch is predicated on the supplier meeting targets of 'hard to reach' companies. The research model provides a technique that can be used with or without professional support. Greater benefits might be accrued if it is developed into a professional offering, but that would need further development.

References

Amicus. (2004). "Amicus and the Motor Vehicles Industry."

AndersonConsulting. (1994). "The second lean enterprise report." Arthur Anderson & Co.

Automotive-Regions. (2006). "Social Dialogue: A Work in Progress." Network of Automotive Regions.

Barlow, N., Strain, T., and Cullen, G. (2002)" Impact of Learning in the UK Automotive Industry." *3rd Global Congress on Engineering Education*, *Glasgow, Scotland*.

Barlow, N. et al. (1999) "Sustainable learning in the automotive supply chain." *International Conference On Education In Automotive Engineering*, National Exhibition Centre, Birmimgham.

Bates, S. (2008). "Meeting Notes." K.Bevis, ed.

Beardwell, I., Holden, L. (1997). *Human Resourse Management, a contempoary persective*, Pitman, London.

Bevis, K. (2006). "A review of the current state and sustainability of in-company training in the Automotive Supply Chain in East of England." Hertfordshire, Hatfield.

Bevis, K. (2007a). "Automotive Regions: Present and Future, Final Report of the Network." Interreg IIIC project funded by EDRF, Hertfordshire.

Bevis, K. (2007) " Training: an inhibitor of innovation in the automotive supply chain?" *ISPIM XVIIIth International Conference: Networks for Innovation*, Warsaw.

Bevis, K. (2008). "Training: an inhibitor of innovation in the automotive supply sector." University of Hertfordshire.

Bevis, K., Kalantaridis, C., Nelder, G. (2001). " Report of the Supply Chain Group Research for the Luton Vauxhall Partnership." Regional Supply Network - East.

Buckler, B. (1996). "A learning process model to achieve continuous improvement and innovation." *The Learning Organization: An International Journal*, 3(3), 31-39.

Caffrey, P. (2008). "Productivity and Competitiveness Framework (PAC)."

Carr, C. (1992). "Productivity and Skills in vehicle component manufacturers in Britain, Germany the USA and Japan." *National Institute Economic Review*, 139(1/92), 79-86.

CLEPA. (2005). "Education, Training and Learning to Increase Competitiveness in the Automotive Industry." European Association of Automotive Suppliers.

Dane, A. J. (1982). "Quality costs as a management tool." *Quality Assurance*, 8(4), 96-8.

Dankbaar, B. (1997). "'Lean production: denial, confirmation or extension of sociotechnical systems design?" *Human Relations*, 50(5), 567-83.

Darling, A. (2006). "Introduction to Automotive Academy 4th Annual Lecture." House of Lords.

Davey, R. (2006). "Rover Case Study." K. Bevis, ed., Skills4Auto.

den Hertog, P. e. a. (1997). "'Intangibles: the soft side of innovation'." *Futures*, 29(1), 33-45.

Dewey, J. (1938). *Experience and Education*, Macmillan, New York.

Drucker, P. (1968). *The Age of Disconinutity: Guidelines ot our changing society*, Harper and Row.

DTI. (1998a). "Our Competitive Future: Building the Knowledge-Driven Economy."

DTI. (1998b). "Study on Japanese Automotive Component Manufacturers in Britain." DTI.

EEF, S., MORI. (2005). "2003-2004 People Skills Scoreboard for the Engineering Industry." EEF and SEMTA.

Eraut, M. (2007). "Transfer of Knowledge between Education and Workplace Settings."

Garrahan, P., and Stewart, P. (1992). *The Nissan Enigma. Flexibility at work in a local economy*, Mansell, London.

Gibson, I. (2002). " The Automotive Innovation and Growth Team (AIGT) Report." DTI.

Hampson, I. (1999). " Lean production and the Toyota production system - or, the case of the forgotten production concepts." *Economic and Industrial Democracy*, 20, 369-91.

Handy, C. (1995). *The Age of Unreason*, Random House, London.

Hill, T. (1993). *Manufacturing Strategy*, Macmillan Press, Basingstoke.

Hounshell, D. A. (1984). "Cul-de-sac: the limits of Fordism and the coming of “flexible mass production”." American System to Mass Production 1800-1932, Johns Hopkins University Press, Baltimore, 263-301.

Hughes, J. (c.1995). "Research Notes for students (T801)." Open University.

IndustryForum. (2008a). "Floor Space Utilisation." AutoIndustry - Quality Cost Delivery.

IndustryForum. (2008b). "Overall Equipment Effectiveness." AutoIndustry - Quality Cost Delivery.

IndustryForum. (2008c). "People Productivity." AutoIndustry - Quality Cost Delivery.

IndustryForum. (2008d). "Quality Cost Delivery." AutoIndustry - Quality Cost Delivery.

IndustryForum. (2008e). "Right First Time." AutoIndustry - Quality Cost Delivery.

IndustryForum. (2008f). "Stock turns." AutoIndustry - Quality Cost Delivery.

IndustryForum. (2008g). "Value Added per Person." AutoIndustry - Quality Cost Delivery.

Jarvis, P. (1983). *Adult and Continuing Education: Theory and Practice*, Nichols Pub Co, 1983.

Juran, J. M., Gryna, F.M. (1980). *Quality Planning and Analysis*, McGraw-Hill.

Kamp, B.;Heylen, Vic;Van der Eeckt, Tom. (2006). "Industry trends, outlook for sectoral activity and employment and policy implications - phase 1 report." Network of Automotive Regions.

Kearns, P. (2005). *Evaluating the ROI from Learning*, CIPD.

Keep, E. (1999). "Employer Attitudes Towards Adult Training." Skills Foresight.

Keep, E., Mayhew, K., Corney, M. (2002). "Review of the evidence on the rate of return to employers of investment in training and employer training measures." *SKOPE Research Paper No.34 Summer 2002*, SKOPE, Warwick Business School.

Kirkpatrick, D. (1994). *Evaluating training programme: the four levels*.

Knowles, M. H., E; Swanson, RA. (1998). *The adult learner: the definitive classic in adult education and human resource development*, Gulf Pub. Co., Houston, Texas.

Kolb, D. (1984). *Experiential learning: experience at the source of learning and development*, Kogan Page, London.

Krafcik, J. K., Macduffie, J.P. (1989) "Explaining high performance manufacturing: the international and automotive assembly plant study." *IMVP International Policy Forum*, Pierre Marques, Acapulco.

Lamming, R. (1993). *Beyond partnership: Strategies for innovation and lean supply*, Prentice Hall International, Hemel Hempstead.

Leitch, S. (2005). "Skills in the UK: The long-term challenge." HM Treasury.

Leitch, S. (2006). "Prosperity for all in the global economy - world class skills." HM Treasury.

Lewis, M. A. (2000). "Lean production and sustainable competitive advantage." *International Journal of Operations and Production Management*, 20(8), pp. 959-78.

Liker, J. K., Yu, Y-C. (2000). "Japanese automakers, US suppliers, and supply chain superiority." *Sloan Management Review*, 42(1), pp. 81-93.

Likert, R. (1932). "A technique for the measurement of attitudes." *Archives of Psychology*, 140, 5-53.

Lindeman, E. (1926). *The meaning of adult education*.

Lloyd, A. R. D., B. G.; Burnes, B. (1994). "A study of Nissan Motor Manufacturing (UK) supplier development team activities." *Proceedings- Institution of Mechanical Engineers Part D Journal of Automobile Engineering*, 208(1), 63.

LSC. (2008). "Skills in England 2007." LSC.

Mabey, C., Salomon, G. (1995). *Strategic Human Resource Management*, Blackwell, Oxford.

Manpower_Services_Commission. (1981). "Glossary of Training Terms." HMSO, London.

Mercer, F. (2005). "Future Automotive Industry Structure, FAST 2015." Verband der Automobilindustrie, Stuttgart.

Monden, Y. (1994). *Toyota Production System.*, Chapman and Hall, London.

MWPonline. (2008). "A year of improving skills in manufacturing."

Ohno, T. (1988). *Toyota Production System: Beyond Large-scale Production*, B&T.

Oliver, N., Holweg, M., Carver, M. (2008). "A systems perspective on the death of a car company." *International Journal of Operations & Production Management*, 28(6), 562 - 583.

Oliver, N. a. B. W., and. (1992). *The Japanization of British Industry*, Blackwell Business Press, Oxford.

Osseo-Asare, A. E., Longbottom, D., Murphy, W.D. (2005). "Leadership best practices for sustaining quality in UK higher education from the perspective of the EFQM Excellence Model." *Quality Assurance in Education*, 13(2), pp. 148-170.

OU. (2005). *T802 Research: Methodology and Techniques*, Open University, Buckingham.

Paoletti, F., Bevis, K. (2006). "Social Dialogue: a work in progress:Case Histories." Network of Automotive Regions.

Parliament. (2002a). "Select Committee on Work and Pensions Minutes of Evidence (Questions 159-179, 8 MAY 2002) http://www.publications.parliament.uk/pa/cm200102/cmselect/cmworpen/815/2050816.htm."

Parliament. (2002b). "Supplementary memorandum submitted by the Trades Union Congress (ES 09A), correspondence between the clerk of the committee and the senior policy officer http://www.parliament.the-stationery-office.co.ukpa/cm200102/cmselect/cmworpen/815/2050818.htm."

Pilbeam, S., Corbridge, M. (2006). *People resourcing; Contemporary HRM in practice*, Pearson Educational, Harlow.

Porter, M. E. (1979). "How competitive forces shape strategy." *Harvard Business Review*.

Reid, M. A., Barrington, H., Brown, M. (2004). *Human Resource Development - Beyond Training Interventions*, CIPD.

Schön, D. (1971). *Beyond the stable state*.

Schön, D. (1983). *The reflective practitioner: how professionals think in action*, Arena Publishing, Boston.

Schön, D., Argyris, C. (1978). "Organisational learning."

Senge, P. (1990). *The fifth discipline: The art and practice of the learning organisation*, Doubleday.

Sharp, J. A., Howard K. (1996). *The management of a student research project*, Gower.

Shigeo, S. (1985). *A Revolution in Manufacturing: The Smed System*, Productivity Press.

Sölderquist, K. E., Chanaron, J-J., Birchall, D. (2001). "Automotive components suppliers facing the learning challenge." *Int. J. Automotive Technology and Management*, 1(2/3), 252- 268.

Tamkin, P. (2005). "The Contribution of Skills to Business Performance, Report RW39." Department for Education and Skills.

Tamkin, P., Cowling, M. Hunt, W. (2008). "People and the Bottom Line Report 448." IES.

Taylor, F. (1923). *Scientific management*, Harper and Row, New York.

Thomas, R. (1996). "Surveys." Research Methods. Guidance for Postgraduates, T. Green, ed., Arnold, London, 115-124.

Tolley, H., Greatbatch, D., Bolton, J., and Warmington, P. (2002). "The validity and transferability of NVQs in the workplace - Composite Report (Stage 1 and Stage 2) for the DfES." The University of Nottingham DfES Publications.

Torrington, D., Hall, L., Taylor, S. (2005). *Human Reourse Management*, Pearson Educational, Harlow.

Westkämper E.; Barthel, H. (2007). "Beyond Lean Manufacturing: ESPE." Fraunhofer IPA.

Whiteman, P. (2005). "Expression of interest in a national skills academy (NSA) to open in autumn 2006." SEMTA, the Sector Skills Council for Science, Engineering and Manufacturing Technologies.

Womack, J., Jones, D.T., Roos, D. (1991). *The machine that changed the world*, HarperCollins, Scarborough, ON, Canada.

Wood, H. (2006). "The closure of Vauxhall, Luton – a case study of the role of regional agencies in organisational restructuring in the UK." London Metropolitan University, London.

Yin. (2002). *Case study research: Design and Methods, 3rd edition*, Sage Publications, Thousand Oaks, CA.