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BIRKBECK COLLEGE

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How Can Small and Medium Enterprises Solve
the UK Productivity Puzzle?

PhD

Academic Year: 2022–2023

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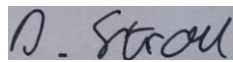
DECLARATION

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David Stroll

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David Stroll

May 11th 2023

ABSTRACT

Since 2008 UK Total Factor Productivity (TFP) growth has collapsed to 0.7% a year, which is one third of the rate experienced in previous decades. Real wages and living standards have barely improved for 16 years leading to the highest taxation rates for 40 years and the highest levels of government debt. The largest academic study of the TFP growth problem conducted by the UK Productivity Institute (2023) listed three major problems: low investment, weak productivity practices in SMEs, low levels of R&D and lower levels of diffusion.

Small and Medium enterprises, with between 20 and 250 employees, are responsible for nearly one sixth of the UK economy, but have much lower gross value added (GVA) and productivity growth than large firms. This leads to the research question: How can small and medium enterprises solve the UK Productivity Puzzle?

To answer this question, a longitudinal, instrumental case study was conducted with a medium sized manufacturing firm based in Watford. The study found that the firm was able to grow labour productivity by 44% over three years by making a series of complementary investments in their three production units and increase their Total Factor Productivity (TFP) EBIT from nil in 2021 to £834,000 in 2024.

This thesis makes three main contributions. The first contribution to knowledge is the creation of a theoretical framework which focuses on work and its organisation and on driving productivity growth through complementary investments. The second contribution is the identification of the “production units” which convert inputs of labour, purchases and capital into outputs. The production unit is where complementary investments grow productivity, measured as TFP EBIT. The combination of TFP EBIT growth and Revenue EBIT growth has been demonstrated to increase firm valuation. Lastly, the development and implementation of a bespoke software platform to support productivity growth also makes a contribution to practice.

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1 Introduction – Overview of the Research Project

The research project has been conducted with a medium sized UK manufacturing firm based in Watford. The firm was founded 20 years ago, is family owned and employs 78 people. In their most recent accounts (2023) their turnover was £9,77m and their EBITDA was £884k. The case study documented and measured both investments and continuous improvements made over a three-year period, during which time the firm increased their labour productivity (measured by GVA per head) from £48,230 in the baseline year to £69,644.

1.1 What is the UK Productivity Puzzle and why does it Matter?

The first article discussing the UK ‘productivity puzzle’ was published by the Bank of England (Barnett, Batten, Chiu, Franklin, & Sebastia-Barriel, 2014) in a Quarterly Bulletin. This drew attention to the weakness in the recovery from the 2008 recession. The authors compared the recovery for 24 quarters since the start of the recession using data from 1961, 1973, 1979 and 1990. The striking difference was the lack of recovery from the 2008 recession. Productivity growth had indeed declined. They also compared this result with the expected recovery based on productivity data from 1997 to 2008. This showed a gap of 16% in expected output per hour from trend.

By 2019 the UK economy was still performing below its 2% trend, but it was no worse than most European countries, all of whom were lagging behind the US. But the Covid pandemic of 2020 and 2021, the implementation of the Brexit agreement with the European Union in May 2021 and the invasion of Ukraine by Russia in February of 2022 had a severe impact on the UK economy. According to the most recent forecast by the International Monetary Fund (IMF), the UK is not recovering from these events at the same rate as EU countries (IMF, 2023). The IMF forecasts a decline of 0.6% in 2023 and a return to slow growth of 0.9% in 2024 — compared to an EU growth of 1.4% in 2023 and 0.9% in 2024. Portes (2022) argues that leaving the EU has already had a negative impact on the value of sterling and the supply of labour. Over the longer term, the reduction of demand from our closest trading partners will further reduce gross domestic product (GDP) growth in the UK relative to the EU and US.

The short-term view of the UK economy published by the Office for Budget Responsibility (OBR) (Hughes et al 2022, pages 18 to 22) makes grim reading:

“Rising prices erode real wages and reduce living standards by 7 per cent in total over the two financial years to 2023-24 (wiping out the previous eight years’ growth), despite over £100 billion of additional government support. The squeeze on real incomes, rise in interest rates, and fall in house prices all weigh on consumption and investment, tipping the economy into a recession lasting just over a year from the third quarter of 2022, with a peak-to-trough fall in GDP of 2 per cent. Unemployment rises by 505,000 from 3.5 per cent to peak at 4.9 per cent in the third quarter of 2024.”

To make matters worse, half a million people have left the labour market since 2000, there have been strikes across the public sector asking for higher wages to compensate for high inflation in 2022, government borrowing is over 90% of GDP, taxation is at the highest levels since the 1950s, interest rates are still rising, and the healthcare system is facing a systemic crisis following the Covid pandemic.

The lack of productivity growth has two impacts. The first can be seen in Chart 1, prepared by the Institute for Fiscal Studies (IFS) for the March 2022 budget. This shows that average earnings reached £30,000 in 2008, but the recovery from the financial crisis has been extremely slow and earnings have been essentially flat since then. The IFS then use the forecast from the Office for Budget Responsibility (OBR) for the following five years to show that the wage gap between 2008 to 2027 will reach £11,000 a year — caused entirely by poor productivity — a 36.6% loss compared to the pre-2008 trend.

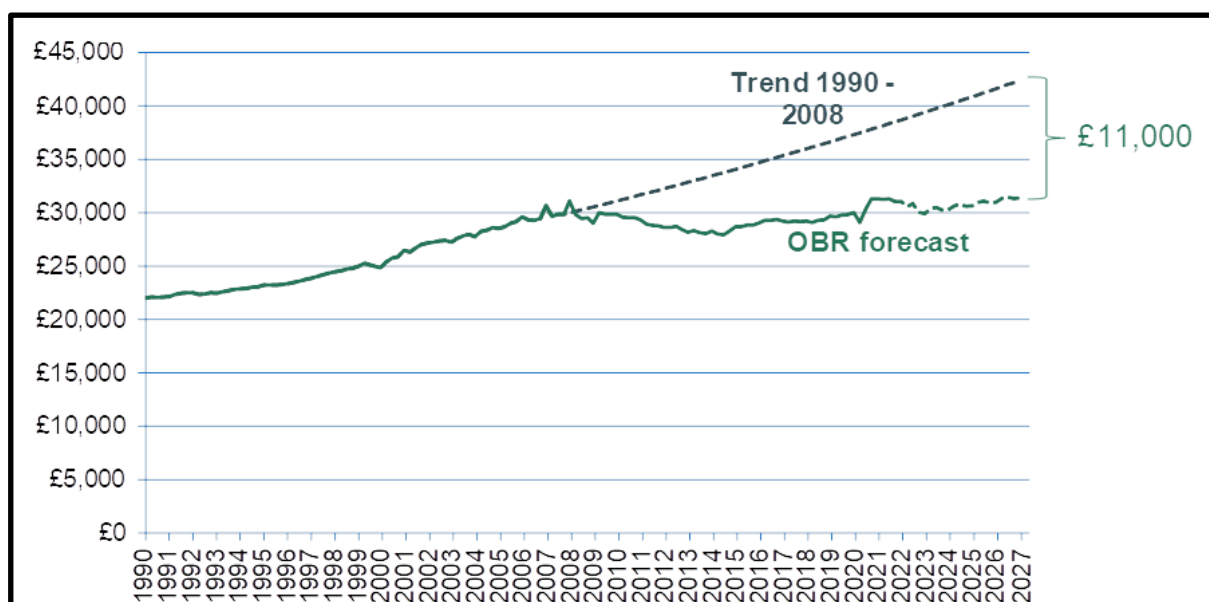


Chart 1: Average real annual earnings forecast in Q1 2022 prices. (Joyce, 2022)

The OBR is required to produce a five-year forecast of the output potential for the UK economy, which it defines as follows:

“Potential output (or ‘potential GDP’ or ‘productive potential’ or ‘supply potential’ or sometimes simply ‘supply GDP’ or ‘trend GDP’) is the value of goods and services that an economy can generate when its productive resources are being utilised at their maximum sustainable rates. We often find it useful to consider potential output as determined by three influences: (i) the available supply of labour; (ii) the available stock of capital; and (iii) the efficiency with which those two ‘factors of production’ can be combined to generate a unit of output, known as ‘total factor productivity’ (OBR 2022b, Page 5).”

The OBR 2022 forecast set the expected growth in TFP at less than 1% (0.7%) per annum. By comparison, before the 2008 financial crisis, the expected rate of TFP growth

was 2% per annum. Over a decade, the pre-2008 economy would have grown 20% (plus any additional labour and capital growth) but in real terms the post 2008 economy has actually not grown at all.

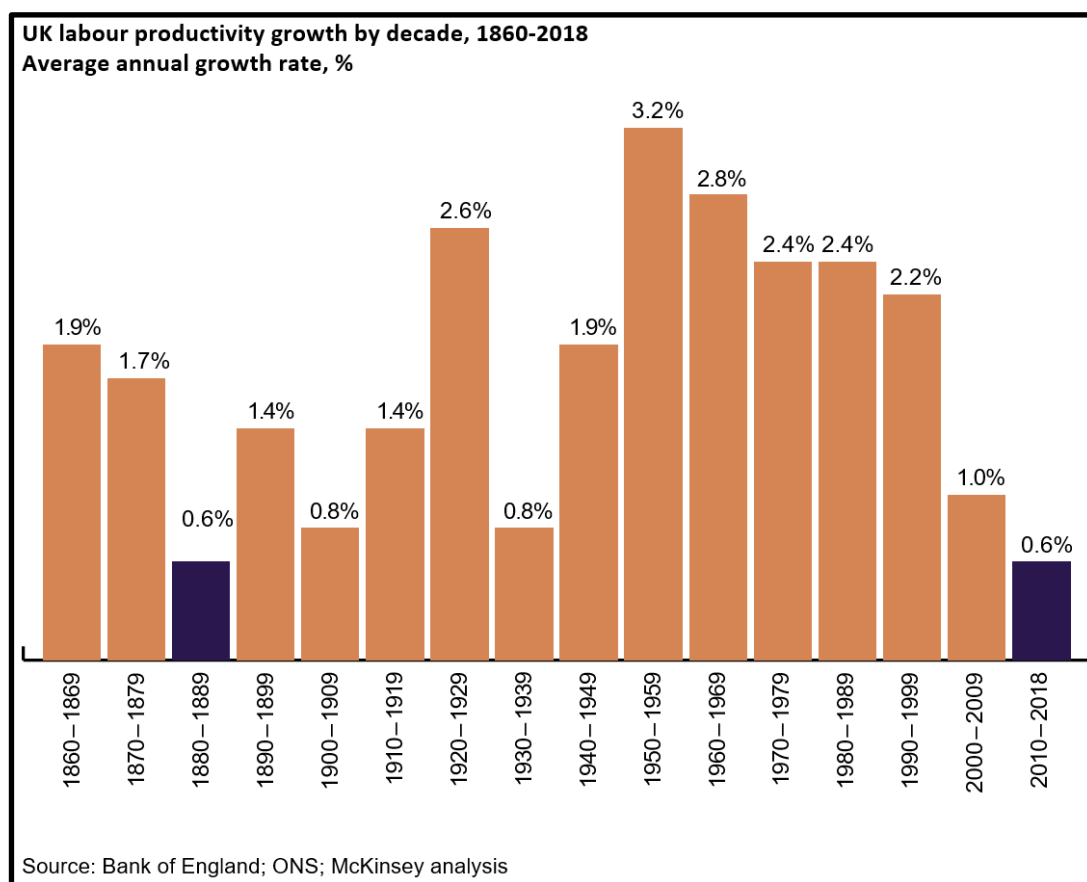


Chart 2: UK Labour Productivity 1860 to 2018

1.2 Setting the Context for the Research Question

The evidence demonstrates that weak UK productivity has had and will continue to have a strong and negative impact on the UK standard of living which will continue to affect all wage earners and their families. The question therefore arises as to whose responsibility it is to fix the problem. In an interview with Chris Giles from the Financial Times in 2021, (van Ark 2021) the then newly appointed Director of the UK Productivity Institute Bart van Ark was asked "Who is responsible for raising productivity." To which van Ark answered "Productivity is done by the private sector. They have by far the biggest share in productivity growth".

There has been no shortage of books, articles and conferences attempting to explain the UK productivity puzzle, but from the author's reading four sets of explanations provide some helpful insights. The first is from Andy Haldane, formerly Chief Economist at the Bank of England who spent a number of years analysing the productivity puzzle and offering some diagnoses.

In a speech to the London School of Economics, (Haldane, 2017) he dug into both the secular productivity trends and the differences in firm level performance. His analysis of the productivity performance of the UK economy and its position in the broader international economy was both detailed and comprehensive. He observed that the rate of productivity growth had been declining in all countries (both developed and less developed) and that, in addition, there seemed to be a market failure in the diffusion process. The diffusion argument refers to economic theory which suggests that, in open and competitive markets, the success of the leading firms will encourage a combination of imitation, innovation and take-over from both leaders and followers which will, over time, reduce the productivity gap between the leaders and the laggards. He cited evidence from the UK (using ONS firm level data) that the top 1% of firms have managed to grow productivity at 6% per year while the bottom 30% have seen no productivity gains since 2008. He also reviews data from studies by the Organization for Economic Cooperation and Development (OECD), which suggests that the same lack of diffusion is not just a UK phenomenon but can be observed right across the OECD.

In a subsequent article, Haldane (2018) explains that the main difference between UK and continental firms is that the UK has a much larger “long tail” of poorly performing firms within industry sectors. He analyses the productivity performance of three sets of firms — the top 0.1%, the top 1.0%, and the remaining 99% of firms — and looks at the picture by industry sector and by geographic region. The results are quite striking. Over the ten-year period from 2004 to 2014, the top 0.1% of firms grew productivity at 12% per annum; the top 1.0% grew productivity at 8% per annum, and the bottom 99% grew at only 1% per annum. Of the 14 industry sectors in the sample, only 4 increased productivity, 10 experienced no (zero) or negative productivity growth).

The second contribution analyses UK investments post 2008. Goodridge and Haskel (2022) have analysed the role of intangible assets in the UK economy for more than 15 years. They looked at investment levels of both tangible and intangible capital, both of which declined after 2008, and found that reduction in capital deepening accounted for over 30% of the slowdown. Furthermore, these declines occurred in a small number of industry sectors which had accounted for most of the total factor productivity (TFP) growth before 2008. These sectors included finance, IT and information services, manufacture of transport equipment, manufacture of ICT equipment, and publishing and broadcasting. This loss of TFP growth in formerly high-growth sectors combined with Haldane’s long tail of poorly performing firms would appear to provide quite a good working hypothesis for the causes of the UK Productivity Puzzle.

A third perspective is provided by the Office for National Statistics (ONS 2024a) in which they analyse the Gross Value Added (GVA) of all private firms in the UK and place them into ten deciles. They find that the top decile contributes 38% of all labour productivity growth, the next four deciles contribute 53%, leaving the bottom five deciles with only a 9% contribution. The ONS data showed that the mean GVA for UK firms was £48,000 in 2022 prices which supports Haldane’s analysis that “the UK has a long tail of poorly performing firms.”

ONS also point out that “ In 2022, 67.7% of firms in the UK had labour productivity below the mean. This proportion has remained unchanged from 2021.”

Finally, the ONS Management Practices surveys (ONS 2024b) show that the firms in the top five deciles have much higher management practices scores than firms in the lower deciles and Saggaw and Calio (2023) in their Statista surveys of IT expenditure show that spending per head in large firms for “enterprise and productivity software” is ten times that of SMEs. The chart below shows the productivity potential for different sectors of UK economy.

UK PRODUCTIVITY GROWTH POTENTIAL			
	EMPLOYMENT CATEGORY	EMPLOYMENT in Millions	PRODUCTIVITY POTENTIAL
1	Public Sector	5.77	LOW
2	Large Firms 250+ employees	15.21	HIGH
3	Large SMEs 20-250 employees	5.41	HIGH
4	Micro SMEs 2-20 employees	2.18	LOW
5	Self-employed	4.21	LOW
	Total UK Employment 2022	32.77 million	
	UK labour force participation rate	75.10%	
	UK Unemployment rate	3.90%	
	Inactive potential employees 16-64	21%	

Chart 3: Productivity Growth Potential by Employment Category. Source ONS, Statista, author's calculations.

The SME segment with between 20 and 250 employees is characterised as having very poor productivity growth (the long tail), weak management practices scores and low IT spend, which makes them potentially fruitful research candidates. This leads directly to the research question: How can Small and Medium SMEs help to solve the UK Productivity Puzzle?

1.3 How will the Research Question be Answered?

ONS publishes comprehensive measurements of GVA for UK firms which provide the equivalent of the football league table but with half as many teams! Given that the majority of SMEs are in the bottom half of the league it is very easy to measure how well a single SME is improving by comparing their GVA growth with the national league table. If the case study SME could rise one decile above the mean that would place them in the top 40% of well performing firms. Two deciles would put them in the top 30%.

The first lesson from the Case Study is that measurements are relatively easy but productivity growth is very hard. The second lesson is that whilst the theory of productivity growth is quite simple: just improve the ratio between inputs and outputs;

the practice of improving productivity is very hard First, managers need to know which parts of the firm can actually increase productivity, (the answer is the marketing, sales and manufacturing production units). Second, and a lot harder, managers and employees have to learn how to increase productivity in each production unit. To do this, managers have to start by describing the work-activities which convert inputs into outputs, this is where the improvements must be made. Once they have described these work activities they need to measure their performance in practice. For every production unit there will be two measures: the output quantity (how many leads, how many orders, how many installations) and the input quantity (how many work activities, how many are reworked, what is the average duration, what is the average cost).

1.4 How will the Research question contribute to new knowledge

In addition to the measurements of GVA per head and Total Factor Productivity (TFP) the case study will make two contributions to knowledge and one to practice.

1.4.1 First Contribution: The New Theoretical Framework

The literature review shows that management practices have been one of the main drivers of TFP growth for the last 250 years, but that work study, perhaps the most important of these, had been replaced by systems analysis by the late 1960s, and the management training curricula which had been built up in UK Technical Colleges after WW2 had also been dismantled and replaced by universities. There appears to be an implicit assumption that digitisation has replaced the need for management practices, but this is surely an ontological misunderstanding.

Work study, from its first introduction as the 'division of labour' has always focused on the work of each individual, the costs of doing the work, the payments to labour for the work, the work-flow from raw materials to finished goods, the machinery required to do the work, the capital investment to fund the machines and the work-place to house the workers and machines and the energy supplies to power the work-place. Popper clearly identified what he called 'the social institution' as the locus of work and the proper object of 'piecemeal social engineering' to improve it.

Jaques (1982) clarified the differences between social institutions in which work is performed (the entities) and the properties of these institutions, which included quantitative measurements of performance of the work, and investments in machines and technology to support the work. But machinery is not work, and measurement is not work, so why do we assume that information technology is anything more than machinery, purchased to support employees doing paid work for an employer in a social institution?

This ontological breakthrough leads to an epistemological one. Organisation and work fall into the sociological discipline, but measurement of outputs and productivity comes

under the discipline of another social science, economics. Information systems and related technologies are in a third discipline. Management practices can be argued to be a discipline in their own right, but one which straddles sociology, economics, information technology and financial accounting.

Once these ontological and epistemological clarifications are applied it become possible to construct a new theoretical framework whose focus is the work of the social institution, the measurement of its performance and the improvement of its performance over time. The chart below summarises this new theoretical framework. The measurement and quantification properties are shown in green, the social entities which comprise the social institution are shown in red, and the software platform is shown in blue.

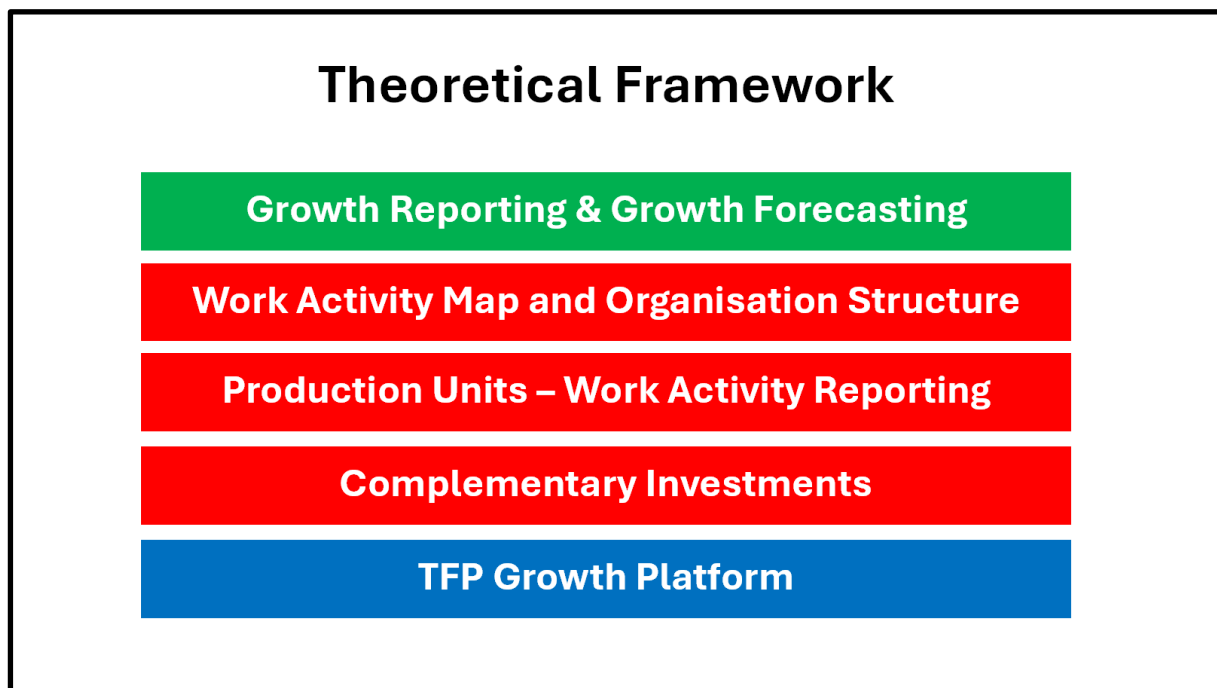


Chart 4: The New Theoretical Framework

TFP Growth Reporting and Forecasting – this functionality enables SME managers to fully understand their historical TFP performance and to forecast and plan how to improve it and how to measure and report these improvements.

Work Activity Map and Organisation Structure – this functionality enables SME managers to fully document the firm’s work activities and the organisation structure which defines how these work activities will be supervised. The Work Activity Map developed with Neatsmith is shown in the chart below.

Growth Strategy, Complimentary Investments & Total Factor Productivity (TFP) Reporting - Level IV														
CEO / COO	Report Metrics Data	Create Metrics TFP Reports	Create Monthly TFP Reports	Hold Strategy Workshop	Understand Drivers & Problems	Document new Drivers & Problems	Create Growth Forecasts and Scenarios	Save Growth Scenarios	Divide in Complimentary Investments	Update Growth Strategy with Cx	Assist in Capital Raise	Allocate Cx to Intangible Assets	Allocate Cx to Tangible Assets	Allocate Cx to Unmeasured Intangible Assets
	Allocate Cx to Innovation	Create Growth Balance Sheet	Update Growth Balance Sheet	Create Stakeholder Reporting										
Productivity Growth Management - Level IV														
CEO/COO	Create First Work Activity Map	Set up Work Activity Database	Allocate Work Activity to Levels of Work	Report Work Activity Maps	Implement Work Activity Reporting	Prioritize Work Activities	Write Work Activity Descriptions	Coach First Line Employees	Clarify Work Objects	Divide on Work Object Databases	Implement Work Object Databases	Implement Fair Work	Implement Fair Growth	Implement Fair Practices
	Implement Continuous Improvements	Document Continuous Improvements	Measure Work Activity Improvements	Update Growth Balance Sheet	Update Human Capital	Provide Implementation on Reporting								
Marketing / Management Production Unit - Level III														
Marketing	Strategy Creation	Media Plan	Ad Reviewing	Photo Shoot	Advert Creation	Poster Creation	Brand Style	Brochure Creation	Business Card	Client Imaging	Client Photo	Update Costs	Social Measurement	Social Ad Measurement
	Google Ad Measurement	Website Updates	Monthly Reports	Weekly Reports										
Sales / Management Production Unit - Level III														
Showrooms Level II Managers Sales	Chelsea	Hampton Hill	Hampton Hill	Brentwood	Hampton Hill	Guildford	London Heath	Channels Employee						
	Empire Month	Get Contact	Appt Booked	Phonecall Meeting	Quota Set	24 Hr Chase	Follow Up - Services	Onboard Taylor	Book Survey	File to Read Office				
Manufacturing Operations / Management Production Unit - Level III														
Planning Level I Manager	Sale Size	# Days to PR	Calendar Entry	Site Visit Date	Site Date Received	Visits / Quote	Lead Time Given	Order Qual Check	Drawings Done	Cut Sheet Check	Doors Ordered	Doors Del Date	Doors Received	Glass Ordered
	Glass Del Date	Glass Received	Internals Ordered	Internals Received	Radware Ordered	Add prod ordered	Add prod received	Snag List Filter						
Shop Floor Level II Manager	Rooming Delivered	Clighans	Hoffman	Arda-Ful Vet	Reflex	Others	Glass	Aluminium	Handels	Walter	Bans	Small Suppliers	Alaska	Golden Glass
	Rama	Stocktake	Wood	Drawers + Duv	Beam Saw	Table Saw	Bulls etc	Red List	Shoe Drawers	Angled Shoe Shelf	Full Out Shelf	Cluster Doors	Series 1 + Arla	Reflex Doors
	Lead Vans	Unlead Vans	Maintenance	Cleaning Schedule	Blade Sharpen	Formless Glass	Angled Corners	Drawer Boxes	Mirrors and P Markers					
Installation Level II Manager	Prepare Area	Measure Space	Check Material	Prep Customers	Snake EP + Internals	Fit Internals	Close Internals	Snake + Fit Header	Hang Doors	Clean Wardrobes	Photos	Sign Off Memo	Remove Tools from Site	Remove Waste from Site
Support Services Level II Manager														
	Accounts	Estates	Fleet	IT & S	HR	Maintenance	Sustainability							

Chart 5: Neatsmith Work Activity Map

The Work Activity Map shows the work activities for the COO and CRO in the top two boxes, the work activities for the three production units in the three boxes below, and the support work activities in the bottom box.

Production Units for Marketing, Sales, Product / Service Development and Manufacturing

The production function concept is borrowed from macro-economics, and it is used to calculate the efficiency of the conversion of inputs (of labour, capital and purchases) to outputs, measured by quantity for intermediate goods and services, and market prices for final consumption. The entire history of economic growth for the last 250 years rests on the year-on-year improvements in the ratio between inputs and outputs, which has averaged 2% a year in real terms.

Complementary Investments and Continuous Improvement

Continuous improvements in the efficiency of each production unit are what drives TFP growth, but in order to achieve these improvements, complementary investments will be needed. These investments have to be carefully applied to each work activity for all production units, and are most successful when employees are engaged in this continuous improvement work and trust their employers to reward them for their

contribution. As documented by Bessen (2014) and Hendel and Spiegel (2014) most improvements are incremental.

1.4.2 Second Contribution: the Production Unit is the locus of improvement

Productivity is the ratio between inputs and outputs, but production units are not all the same. This means that each production unit has to be considered separately. It also means that the types of capital investment differ between production units. Sales would like to invest in new Showrooms, whilst Manufacturing want new machinery, and Marketing wants more data analytics. If productivity is only measured at firm level (which is what National Statistical Offices like ONS do) it is not possible to see the differences between production units or how to allocate investments appropriately. It is in fact quite easy to over-invest in one production unit, whilst at the same time, underinvesting in another. These productivity facts can only be obtained by a rigorous and comprehensive description and measurement of each production unit.

1.4.3 Third Contribution: The Software Platform

To support the implementation of the new theoretical framework by employees and managers, a software platform has been constructed which embeds the improvement techniques and management practices into software modules. The applications and databases implemented to support productivity growth are quite different to those found in ERPs. Unlike ERPs, where the work activities and cases are pre-defined for each department, and have to be customised for each firm, the KnowledgeGrid which supports each production unit is a 'tabula rasa' for which the customer has to define their unique work activities and cases and then allocate roles and posts to them. This makes it possible to implement a production unit very quickly and provide labour productivity reporting without any further effort.

1.5 How is this Thesis Structured?

The thesis is composed of eight chapters, references and two appendices

1. Introduction
2. Chapter 2 Literature Review
3. Chapter 3 Methodology
4. Chapter 4 Theoretical Framework
5. Chapter 5 Case Study
6. Chapter 6 Results and Discussion
7. Chapter 7 Conclusions
8. Chapter 8 Limitations and Future Research
9. References
10. Appendices: Productivity History; Research History

2 Literature Review

This literature review covers a wide range of topics. It includes a brief history of productivity from 1776 to World War Two which can be found in Appendix 1. This history showed that even before WW2, US manufacturing industries were twice as productive as those in the UK or Germany. During WW2 the USA implemented what can only be described as a productivity miracle, by doubling output during the war to support their own military plus the UK, USSR, China and other Allies. During the same period the US grew its Army, Navy and Airforce to fight in both Europe and Asia. The management practices and national feedback loop which contributed to this also enabled the USA to provide the US Productivity Program to Europe and Japan after the war as part of the Marshall Plan, which provided a much more rapid and successful recovery than was achieved after the first World War. US productivity growth continues to set the frontier for the world.

After WW2 there were further significant developments in management practices which included the development of socio-technical systems (Emery and Trist Op Cit), the discovery of levels of work complexity (Jaques Op Cit), the development and scope of Work Study (Currie 1954), the development of O&M (Mills and Standingford (1962), the widespread deployment of work study (Whitmore 1968) and then the disappearance of Work Study (Caminer et al 1996) and Briscoe (2019). Management practices reporting was developed by Bloom and van Reenen (2008) and then more widely reported by MOPS (Buffington et al 2017) and MEPS (Awano et al 2018).

The third part of the literature review is the growth of Total Factor Productivity reporting since its development and testing in the USA during WW2. TFP now provides the gold standard for macro-economic reporting and National Statistical Offices like ONS in the UK produce GDP reporting quarterly with detailed breakdowns by industry and region. The office for Budget Responsibility (OBR 2022) also publishes five-year productivity forecasts on a regular basis. This thesis also explores how TFP reporting might be implemented within firms and the extent to which that measurement knowledge and experience might help firms focus to deliver TFP growth themselves.

The final part of the literature review looks at the growth of the Information and Communications industries since 1970 and how these industries have impacted TFP growth since that time. This section also looks more closely at the use of ERP applications within large SMEs and their spending on ICT and discusses the extent to which ERP adoption impacts TFP reporting and improvement.

2.1 The US Productivity Miracle

As documented in the productivity history in Appendix 1, Frederick Taylor (1905) invented the modern study of productivity measurement and growth, and Henry Ford (Arnold and Faurote 1919) implemented it through mass production of the Model T. The US Productivity Program was developed to win WW II and then extended to win the peace, which followed the most ruinous war in history.

2.1.1 The Arsenal of Democracy

Following the outbreak of WW II in September 1939, the United States Government, led by President Roosevelt, began to make plans to support France and England in their fight against Nazi Germany. This support increased following the appointment of Winston Churchill as prime minister of the UK in May 1940 and the fall of France the following month. Whilst the US maintained a position of neutrality, it began to mobilise its productive capacity and all branches of its military for a long war. Wasser and Dolfman (2005) in their brief history of the contribution of the Bureau of Labor Statistics (BLS) to the Marshall Plan, noted that: 'On June 7th, 1940, Congress passed an act authorizing BLS to make continuing studies of labor productivity and appropriated funds for establishment of a Productivity and Technological Development Division'. This division became fully operational in 1941, and its Productivity Statistics section compiled indexes of output per hour of labour and unit labour cost. Its Productivity Studies section focused on labour requirements per unit of output in specific industries and examined factors influencing output trends in these industries. BLS subsequently found that the airframe industry had achieved a 200% increase in output between Pearl Harbor (December 1941) and 1944 by following best practices.

This need to fully mobilise the US economy at a national level was directly driven by Roosevelt's commitment to Churchill during 1940. In order to brief Roosevelt and Secretary of State Marshall on what levels of industrial production would be needed to win WW II Churchill sent Walter Layton to Washington. Layton was a very able Cambridge economist and statistician and was a contemporary of Maynard Keynes at Kings College before the first world war. During WW I he was drafted to the Ministry of Munitions, which had been established in 1915 to scale up British war production following the unprecedented demands of trench warfare on the Western Front. Layton's job, which he did until the end of the war, was to compile weekly reports of all munitions produced in the UK (as well as forecasts). After Lloyd George left to become prime minister in 1916, there was a gap until 1917 when Winston Churchill was appointed as the minister of munitions and re-joined the war cabinet. By the end of World War 1, Walter Layton was the first man in history to have constructed the complete bill of materials to win a world war. The US did not join WW I until 1917, but their munitions production was only just getting into gear, so they fought mostly with British supplies. Layton's unique knowledge and relationships is the reason Churchill sent him to Washington.

Roosevelt's subsequent decisions set output levels for airplanes, ships, tanks, guns, munitions, and vehicles at levels which had never been achieved by any nation and which were thought to be impossible. In parallel to this increase in war production, General Marshall set about increasing the fighting strength of the US Army, Navy, and Airforce to the levels proposed by Layton and beyond. In order to deliver these extraordinary levels of output and simultaneously commit enormous levels of human resources to fighting in both European and Asian theatres of war, the US understood that these two objectives could not be achieved unless productivity was raised even beyond the high levels already achieved between 1900 and 1940.

2.1.2 Four Pillars of WW2 Growth in Output and Productivity

Pillar 1: Scientific Management

In order to mobilise the US economy for a global war, the US built upon and developed four very solid pillars. The first was the extraordinary impact of scientific management, based on the Division of Labour together with and accurate daily performance measurement of all work activities and payments based on actual results. These methods, first implemented and documented in high volume automobile manufacturing by Ford at their Rouge River plant (Arnold & Faurote, Op Cit), were implemented by GM and Chrysler in the 1920s, by the aerospace industry in the 1930s (Wright, 1936) and by the whole of US industry for war production in the 1940s. The US not only supplied its own forces in Europe and Asia, but it also supplied its main allies (the UK, Canada, Australia, Soviet Union, and later China) with supplies under the 'lend lease' program. During the five years from 1940 to 1945 these extraordinary levels of productivity and production resulted in a doubling of US GDP.

Pillar 2: Training Within Industry

The second pillar, developed by the US Department of Labor was the *Training within Industry* (TWI) program, which focused on training supervisors. This approach had also been a major part of the Hawthorne projects. The TWI curriculum was based on work in government-managed shipyards during WW I and promulgated widely during WW II (Bianchi & Giorcelli, 2020). The TWI program was a voluntary government-sponsored program that offered free in-plant management training to US firms involved in war production between 1940 and 1945. It encompassed interventions in three main areas, called *job modules* or *J-modules*. The Job Instructions (J-I) module taught supervisors and managers how to establish standard procedures for operations; the Job Relations (J-R) module taught how to manage and motivate workers; the Job Methods (J-M) module covered how to introduce improvements to current production processes. While the initial plan of the US government was to train all the 11,575 US applicant firms in all the three J-modules, limited funding and personnel constraints made this goal unreachable. As a result, while only 7% of applicants received training in all J-modules, 48% did not receive any training at all, and the others received either one or two J-modules training.

We find three key results. First, the effects of the TWI training on firm performance were positive and lasted for at least ten years after the program implementation. For example, sales of trained firms increased by 5.3% within one year of the TWI training compared with nontrained applicants. This effect peaked at 21.7% in period eight and then decreased to 16% in period ten. The effects on productivity were large and persistent, spanning from a 4.8% increase one year after the training to a 36% increase after ten years.

In one of the many inexplicable twists and turns of the economic history of productivity measurement, at the end of WW II the US Government closed down the federal agency that delivered TWI, but the training was included in the Marshall Plan's Productivity Program and implemented in a number of countries including Japan.

Pillar 3: Plant Level Productivity and Innovation Measurement

The third pillar supporting the mobilisation of the US economy for war was the extraordinary collection of sector, firm, plant, and shop-level productivity data collected by Silberman's division in BLS. (Wasser & Dolfman, 2005). Silberman's broad understanding of both the details and the issues in productivity derived from his responsibilities as Director of BLS's Division of Industrial Productivity and Technological Development. His experience was honed during 1,900 personal visits to American manufacturing plants, his knowledge expanded by the 3,000 plant visits made annually by the division's staff, and his access to information collected each year from 20,000 manufacturers.

These visits provided detailed feedback on production levels, productivity and innovations for every sector of manufacturing, and enabled BLS to provide rich reports about every industry sector to the US War Cabinet. Both the US and UK had adopted similar approaches to managing labour and production during the war, and each required a new systems management approach. Given the need to recruit, train, equip, and deploy millions of US men for war-fighting, human resource and production data was needed from every industry, and decisions had to be taken rapidly.

Pillar 4: Comprehensive Industry Sector Reporting

The fourth pillar was the need to report on the performance of every industry sector within the US War Economy so that a complete national view of GDP could be created to inform policy makers. In order to construct these new experimental statistics of the performance of the whole US economy, BLS commissioned Wassily Leontief at Harvard to create the first set of input-output tables. The tables map every sector of the economy to capture the flows of goods and services supplied by firms (called intermediate inputs) to the final goods and services purchased for consumption. This enabled the reporting of Gross Value Added at the national level for the first time which provided the foundation for GDP reporting. After the end of WW2 this work contributed to the System of National Accounts adopted by the newly created United Nations (SNA). The first Productivity Feedback Loop shown in the Chart 6 below was the result of these combined efforts.

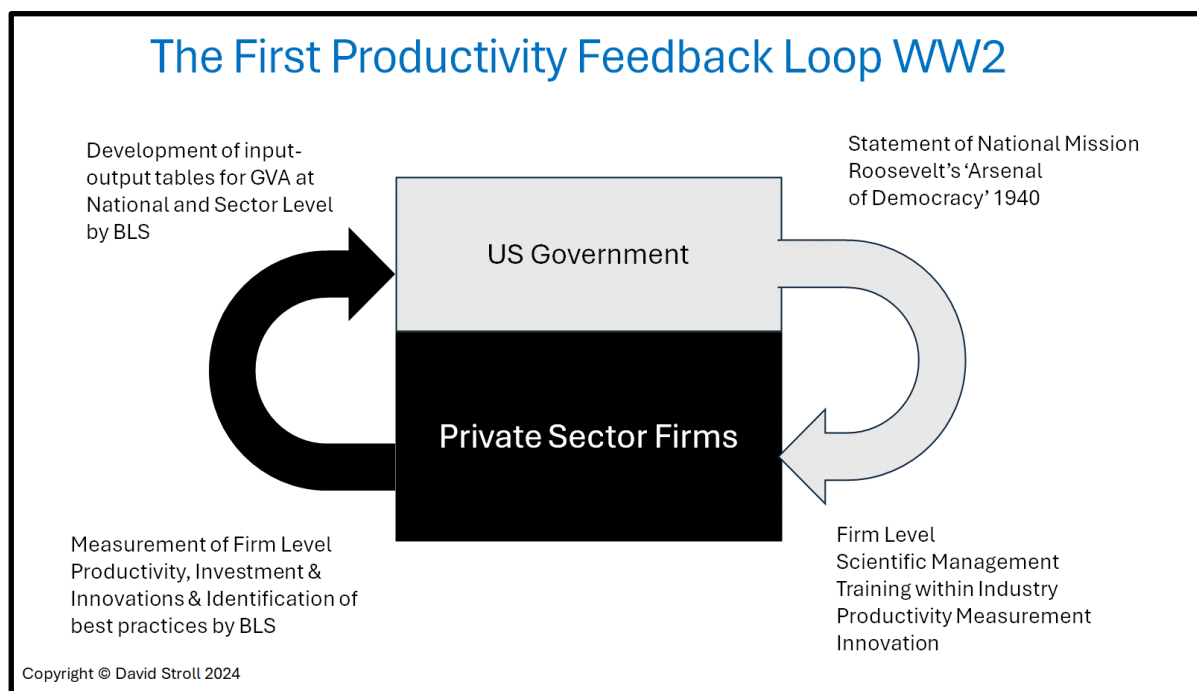


Chart 6: The first National Productivity feedback loop

2.2 The Marshall Plan

Michael Hogan's *The Marshall Plan* (2008) provides a rich historical view of the program which provided technical assistance and funding to the war-torn countries in Western Europe and Japan. At the end of the war Germany was divided into four zones of occupation by the victorious Allies (Russia, France, UK, US) and Japan was also occupied by the US. The infrastructure of the defeated Axis powers had been systematically destroyed by strategic bombing between 1942 and 1945, and the Red Army had occupied most of Eastern Europe and moved the Polish border (and its previous inhabitants) two hundred kilometres to the west. The US had assumed that European recovery would progress with limited bilateral support but by early 1947 it was clear that this was not the case.

"As 1947 dawned, however, there were very few signs that American strategies were promoting a stable recovery in Europe. By that time, the US had expended over \$9 billion in a variety of aid programs on the Continent. But European industrial and agricultural production still lagged pre-war levels. Despite strenuous efforts by some European countries, capital equipment and plant facilities remained hopelessly obsolete or in need of wholesale repair from war damage." (Hogan, 2008, p. 30)

In addition to the difficult economic situation, there were disagreements within the Allies on whether the Rhineland and Saar should be occupied by France, how Germany should be governed, how the Soviet Union and occupied Eastern Europe should be dealt with, and how Communist influences in France and Italy should be responded to. The Americans also disliked the UK Labour Government's policies on social welfare and

nationalisation of key industries, as well as their insistence on maintaining the Sterling Area which they felt were slowing down reconstruction. During the first months of 1947 a consensus emerged within the US administration and key senators from both parties which became known as the *European Recovery Program* or more popularly, the *Marshall Plan*. Within the BLS, this was also called the *US Productivity Program* (Wasser & Dolfman, 2005).

During the preparation for implementing the Marshall Plan, Paul Hoffman, the newly appointed administrator, expressed great concerns about the ability of the UK economy to use the investments proposed by the US Productivity Program. As reported by Gottwald (1991), before signing off on the plan, he asked James Silberman, from the US Bureau of Labour Statistics (BLS), to review the current state of productivity in UK and French manufacturing. Silberman's report, based on visits thirty-five factories to the automobile, radio, electrical, machine tool, apparel, footwear, and textile industries in May 1948 was presented to Stafford Cripps (then Chancellor of the Exchequer in the post-war Labour government) and its conclusions were as unwelcome as they were damning.

Silberman conducted a remarkable, highly-disciplined four-week tour involving visits to thirty-five British factories, and including talks with every level of factory management, notes on products, manufacturing methods, equipment, and presentations to top British officials. On completing the visits, he felt he had witnessed an antique world:

"Expecting to see equipment, processes, and procedures similar to those in the States, he saw instead *factories as they were in America at the turn of the century*." (Author's italics)

Most industrial plants used the already antiquated system of belt-driven machines powered by a central motor. There were few jigs, fixtures, or power hand tools. Forklift trucks and pallets were rarely available to ease the movement of heavy loads or to save space by vertical stacking of pallets. Even the American-owned GM, GE, and Hoover plants were not appreciably different. The British seemed to have little idea of the progress made by American industry after the turn of the century. Silberman concluded that his existing judgment in British industry on the prospect of purchasing new plant and equipment with Marshall aid would result simply in reproducing the existing state of their technology, the continuation of a craft rather than a productivity-oriented society.

Cripps was one of the few politicians with any high-level managerial experience, having served as the minister of aircraft production from November 1942 to May 1945. He was well aware of the need to increase the productivity of UK industries and had already set up the British Institute of Management in 1947. He argued strongly for the Marshall Plan and for active UK participation; this resulted in the Anglo-American Productivity Council (AAPC) which organised a comprehensive programme of visits by UK management and trades unions to a wide variety of American firms. At the end of the Marshall Plan in 1952, the Conservative government created the British Productivity Council to continue this productivity work.

2.2.1 Diffusion of the US Productivity Program

Chart 7 below shows the effects of the diffusion of the US Productivity Program.

Country	GNP Annual Growth Rate (%)
Japan	9.5
Germany	5.7
Italy	5.1
France	5.0
Netherlands	5.0
Canada	4.6
Denmark	4.2
Norway	4.2
US	3.7
UK	2.7

Chart 7: The effects of the diffusion on GNP annual growth rates

This data is taken from Peter Hennessey's book (Hennessey, 2019) and shows relative performance for a good part of the same time period. Japan grew almost three times faster than the UK, our closest European neighbours nearly twice as fast. It is a story of relative failure which demonstrates that diffusion of other people's inventions, even when offered for no charge, is not a free lunch. The chart shows wide differences in diffusion and the following sections look at five of the leading economies, UK, France, Germany, Italy, and Japan.

2.2.2 Diffusion of the US Productivity Program – UK

In 1979, Graham Hutton was asked to write a paper to assess Britain's economic progress since the start of the Marshall Plan in 1948. In a short paper written for the Institute of Economic Affairs (Hutton, 1980) he wrote:

*"Since 1953, in 26 years, Britain has fallen from second place in the economic growth and productivity stakes to 20th place among the 24 leading industrial nations of the Western, or Free world." **That is a catastrophic performance** (Author's italics and bolding).*

According to Hutton, output per worker-hour in manufacturing industries in 1977 was £2.70 in the UK, £4.50 in France, and a massive £7.10 in Germany. His paper went on to argue that whilst UK manufacturing industries compared poorly in productivity terms with their European competitors, the position of the public sector and services sector (which at that time accounted for 50% of GDP) was even worse. Absence of measurement of public sector productivity, and difficulties in measuring private sector services industries, suggested little or no productivity growth at all.

In early 1952, Hutton, a well-respected UK economist, had been asked by the British Productivity Council to write a book entitled *We Too Can Prosper*, with the subtitle 'The Promise of Productivity'. The book was published in 1953 (Hutton, 1953) and became a best-seller. In it he enthused that management, workers and government could work together to increase productivity and prosperity, stating that the differences between the US and UK in productivity matters were primarily cultural.

The UK did indeed embrace the Marshall Plan and when it formally ended in 1952, the then Conservative government created the British Productivity Council (BPC) to continue the productivity work. The BPC published a large number of books and training materials which stressed the importance of Work Study and co-operation between management, unions, and the government. This term brought together Industrial Engineering, which had been traditionally implemented in manufacturing industries since Taylor's time, and the newer discipline of *Organisation and Methods* (O&M), which was pioneered by John Simmons and colleagues at Lyons and other leading UK Firms and Government institutions. The BPC was active between 1952 and 1980, when it was defunded. The UK did get positive results from the AACP and the Marshall Plan by achieving several decades of higher rate of productivity and growth post 1950 than had been achieved since the 1920s. The problem was that UK growth rates were half those achieved in continental Europe, and only one quarter of those achieved by Japan.

Tiratsoo and Tomlinson (1997) considered four possible explanations for this poor performance: UK Economic Context; Applicability of American methods; Management Culture and Employer Politics and British Government attitudes. Cripps (based on his own experience and knowledge from the aircraft industry during the war), and the Labour Government, had enthusiastically welcomed American assistance and was strongly supported by Trade Union Leadership. However, by the early 1950s the Americans were starting to have doubts.

"The second phase of U.S. technical assistance began during 1952-3. By now, American productivity programs were running in several other European countries, and Washington officials could assess what was successful and what had failed. Most concluded that a "broad brush" approach to the productivity problem, based simply on demonstrating the superiority of American methods, would only achieve limited results. Real and lasting gains meant turning productivity into something of a moral crusade. Wide sections in each society, from both sides of industry, must take part and if possible, assume responsibility for their own programs." (op cit p. 48).

Tiratsoo and Tomlinson summarise the reasons for the poor performance and highlight the weakness of UK management and their refusal to adopt modern management techniques summarised below:

"Finally, reference can be made to a University of Bradford Management Centre survey of work study in British industry, published during 1983:

Perhaps the most disturbing finding ... is the overall low usage of all the techniques of work study, particularly in the small to medium size firms, when compared to the knowledge which is available. *A high proportion of production operations managers have learned about work study and have proceeded to ignore it.*" (Tiratsoo & Tomlinson, 1997, p. 79 [author's italics])

There were a number of what would now be called "frontier firms" who did adopt American management practices including Lyons, Courtauld and ICI but these were a very small minority, and even today as Haldane (2018) pointed out, the UK still possesses a longer tail of poorly performing firms than our European rivals.

According to Hennessey, Macmillan had understood Britain's relative growth failure in the late 1950s and had already decided that joining the Common Market, as it was then called, was necessary to expand UK markets. De Gaulle vetoed this in the early 1960s, and the UK did not join until 1973 under the leadership of Edward Heath. The oil crisis in 1973 led to the highest post-war rates of inflation, a miner's strike which led to the 'three-day week', as electricity was rationed, and the 'winter of discontent' in 1978 which led to piles of rubbish on the streets and the unemployment of one million workers. The political consequences of this failure were that the Labour Party lost the 1979 election to Margaret Thatcher's Conservative Party, who quickly implemented Friedmanite policies imported from the US in tandem with President Reagan.

2.2.3 Diffusion of the US Productivity Program: France

In France another economist, Jean Fourastié, had also been involved in the post-war recovery as a member of the *Commissariat Général du Plan*, an advisory body set up by De Gaulle after WW II and which reported to the government of France from 1946 to 2006.

The aims of the Commissariat were: (1) to develop national production and foreign trade, particularly in those fields where France is most favourably placed; (2) to increase productivity; (3) to ensure the full employment of manpower; (4) to raise the standard of living and to improve the environment and the conditions of national life. This plan is commonly known as the Monnet Plan after Jean Monnet, the chief advocate and first head of the General Planning Commission. In pursuit of its objectives, the General Planning Commission set production targets for 1950 according to the resources that were then expected to be available, starting with six crucial sectors: coal mining, steel, electricity, rail transport, cement, and farm machinery. Later oil, chemicals, fertilizers, synthetic fertilizers, synthetic fibres, shipbuilding, and other sectors were added. The Commission's plan emphasized expansion, modernization, efficiency, and modern management practice. It set investment targets, and allocated investment funds and reported on results. (Wikipedia, downloaded July 14th 2023)

Fourastié wrote a best-selling book in 1979 called *The Thirty Glorious Years (Les Trentes Glorieuses)*, which celebrated the extraordinary success of the plan in delivering annual GNP growth rates of 5% which transformed the country. During that period France

developed and implemented the largest fleets of nuclear reactors in Europe and led the growth of Airbus, the strongest commercial aircraft industry in Europe and a rival for Boeing in the US. Monnet also played a founding role in European political and economic integration as the first chair of the European Coal and Steel Community which was the precursor to the Common Market founded in 1956.

2.2.4 Diffusion of the US Productivity Program: Germany

The productivity performance of the West German economy was even better than that of France, growing GNP at 5.7% a year according to Hennessey. Before WW II Germany had been a powerful industrial country with quite similar productivity to the UK as Rostas (1943) had observed. Germany had a number of large firms with dominant positions in chemicals, electrical engineering, automobile manufacturing and aircraft all of which were boosted in the 1930s by an intense re-armament programme. At the end of WW II, the country had been reduced to rubble by three years of 'strategic bombing' by the RAF and USAAF, occupied by the four victorious powers (US, UK, France, and the Soviet Union) and permanently lost East Prussia and Silesia.

Before the end of the war, the Morgenthau plan proposed the complete de-industrialisation and disarmament of Germany and its division into a small number of predominantly agricultural states. This planned was very quickly dropped by the occupation powers, as they realised that the costs of rebuilding the country and feeding the German population would be astronomic. Only the Soviet Union called for reparations by shipping all industrial plant from East Germany to the Soviet Union, where much of it lay until it rusted. The American, French, and British zones concentrated on feeding the remaining population and putting them to work on clearing bomb damage and reconstructing the roads, railways and factories that had been destroyed to get them working again.

In this work they were aided by two extraordinary individuals (Gethard, 2021) Walter Eucken and Ludwig Erhard. Eucken had argued for a free-market economic system with an independent central bank and a strong social welfare system which mirrored quite closely the New Deal settlement developed by Roosevelt. It also matched quite closely the objectives of the Marshall Plan as explained by Silberman in his retrospective (Silberman & Weiss, 1992):

"In the first phase of the Marshall Plan, it was tacitly agreed that the benefits of productivity increases would be shared among owners (in the form of higher profits), workers (in the form of higher wages) and the consuming public (in terms of lower prices). When the program was continued and expanded in 1953, the US Congress required that a formal agreement be signed between the recipient government and the Marshall Plan and eventually between the government and the participating enterprise. This was intended to prevent a repetition of early patterns of industrialization in Western Europe, which had achieved their ends by mechanizing production, limiting output, maintaining prices, and firing

surplus workers, a process the unions were determined not to repeat.”
(Silberman para 1.21. page 8)

Ludwig Erhard was strongly anti-Nazi, but survived the war and was quickly recognised by the US military occupation force as highly able. He was appointed by them as Finance Minister of Bavaria and was quickly co-opted into the military administration. During this time, he planned the new German currency, the Deutsche Mark and on the day of its introduction abandoned price controls, which had been in force since 1933 and maintained by the Allies, and instituted a number of tax cuts to increase consumption.

According to Gethard (2021):

“Erhard was brought into the office of US General Lucius Clay, who was the commanding officer overseeing the occupied western half of Germany. Clay told Erhard that his advisors informed him that the German's drastic new policy would be a terrible mistake. Famously, Erhard responded, ‘Don't listen to them, General. My advisers tell me the same thing.’”

Erhard was so successful that he became Germany's Finance Minister under Chancellor Adenauer and also embraced the Marshall Plan which contributed to the post-war recovery. Unlike the period after WW I, there were no reparations payments from Germany, and the Rhineland and Saar regions, the heartland of Germany's coal and steel industry were gradually returned to German ownership under the supervision of the European Coal and Steel Community (ECSC) which had the support of France, Belgium, the Netherlands, Luxemburg, and Italy.

The Marshall Plan also provided political support from the US government for the ECSC though the OECD established after the war to work with the US and European countries to support the implementation of the Marshall Plan. In the German case, as with France, extremely able people and new institutions combined to create what the Germans still call the *Wirtschaftswunder* – the German economic miracle.

2.2.5 Diffusion of the US Productivity Program: Italy

In her study of the impact of the Marshall Plan on Italian firms, Giorcelli (2019) studied the impact of the US Productivity Program in Italy. This was announced in 1950, and 6,605 Italian firms were selected as being eligible to apply. During 1951, 3,264 firms applied and were evaluated. Firms could also choose which parts of the program to apply for. The program included study trips which lasted from eight to twelve weeks and could be complimented with new machines to be provided by the US firms. The Productivity Program loaned the funds for the machine purchase, repayable over 10 years at a 5.5% interest rate (which was significantly lower than the 9% rate available from Italian sources). In addition, study trips for Italian engineers to learn how to best operate the new machines were also arranged. All firms that participated in the Productivity Program were subject to a three-year monitoring period by US experts. On average, eligible firms were multi-plant organizations with 48 employees, assets of \$1.6 million, and sales of \$1 million (in 2010 USD), that had been in operation for 12 years.

Almost all firms were family owned, 43% of them were also family managed, and only 13% were exporters.

The outbreak of the Korean War resulted in a budget cut to the Marshall Plan, which resulted in only half the firms which applied for the program being accepted. This enabled Giorcelli to compare the performance of firms which participated with the ones that did not. The results were striking:

“Total Factor Productivity (TFP) of firms that got the management training went up by 15.0 per cent and the combined management and technology transfers went up 21.7 percent, respectively, within 1 year since the intervention, compared to firms in comparison provinces. The difference in TFP between the two groups of firms constantly increased and, *after 15 years, it amounted to 49.3 percent and 86.3 percent, respectively.*” (author’s emphasis).

This increase in firm level productivity contributed to Italy’s 5.1% annual GNP growth as reported by Hennesey.

2.2.6 Diffusion of the US Productivity Program: Japan

Bianchi and Giorcelli (2020) also reviewed the implementation of TWI in combination with Deming’s teachings in Japanese industry. The TWI program was a voluntary government-sponsored program that offered free in-plant management training to US firms involved in war production between 1940 and 1945. It encompassed interventions in three main areas, called J-modules. The Job Instructions (J-I) module taught supervisors and managers how to establish standard procedures for operations, the Job-Relations (J-R) module how to manage and motivate workers, and the Job-Methods (J-M) module how to introduce improvements to current production processes.

One of the firms that was able merge Deming’s teachings with TWI was Toyota, whose senior production engineer Taichi Ohno had already studied the Ford production system in Detroit. He had understood that that the economies of scale achieved by Ford were based on the output of 8,000 cars per day, whereas in 1950, Toyota could only produce 2,500 cars per year. Ohno realised that the best way to manufacture in volumes far smaller than were common in the US or even Europe was the increase the ‘flexibility’ and utilization of the key elements in their manufacturing systems – equipment, workers, and suppliers. Ohno also sought to lower, as much as possible, equipment needed for in-house personnel, factor or warehousing space, and variable costs such as in-process or finished goods inventories. (Giorcelli, p. 19.)

2.2.7 Why Did the UK Fail to Diffuse the US Productivity Program as Successfully as its Rivals?

The chart below shows UK productivity from 1860 to 2018. Out of the sixteen decades from the Great Exhibition, the two best decades for productivity growth occurred

between 1950 and 1969 and the third best decade was the 1920s. The much-maligned 1970s (Crisis, What Crisis?) and the much-praised 1980s (North Sea Oil and Big Bang), turned out to deliver the same levels of productivity growth as each other.

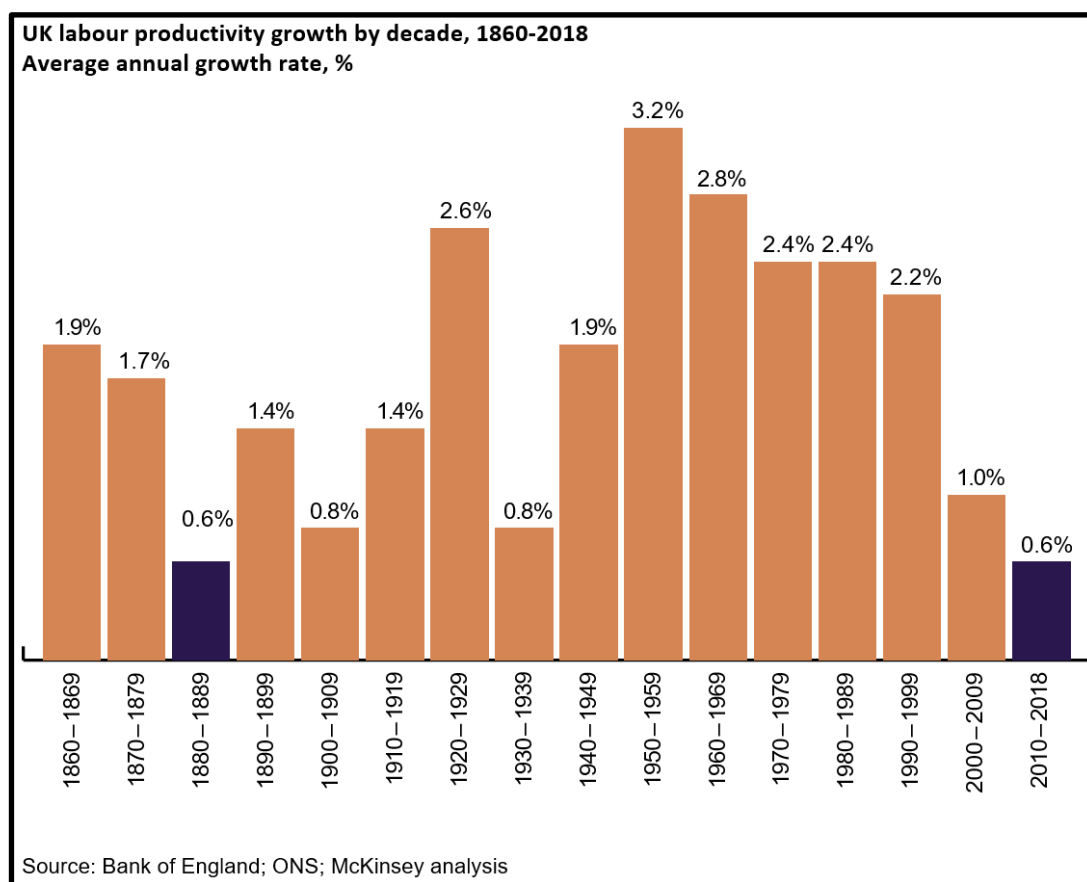


Chart 8: UK labour productivity history since 1860.

There are a number of possible explanations for this relative failure. The US and the UK both implemented strong national-economic systems during the war, during which the allocation of labour and capital, as well as innovation expenditure, were tightly managed to deliver victory against the Axis powers. This was combined with careful management of domestic consumption and prices to deliver successful war time economies. The UK also implemented strong rationing of basic foods and transportation from the start of the war, which did not end until the early 1950s.

Corelli Barnett (1955) documented how the UK wasted the post-war opportunity presented by the Marshall Plan and Hutton confirmed this (Hutton, 1980). But Fourastié (1976) was able to do the opposite by celebrating *Les Trentes Glorieuses*, which clearly owed something to the French implementation of their national economic system after the war under De Gaulle's direction and Monnet's management.

Weatherburn (Op Cit) notes that highly sophisticated scientific management / work study systems were implemented in the UK munitions industries by firms without any prior experience in these industries, and that work study for manufacturing industries and organisation and methods (O&M) for office work were also strongly supported by

the British Productivity Council and British Institute of Management, both established by Cripps after the war.

The problem for the UK may have been that these innovations were only implemented by a small number of frontier firms and not diffused as widely as in the other countries in the Marshall Plan. As recently as 2018, Haldane (2018) was suggesting that the 'long-tail' of poorly performing UK firms was partly responsible for the UK Productivity Puzzle.

Another contributory factor might be that the UK never implemented the third leg of the US Productivity Program which was the delivery of regular productivity reporting at shop, firm, and industry levels. This lack of reporting is still the case today.

A final contributory factor, which was quite explicitly made by Hutton (1980), was the large growth in public services since WW II. In the internationally agreed System of National Accounts (SNA) inputs are equated to outputs for public services which means that productivity is not measured at all. Dunleavey (2013) argued that this was a great mistake given that these services now accounted for 20% of UK GDP, which was roughly equivalent to the Manufacturing, Construction and Utilities industry sectors, and set out a number of recommendations to measure outputs directly in the same way as private services. This turns out to be both possible and desirable as was argued by the Donegal County Council manager in his submission to the Irish local government department following the 2008 financial crisis. (McLoone, 2010b).

The Atkinson report (2005) recommended that public services productivity be measured by how effectively inputs were converted into outcomes rather than outputs and this recommendation was accepted by Government and implemented by ONS as a satellite account, so there is still no accurate reporting on how inputs are transformed into outputs in public services.

2.2.8 Scaling and Diffusion

One way of looking at an economy is to look at how successful its firms are at scaling. By scaling we mean the normal growth in revenue, profitability (and ideally productivity) which a firm can report in its annual accounts. Economists already use scale factors like revenue growth and productivity growth to distinguish between high-growth firms, (three consecutive years of 20% per annum revenue growth); and frontier firms, the one percent of firms who achieve productivity growth rates greater than 10% per annum. Management teams, particularly those in large publicly listed firms, are very focused on delivering consistent growth in revenue and profits, and a small number of frontier firms also talk about their growth in productivity and the innovations which drive these increases.

At national level, governments are also interested in scale-ups but are even more interested in diffusion. As Haldane (2018) pointed out, from the productivity perspective, the UK has a long tail of poorly performing firms. Looking back at the US Productivity Program, it can be seen that this comprised a rich set of intellectual property

and associated intangible assets which had already demonstrated diffusion in the US economy during WW II. Following the end of the war, it therefore made perfect economic sense for the US Government to offer these intangible assets to their Allies and provide them additional financial support to implement them. As has been noted, the US Productivity Program was very widely diffused in most countries to which it was offered and supported extraordinary GDP growth for nearly 30 years. US Allies used the proceeds from economic growth to purchase US exports and invest in US Firms, thereby directly benefiting the US itself. The US, by following the tripartite distribution of its own productivity growth, managed to ensure that real wages matched real productivity growth until 1980.

From a macro-economic perspective, countries which have firms which are scaling successfully and implementing the most advanced managerial methods and tools (of which the US Productivity Program is an excellent example) and distribute the proceeds of productivity growth to workers, customers and investors, have the highest sustainable rates of growth because higher wages drive higher consumption which results in higher demand for products and services to which firms respond by scaling their businesses.

2.2.9 Research Gaps in Diffusion

From a review of the history of knowledge diffusion as it pertains to key productivity programs over the last century, four significant issues can be identified:

1. The UK's diffusion of the US Productivity Program between 1948 and 1979 was significantly weaker than comparably sized European countries and Japan. This is despite the fact that the UK had a number of what are now called 'high performing firms' at the start of the program.
2. Lack of Growth Investment: As documented by Goodridge and Haskel (2022), the UK has suffered from much lower growth investments since the 2008 financial crash than other countries, and this was explained by the decline in intangible investments in a small number of pre-2008 high-performing sectors.
3. As argued by Haldane, the UK has a much longer tail of poorly performing firms than its European or American competitors, which could account for a significant percentage of the productivity puzzle.
4. The UK still lacks detailed productivity growth reporting at firm, region, and national levels which BLS implemented during and after WW II, which provided rich and detailed reporting at firm, region, and national levels (which increasingly relied on administrative systems data). Even though the firm level data collection was ended in the 1980s productivity reporting is still more granular than that in the UK.

2.3 Post-War Management Practices

In addition to the Management Practices which have been documented as part of the US Productivity Program and Marshall Plan there have been a number of additional strands of theory, some of them developed in the UK and more recently in the USA. These include:

- Socio-Technical Systems
- Work Study and its Replacement by Technical Systems
- The Addition of Econometric Measurements within the Firm
- Levels of Work Complexity
- Complementary Investments
- Measurements of Management Practices

2.3.1 Socio-Technical Systems

Socio-Technical systems were first developed by Eric Trist (Trist and Murray 1993) at the Tavistock Institute in London which was founded in 1946 with a grant from the Rockefeller Foundation. As Trist writes:

“By 1948 the British economy was in serious trouble. The pound had been devalued, productivity was low and there was a scarcity of capital for investment in new technology. The Government formed an Industrial Policy Committee which had a Human Factors Panel. This made grants for research aiming to secure improved productivity through better use of human resources. The grants were for three years and were administered by the Medical Research Council (MRC). The Institute proposed three projects, all of which were accepted.”

Socio-technical thinking built on the blending of Kurt Lewin's group theory, the psychiatric theories of Freud and Klein and the psychological assessment of military personnel as part of officer selection and rehabilitation of military veterans during WW2. These experiences shaped the thinking and research agenda of the Tavistock founders who were predominantly practicing psychologists and psychiatrists.

Trist's definition of Socio-Technical Systems

This was based on the research project conducted by Trist and Bamforth at the Haighmoor seam in a South Yorkshire colliery funded by the MRC grant. The implementation of new roof control by the Area General Manager had made “shortwall mining” possible. The miners, with union support, had developed the new manning arrangements and the Tavistock was invited to study these new arrangements. Trist summarised the initial findings:

“The work organization of the new seam, was, to us, a novel phenomenon consisting of relatively autonomous groups interchanging roles and shifts and regulating their affairs with the minimum of supervision. Cooperation between task groups was everywhere in evidence, personal commitment obvious, absenteeism low, accidents infrequent, productivity high. The contrast was large between the atmosphere and arrangements on these faces and those in the conventional areas of the pit, where the negative features characteristic of the industry were glaringly apparent.” (Trist & Murray, 1993 P. 37)

Trist's insight was radical. He understood that the revolutionary industrial engineering approach which started at Ford's Rouge River plant in 1908, and which was widely copied in manufacturing industries in the USA, Germany, France and the UK over the next 40 years was founded on an organizational model that fused Weber's description of Bureaucracy with Frederick Taylor's scientific management. The Highmoor experience showed that this was not an inevitability, in there were organisational choices. This led to the development of the socio-technical paradigm of work in which the best match would be sought between the requirements of the social system and the technical system. Trist also adopted the feedback loops popularised by Cybernetics as a key part of the socio-technical system. Later work by Trist and Emery led to the development of a set of principles to be followed and to the identification of the three different levels of analysis which they called Primary Work Systems: Whole Organisation Systems and Macro Social Systems.

Later Evolution of Socio-Technical Systems

There does not seem to have been much communication between the Work Study practitioners who, during the 1950s, were well established in UK industry, commerce and government, and the new Socio-Technical specialists. However, the socio-technical definition is an important and useful one and continued to influence researchers as diverse as Doug Engelbart (1963), Cal Pava (1993) and Professor Enid Mumford (1989), whose study of the of one of the earliest Artificial Intelligence (A.I.) implementations has even greater relevance today than when it was first published. Mumford's later work (1996) on the Ethics of Socio-Technical systems stresses the importance of engaging the employees, first and second level managers in any technology driven change. She argued that without their active participation, the results of these projects may not reach their potential.

Critical Review of Socio-Technical Systems

From a mainstream IT perspective socio-technical systems are a historical relic, replaced by Business Process Management in the 1980s and 1990s and Agile methods in the 2000s. However, as Bostrom and Heinen (1997) explain in their two articles, the socio-technical systems method complements the traditional systems analysis and programming approaches for developing applications software. The important shift is the engagement of the end-users of the design and implementation of the software, so their use-cases do not include implementation of applications packages like ERP. Mumford (1979) also used a similar approach in her description of the implementation of a first generation A.I. application. From the author's perspective what is missing from socio-technical approach is the economic impact of the application software on business performance. The assumption is always that investment in application software, or 'digitisation' as it would be called today will always be economically productive but there is no guarantee that investments in applications software will deliver TFP growth unless the measurement is part of the original system design, in other words a socio-economic, technical system.

2.3.2 The End of Work Study and the Disappearance of Work

The Marshall Plan and the British Productivity Council Productivity Council

Stafford Cripps was one of the few politicians with any high-level managerial experience, having served as the Minister of Aircraft Production from November 1942 to May 1945. He was well aware of the need to increase the productivity of UK industries and had already set up the British Institute of Management in 1947. He argued strongly for the Marshall Plan and for active UK participation; this resulted in the Anglo-American Productivity Council (AAPC) which organised a comprehensive programme of visits by UK management and trades unions to a wide variety of American firms.

At the end of the Marshall Plan in 1952, the Conservative government created the British Productivity Council (BPC) to continue this productivity work. The BPC published a large number of books and training materials focused on Work Study. This term brought together Industrial Engineering which had been traditionally implemented in manufacturing industries since Taylor's time and the newer discipline of 'Organisation and Methods' also known as O&M, which had been pioneered by John Simmons at Lyons and colleagues in other leading UK Firms and Government. The BPC was active between 1952 and 1980 when it was defunded.

One of the first impacts of the new information technologies was the replacement of scientific management and work study in the 1960s by Systems Analysis, which by definition, is focused on the technical system and not the social institution. This disappearance was explained to the author by a former work study engineer.

Graham Briscoe's explanation

Graham Briscoe (2019) explained over the course of several interviews that he had trained as a Work Study engineer in the Midlands in manufacturing industry. He later moved to the insurance industry, but was encouraged by them to convert a Systems Analyst role, since they were about to buy a new computer, and no-one knew what to do with it! The training as a Work Study engineer equipped Graham to understand the social system that was to be computerised, and the systems analysis work was focused on translating the user requirements into a systems specification that could be programmed for the computer system.

During his career in Work Study and Systems Analysis, Briscoe amassed a personal collection of more than 400 books on work study, as well as copies of industry journals, all of which he gave to the Open University. The author can remember hearing about work study and time and motion on joining the computer industry as a graduate trainee in 1968, but none of the graduate trainees ever learned what it was. By that time graduates were being trained as computer people, to become systems analysts, software engineers or salesmen.

It was the changing economics of the computer industry which led to the extraordinary growth in demand for systems analysts. The early computers in the 1950s were extraordinarily expensive and used vacuum tubes which were large and relatively unreliable. Once the transistor could be applied to replace valves as was done by the IBM 1400 series in the early 1960s sales and installations of computers rose very rapidly due to the much lower costs these new systems. Because Wright's Law applied to computer manufacturing in the same way as it applied to automobiles and aeroplanes, IBM's high production volumes of over 10,000 1400 series machines delivered between 1960 and 1970 led to significant cost reductions year on year. Because IBM shipped between five and ten times more units than any of its competitors, its unit costs were much lower than them as Wright's law predicted and their profits much higher.

This enabled IBM to increase market share at the expense of all competitors, many of whom were selling in the hundreds rather than thousands of machines. In the UK this squeeze resulted in the exit of Lyons from the computer industry in the early 1960s, being sold to English Electric. In 1968 English Electric, Lyons Electronic Office (LEO), Marconi (EELM) and International Computers and Tabulators (ICT) were merged under the guidance of Anthony Wedgwood Benn (later Tony Benn) to create the new British champion in the computer industry, International Computers Ltd. The author joined ICL as a graduate trainee in September 1968 and met David Caminer a number of times in the mid-1970s.

This dramatic reduction in the price of computers and the dominance of IBM and a small number of other American firms led to a second unexpected consequence, first identified by David Caminer, who was at that time a senior manager in LEO. In his book co-authored with two other Lyons alumni (Caminer 1996) he identified this dramatic shift in the early 1960s with the arrival of the IBM 1401. In the early years of selling LEO, the approach was not to sell the hardware, but to work with the customer with a consulting engagement to fully understand the business problems that were to be addressed. This approach built on Lyon's long experience in using Work Study techniques to document and manage their own administrative processes which dated back to their first contract with the Bedaux company, in 1927, as pointed out by Weatherburn (2014). The Work Study approach was led by J R M Simmons who had worked as Head of Systems Research at Lyons since 1931 having joined the firm from Cambridge in 1921.

Without articulating it, Lyons had developed a practical implementation of the socio-technical systems approach by bringing together Work Study, which focused on the work-activities and the processes, and the new technical computing system provided by LEO. Caminer's user driven innovation followed this approach by using Work Study techniques to document user processes and nascent systems design methods to develop requirements which could then be coded by software engineers. LEO not only developed the computing hardware, but the systems analysis, programming and operations roles needed to deliver a working application. Once the IBM 1400 series

ramped up production, computer sales were taken over by specialised salesman, who focused on the features and benefits of the computer hardware compared to alternative sellers.

The power of Work Study

The benefits of work study during WW2 have been very well documented by Weatherburn (2014). As noted earlier, Lyons, were one of the UK's leading implementers of Work Study, or Organisation and Methods (O&M) as it was also called. Under the leadership of J.R. Simmons, Lyons became widely known for the development and implementation of Lyons Electronic Office (LEO), the first computer designed specifically to support administrative work. Work Study practice was sufficiently advanced to enable entire factories to be staffed and operated in a completely different industry sector.

Why is Work Study not the same as Systems Analysis?

The answer to this question is very simple: work study is about work-activities, work measurement, working relationships, payments for work, targets for work, best methods of doing work, motion study, best way of laying out factories to minimise time and waste.

Systems analysis deals with the specification of information systems and is concerned with data, software, databases, data security, data access, data reporting, backup and recovery, access security and so forth. In the 1950s and 1960s, when the computer industry was new, and computers were extremely expensive there was a sudden need for a new group of occupations. This group included systems analysts to document user requirements. software engineers who would write and test the code, computer operators who managed the physical resources in the "computer room" an air-conditioned room which housed the computer itself, the punched card and / or paper tape machines for data entry, the magnetic tapes for data storage and the line printers for outputs. The fourth job was that of the key punch operators, nearly always females, who entered data onto 80 column punched cards, which were at that time the main method of entering data.

The End of Visible Work

Zuboff (1988), the author of 'In the Age of the Smart Machine', studied a number of firms between 1978 and 1986 who were computerising their operations for the first time. This meant that they were transferred from analogue systems which required filing cabinets, documents, photocopiers, typewriters, tabulators and other types of office machinery that would have been familiar to most office workers since 1900 and were comprehensively documented by Mills and Standingford (1962).

Zuboff's case studies "included two pulp mills and one pulp and paper mill (located in separate division of the American Paper Company; Metro Tel, an operating unit of a telecommunications company; the dental claims operations of Consolidated

Underwriters Insurance; the Brazilian offices of Global Bank; and a large pharmaceutical company called Drug Corp.”

In order to fully explain the impact of computerisation Zuboff goes back to the beginning of scientific management in which Taylor observed and measured work using a stop-watch to which the Gilbreths added motion study to better understand the movement of the worker in the performance of the work. The combination of the two methods led to ‘time and motion study’. One feature of scientific management was to make the ‘implicit knowledge’ of the worker into “explicit knowledge’ which could be codified and communicated.

“This helped to fuel an explosion in the ranks of those who would measure, analyze, plan, report, issue orders, and monitor the various aspects of the production process. Armed with such data, planners, time-study experts, and production specialists (frequently organized as a staff group for the plant manager) became responsible for analyzing work tasks, controlling and monitoring their execution, coordinating functions, managing the flow of materials and keeping records”. (Zuboff page 43)

Having painted a rich picture of scientific management Zuboff then turns her attention to the use of information technology and examines the differences between information technology and scientific management. Her main point is that whilst “information technology is used to reproduce, extend and improve upon the process of substituting machines for human agency, it simultaneously accomplishes something quite different. The devices that automate by translating information into action also register data about those automated activities, thus generating new streams of information”. Zuboff calls this new phenomenon “infomating”. “Activities, event and objects are translated into and made visible by information when a technology *infomates* as well as automates”. (Zuboff page 9)

As she points out, the *infomation* of work means that a computerised version of the work is created, but there is no guarantee that this “infomated” version will actually be made available to the workers or managers concerned. In large firms, a version of this “infomated knowledge” has been made available to a new discipline called “enterprise architecture,” but this is a technical discipline whose specialists have neither a managerial interest nor relationship with the infomated work and are not accountable for it.

What Zuboff describes in the 1980s is a precursor of what ERP systems did in the 1990s. The value of ERP systems is precisely because they come with pre-built and standardised implementations of the work activities, work objects, user interfaces and database schemas for every department of the firm. Despite the costs of customisation for most Fortune 500 firms the total cost of ERP was still less than the cost of building, maintaining and updating their own bespoke software. Carr (2003) argued in his HBR article that “IT Doesn’t Matter”. He pointed out that using the same software as every other firm could reduce competitive advantage.

However, there is a downside to adopting ERP which is that as technologies and markets change, the customised implementation of an ERP system makes it much more difficult for the firm to adapt to these new circumstances. Bessen (2002) explores this by examining the relatively small number of frontier firms who have sufficient investment funding and are prepared to create and develop their own IT departments which can build, operate, maintain and improve their own, entirely bespoke, software. We can see the emergence of a three-tier marketplace: frontier firms who do their own (Tesla is possibly the best example of this by developing their own software to manage their Giga Factories). The second tier is large firms who choose to stay with the known costs of ERP even at the expense of giving up some flexibility and the third tier (mostly Small and Medium Enterprises who cannot afford ERP software, and do not have an IT department, but who still need to digitise their production units cost-effectively to grow productivity).

Critical Review of the End of Visible Work

Staudenmaier (1990) provides a critical review of Zuboff's book and points out that "informating" challenges the hard-wired Taylorist hierarchical structures prevalent in US firms by creating a different view of the enterprise which many managers found extremely challenging. In retrospect, the arrival of ChatGPT, Grok and Google AI, can be viewed through the informing lens, as taking an important step by further disconnecting the analysis of the work of the firm from the informed version (maintained by enterprise architects for large firms) to large language models owned by an oligopoly of large US firms.

2.3.3 The Addition of Econometric Measures within the Firm

A group of US Labour economists which included David Autor, Frank Levy and Richard Murnane (2003) added econometric measurements to socio-technical systems. Their hypothesis is both simple and powerful:

"Computer capital (1) substitutes for workers in performing cognitive and manual tasks that can be accomplished by following explicit rules, and (2) complements workers in performing non-routine problem solving and complex communication tasks." (Autor, Levy and Murnane page 1280)

Levy and Murnane (2004) expanded this hypothesis in their book, *The New Division of Labor*, by providing examples of different types of work and the extent to which they could be digitised. The five types of work with brief definitions are set out below: definitions are set out below (Levy and Murnane page 47):

"Expert thinking: which includes solving problems for which there are no rule-based solutions.

Complex communication: which focuses on interacting with other humans to acquire information, to explain it, or to persuade others of its implications for action.

Routine cognitive tasks: these include mental tasks which are well described by logical routines.

Routine manual tasks: these include physical tasks that can be well described using rules.

Nonroutine manual tasks: which are those physical tasks that cannot be well defined following a set of *if-then-do* rules because they require optical recognition and fine muscle control that have proved extremely difficult for computers to carry out.”

Levy and Murnane then reviewed these categories against the changes in the US labour market from 1969 to 1998. The authors argue that the impact of information systems shows up in the decline of routine cognitive tasks and routine manual tasks, but non-routine tasks are harder to automate. They also show a big increase in expert thinking and complex communication where information systems are used to complement rather than replace labour.

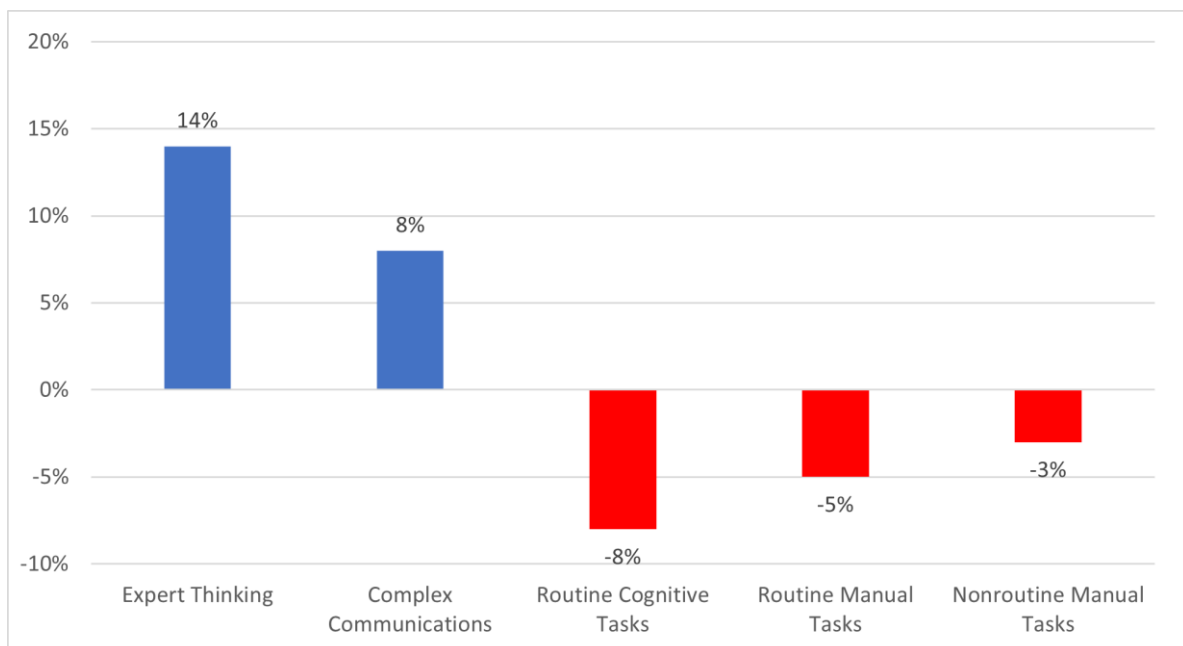


Chart 9: Changes in the US labour market from 1969 to 1998 (Levy & Murnane, 2004).

Critical Review of the New Division of Labor

There are four main criticisms of the task-based approach. The first, raised by Piketty (2014) is the association between technology and the increasing concentration of wealth in fewer hands. This trend has been well documented for the USA by Reich (op cit) and others, and goes back to Friedmanite policies (op cit) of shareholder primacy implemented under the Reagan administration. The second criticism concerns

outsourcing, which was one of the main mechanisms used by US firms to reduce labour costs, by moving work to China in the 1990s and 2000s as documented by Frey (2019). The third criticism, by the OECD, is the lack of detail on the institutional responses to the changes in work introduced by new technologies. If the combination of technology and outsourcing creates widespread unemployment, who is responsible for fixing this problem? The final criticism is the author's, which is that these are the wrong set of econometric measures to be introducing. It would be more helpful to managers, investors and policy makers to understand the TFP impact of technology and outsourcing, as well as the new knowledge and skills required by managers and employees following implementation.

In a more recent publication, entitled *The 'Task' Approach to Labor Markets*, Autor (2013) argues that changes in the allocation of tasks between capital and labour, and between domestic and foreign workers, cannot be fully explained within the macro-economic production function because this model is essentially static. An alternative approach to assigning skills to tasks is therefore needed. At the firm level, where managers need to assign skills to tasks with firm productivity in mind, a more dynamic model that takes into consideration the variations in work activities, the manner in which work objects are delivered, and the value of human capital is key.

One of the problems with Autor's approach is that his unit of analysis is really the occupation rather than the work activity and work object. The reason for this is that the available data is provided by the Standard Occupational Classification (SOC) taxonomy maintained by the US Bureau of Labor Statistics. (BLS 2024).

Autor and his colleagues focus on cognition as the main contribution by labour (with an exception for non-routine manual tasks). The ability to think, in this analysis, is the added value that distinguishes human employees from robots and artificial intelligence (AI) engines.

Critical Review of the Task Based Approach

Autor's shift from the focus on the econometric view of occupations to the econometric view of tasks is, in the author's view a helpful move. Unfortunately, it is incomplete. Occupations do indeed perform tasks but tasks are made up of work-activities and work-objects. It is possible, and desirable, to record the variety, quantity and quality of the work activities performed by any role in any occupation. These represent the labour inputs to the production function. It is also possible, and desirable, to record on the variety, quality and quantity of work objects produced by the work activity for each role and occupation. These represent the outputs of the production function and are often measured by Key Performance Indicators (KPIs) at the end of the process. In order to calculate both labour productivity and TFP it is necessary to know both labour work activities and labour work objects separately and to assign them to the appropriate production unit.

2.3.4 Levels of Work Complexity

Sociologists have provided an alternative view of levels of work complexity compared to that used by Autor and colleagues. Elliot Jaques, in his *General Theory of Bureaucracy* (1976), drew on his longitudinal research project at the Glacier Metal company, which ran from 1948 to 1965, and makes three important contributions to Weber's work. First, Jaques outlines eight levels of work complexity; second, he attaches a timespan to each level; and third, he distinguishes between those levels of work that deal with concrete work objects (the first four levels), and the levels of work which deal with abstract work objects (the fifth level and above).

Whilst some of the timespans, particularly those for very high-level roles may appear unrealistic, research in disruptive innovations and substitution curves (Seba & Dorr, 2020) provides many illustrations for the timespans of disruptive innovations which are often 20 years or more. Seba's first example is the substitution of the horse by the automobile, driven by Henry Ford, which took from 1905 to 1925 in some cities in the US, notably New York. A more modern example is the substitution of internal combustion engine vehicles (ICE) by battery electric vehicles (BEV), which began in 2008 and will complete sometime in the late 2040s with the replacement of the entire ICE fleet, a timespan of well over 30 years. Every one of these disruptive innovations is driven by an individual manager who sets the completion date for his S shaped curve and works until he or she achieves it. These timespans, first developed by Jaques, are illustrated in Chart 10 below.

	Time-Span	Stratum	Mental Process	Industry	Army
Conceptual Abstract		STR VIII	Parallel	Super Corporation CEO	5-Star General
	50 YRS				
		STR VII	Serial	Corporate CEO	Army (4-star General)
	20 YRS				
		STR VI	Cumulative	Corporate EVP	Corps (3-star LTG)
	10 YRS				
Symbolic Verbal		STR V	Declarative	Business Unit President	Division (2-star MG)
	5 YRS				
		STR IV	Parallel	General Manager	Brigade (1-Star BG Col.)
	2 YRS				
		STR III	Serial	Unit Manager	Battalion (Lt. Col. Major)
	1 YR				
		STR II	Cumulative	First Line Manager	Company (Cpt./Lt.)
	3 MTHS				
		STR I	Declarative	Operator	Pvt & NCO (E7-E1)

Chart 10: Jaques outlines eight levels of work. (Hodes)

Assessment of Capability

A colleague of Jaques' at the Brunel Institute of Social Sciences (BIOSS), Gillian Stamp, subsequently developed a method for assessing human capability of individuals based on Jaques' Levels of Work hypothesis. Asked by the US Army Research Institute for the Behavioral and Social Sciences (ARI) to assess levels of capability for groups selected by the US Army, Stamp (1988) published her findings in a longitudinal review of 182 assessments. The executive summary, written by the ARI Technical Director, summarises the key points from the research (Stamp page 2):

"For the whole sample, the correlation coefficient between the predicted rate of growth of capability and level of responsibility was 0.79. By 1979, the procedure for predicting potential had been refined into a guided interview called a Career Path Appreciation (CPA). The correlation coefficients for follow up of CPA are 0.89. This figure may be compared with two other longitudinal studies of potential: one in the US (Bray; AT&T) and one in the UK (Anstey; UK Civil Service) where the correlations were 0.44 and 0.66, respectively."

The remarkably high predictive validities obtained in this research are convincingly supportive of levels of work and further support the contention that the potential for development beyond the lower and middle levels of organization rests largely on conceptual ability.

For the US Army, Stamp's findings about work activity, human capability, and complexity strongly reinforced their existing practices. In peacetime, the US Army is acutely aware of the need to be able to staff up for wartime operations, which requires personnel planning of a much higher order than is found in commercial firms, particularly for roles at Level 4 (Brigade commander) and above (Jacobs & McGee, 2001). The US Army operates as a seven-level hierarchy during peacetime, during which the top level is a four-star general. However, in wartime, Congress can appoint five-star generals to reflect the increased complexity of the job, which creates an eight-level hierarchy.

All these studies point to the challenges inherent in both understanding and describing work activities and the challenge of mapping the right people to the different work activities that need to be completed. Within the context of the new theoretical framework, it becomes important to capture and document the work activities for all four levels of work with a high level of detail. It is also important for managers and organisations to capture and document individual skills, interest, and levels of cognitive capabilities that would indicate competence to complete work tasks at different levels (in the Jaquesian sense). Without insights into these dynamics, an SME striving to improve firm-level productivity by refining work systems and personnel deployments will be unable to move these levers other than blindly.

Critical Review of Levels of Work Complexity

It has been argued that management requires more than cognitive capabilities but must have emotional intelligence (Goleman, 1998). In fact, Jaques was a practicing psychoanalyst for much of his career and worked closely with Melanie Klein (1957) on her book 'Envy and Gratitude' so would have strongly agreed with Goleman about the importance of emotional intelligence.

The second criticism concerns the types of organisations which Jaques and his colleagues studied. These included Glacier Metal, a large UK engineering firm which produced ball bearings, a number of UK NHS organisations in Health and Social Care, CRA, a large Australian Mining Company and the US Army. Parker suggested that modern start-ups and Agile organisations bore little resemblance to the large hierarchical organisations which Jaques had studied. There is some truth in this statement, in that Jaques was never really interested in technology in a theoretical sense. Even though he had worked with Trist from the founding of the Tavistock Institute, their focus on small group working and socio-technical systems was not his.

From the author's experience, any focus on improving the productivity of work requires an understanding of the work itself, including the organisational structure, roles, responsibilities, tasks, work activities and work objects. This analytical lens can be

applied equally well to start-ups, Agile development projects and medium and large SMEs.

2.3.5 Post War Thinkers

Milton Friedman – the Purpose of the Corporation

In 1970, Milton Friedman published his seminal paper in which he outlined the purpose of the corporation, which is to maximise profits for its shareholders.

“In a free-enterprise, private-property system, a corporate executive is an employee of the owners of the business. He has direct responsibility to his employers. That responsibility is to conduct the business in accordance with their desires, which generally will be to make as much money as possible while conforming to the basic rules of the society, both those embodied in law and those embodied in ethical custom.” (Friedman 1970 page 1)

Andersen (2000) documented how Friedman’s doctrine became a part of the Republican party’s policies which were successfully implemented under President Reagan. The economic consequences are well-known. Under Roosevelt’s New Deal there had been an explicit assumption that the results of national productivity growth would be treated as a “social good” from which all citizens would benefit. As Silberman (Op Cit) documented, Congress even updated the Marshall Plan policy to ensure that this happened in all its participants.

National Statistical Offices (NSOs) measures productivity growth and the distribution of productivity growth between firms and their employees. In the USA, since 1980, the majority of the gains from productivity growth have gone to the shareholders and real wages, particularly those without college education, have stagnated.

Alan Fox Inequality and Growth

Fox was a British sociologist writing in the 1970s, during the years in which the UK’s industrial relations fell apart. It was the decade which started with the “three-day week” caused by the miners’ strike, saw the failure of the UK car industry and ended with mounting rubbish on the streets caused by public sector strikes. The end of the decade culminated with the election of Margaret Thatcher and nearly 20 years of Conservative party government. Fox asked hard questions about the levels of trust between management and workers which had demonstrably broken down. He concludes with a question which is as pertinent today as when it was first posed:

“The accelerating pace of change in technology methods and markets is thought to create a growing need for a rank-and-file response to managerial leadership. The manager needs to ask himself whether this response is ever likely to be forthcoming from the lower ranks of an organisation which, like the society that contains it, is highly unequal along all the important dimensions of life and experience.” (Fox 1974 page 176)

Deming's insights

Based on his extraordinary experience in post WW II Japan as part of the Marshall Plan, W. Edwards Deming (Deming 2018) taught that productivity *measurement* is not the same as productivity *improvement*. He stressed, based on his personal experience with large numbers of productivity projects in many firms, both public and private, that before any improvements were to be attempted, the work activities within each department must first be specified, and the changes in system state must be reported on using statistical quality control methods. He sets out the firm level approach and its consequences as a sequential process which is illustrated in Chart 11 below.

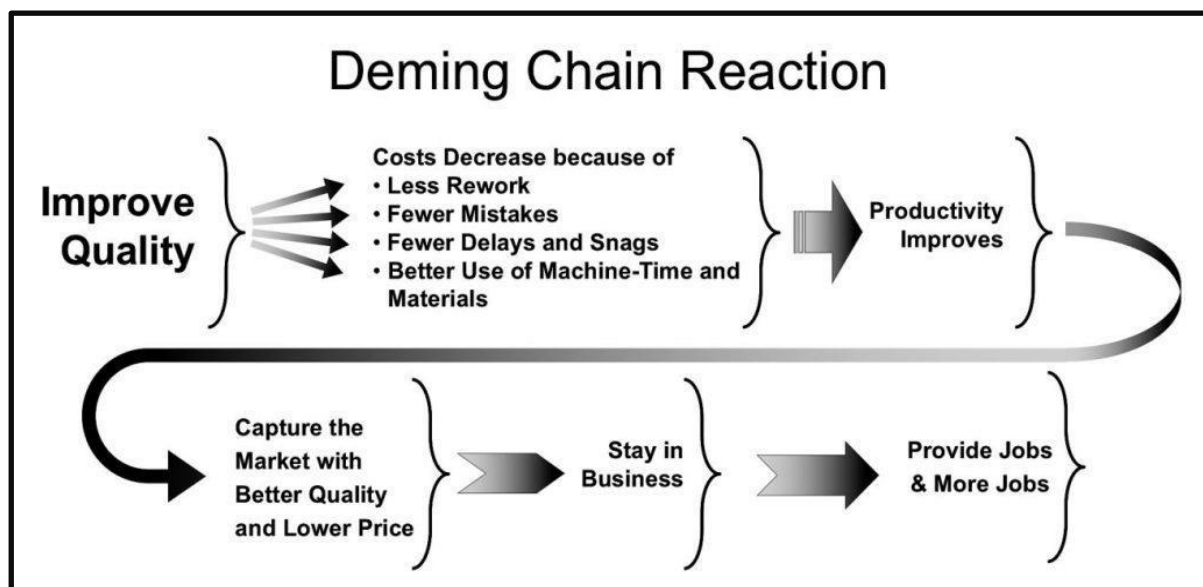


Chart 11: The Deming Chain Reaction (2018)

Deming says that ““this chain reaction was on the blackboard of every meeting with top management in Japan from July 1950 onwards.”” (Deming 2018 page 3)

Under Deming's guidance, Japanese industry, which had been completely decimated in WW II, recovered to drive the Japanese economy to deliver 10% annual growth in GDP from 1950 to 1970. During the 1980s another group of scholars from MIT (Womack, Jones, & Roos, 1990) studied the Toyota Production System, the implementation of which had enabled Toyota to overtake General Motors as the world leader in automobile production. They explained and communicated Toyota's lessons to the global automotive industry under the banner of 'LEAN' production. They summarised the benefits of LEAN as follows.

“Lean production is 'lean' because it uses less of everything compared with mass-production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also, it requires keeping far less than the needed inventory on site, results in many fewer defects and produces a greater and ever-growing variety of products.” (Womack, Jones, & Roos, 1990, p. 11)

Critical Review of the Deming Out of the Crisis

Deming's original improvement cycle (PDCA) Plan-Do-Check-Act was developed by him in post-war Japan and was widely implemented as part of the Toyota Production System between the 1950s to 1970s. The Toyota Production System was as introduced to the USA by the Lean Institute at the Massachusetts Institute of Technology. Moen and Norman (2009) outline how Drucker later refined PDCA to PDSA "Plan-Do-Study-Act" and the method was further extended by Moen (page 9), who called it "Model for Improvement" by adding three contextual questions:

1. What are we trying to accomplish?
2. How will we know that a change is an improvement?
3. What change can we make that will result in an improvement?

One of the weaknesses of the Deming approach stems from its original use in manufacturing industries with statistical quality control being the main type of measurement. As the use of PDSA spread beyond manufacturing into service industries and healthcare the need for more relevant measurements became clear. The author's view is that using TFP to measure the performance improvements of PDSA for SME production units would be helpful for existing PDSA practitioners.

Drucker's Retrospective: Applying Knowledge to Knowledge

In 'Post Capital Society' Drucker (1993) explained the two fundamental differences between industrial and manual work and knowledge work. Drucker begins by outlining the extraordinary success of Taylorism.

"What, then, overcame the 'inevitable contradictions of capitalism, the 'alienation' and 'immiseration' of the labouring class, and with it the whole notion of the proletariat'?" The answer is the Productivity Revolution. When knowledge changed its meaning two hundred and fifty years ago, it began to be applied to tools, processes and products. This is what 'technology' means to most people and what is taught in engineering schools. But two years before Marx's death, the Productivity Revolution had already begun. In 1881, an American, Frederick Winslow Taylor (1856-1915), first applied knowledge to the study of work, the analysis of work, and the engineering of work. (Drucker 1993 page 33)

The application of knowledge to work explosively increased productivity. For hundreds of years there had been no increase in the ability of workers to turn out goods or move goods. Machines created greater capacity. But the workers themselves were no more productive than they had been in the workshops of ancient Greece, in building the roads of ancient Rome, or in producing the highly prized woollen cloth which gave Renaissance Florence its wealth." (Drucker 1993 page 38)

Drucker's first great insight, based on his continuous observation of work and working practices since the 1930s, was that as the number of people working to make or move things declined from the majority in the 1950s to less than 10% in the 1990s, what now mattered was the productivity of non-manual workers. But increasing the productivity of these new knowledge and service workers would require in Drucker's phrase 'applying knowledge to knowledge.'

This shift represented a significant challenge according to Drucker, as Taylor's approach was based on direct observation of manual work, its measurement, and its improvement using standard activities and standard times enforced by individual bonus payments. This approach was both enormously successful and highly prescriptive. But as Drucker pointed out, knowledge and service work are quite different to manual work.

"By now we have learned that those who actually do a job know more about it than anybody else. They may not know how to interpret the knowledge, but they know what works and what doesn't. And so, in the last forty years, we have learned that the work on improving any job or task begins with the people who actually do the work. They must be asked: 'What can we learn from you? What do you have to tell us about the job and how it should be done? What tools do you need? What information do you need?' Workers must be required to take responsibility for their own productivity and to *exercise control* over it." (Drucker 1993 page 90)

The irony of this statement is that at the very time Drucker was writing this, ERP systems were already the dominant technology investment for Fortune 500 firms, and ERP systems implement a digital version of Taylorism. Instead of work study engineers defining and measuring the work, software applications, built by systems analysts and software developers, do the job. However, unlike work study, which was always specific to the firm, ERP systems are, by definition, universal, in that they apply to all firms of a certain size. When combined with Friedmanite economics, ERP systems enabled US firms to both measure productivity and appropriate it to the benefit of their shareholders, as documented by Weil (2014) and Reich (2017 and 2021)

Critical Review of Post Capitalist Society

There are two distinct criticisms of Drucker's post capitalist society. The first is the modern Marxist perspective argued by Braverman (1974) who claimed that "computerisation" (as it was called in the 1970s) which we would now call it "digitisation" would enable the owners of capital to more easily appropriate the resulting productivity gains from the employees who delivered the gains to the firm's investors. Braverman's analysis was proven correct by the adoption of Friedmanite economics in the USA from 1980. By rewarding shareholders and executive managers with all the gains from productivity growth, real wages for US workers have remained basically flat since that time, but the value of the stock market (Dow Jones Industrial Index) has increased from 874 in January 1980 to 35,000 in January 2025. This is an

increase of 4,000% which represents an average annual growth rate of more than 7%. During the same period the USA delivered annual TFP growth of 1% per year.

A second, more recent critique by Standing (2014) argued that the impact of technology and outsourcing (mostly to China) had created a new class of employees which he called “the Precariat”. They replaced the “Proletariat” who traditionally worked in heavily unionised manufacturing industries with protected wages and conditions. This new class were the ones that had suffered the consequences of new technology and outsourcing and their work is characterised by zero hours contracts, low wages, and little or no control over their working conditions. Occupations such as Uber drivers and delivery drivers of all kinds are typical of the precariat.

2.3.6 Learning by Doing, Incremental Innovation & Continuous Improvement

Abernathy and Utterback (1978) studied the US auto industry in the 1970s and identified two types of innovation, the first of which they called *incremental* innovation and second of which they called *radical* innovation. Their observation was that the majority of productivity gains actually resulted from incremental innovations. More recently, Bessen examined the nineteenth century textile industry in the US and concluded that learning by doing, or incremental innovation, contributed to productivity growth to a greater extent than new capital investment (Bessen, 2014). A study involving a steel mini-mill (Hendel & Spiegel 2014) reached similar conclusions: ‘Tweaking,’ as they called it, without additional capital investment could deliver substantial productivity gains over a long time period.

Nonaka’s Organizational Knowledge Creation

In 1994 (Nonaka 1994) published a paper titled “*The Dynamic Theory of Organizational Knowledge Creation*” which focused on how new knowledge was created and communicated following a simple sequence:

Implicit → Explicit → Codified → Communicated.

They extended this thinking to what they called “Middle Up Down Management” which in their view combined the best characteristics of the top-down model and the bottom-up model. In their model they acknowledged Jaques (Op Cit) and his levels of work complexity and timespans and also introduced a new organisational concept which they called the “Hypertext Organisation” which follows Engelbart’s (Op Cit) bootstrapping approach first implemented in his “Augment” software.

“The central requirement for the design of the knowledge creating organization is to provide the organization with the strategic ability to acquire, create, accumulate new knowledge continuously and repeatedly in a circular process.” (Nonaka 1994 page 1)

2.3.7 Complementary Investments

The principle of complementarity was first introduced by Milgrom and Roberts (1990) in their analysis of US manufacturing firms. They argued that:

“Given the existence of complementarities among organizational practices, a range of organizational choices may have to be altered together for a particular technological advance to improve efficiency. In the presence of complementarities, success is not a matter of small adjustments, made independently at each of several margins, but rather involve[s] substantial and closely coordinated changes in a whole range of the firm’s activities.” (Milgrom & Roberts, 1990, p. 511)

During the 2000s scholars at MIT and Chicago studied the impact of complementary investments of tangible and intangible assets on firm productivity and found that they did increase productivity (Garicano 2000). However, Garicano, in his second paper with Heaton (Garicano & Heaton, 2010) were able to demonstrate in their study of US Police Forces that investment in ICT alone, in other words, without these complementary investments, did not increase productivity.

Empirical studies of Complementarity

Brynjolfsson and Hitt (2003) studied the impact of ICT and complementary intangible assets in a number of papers. The abstract quoted below shows the importance of these complementary inputs and the extended timetable taken to deliver significant increases in productivity.

“We explore the effect of computerization on productivity and output growth using data from 527 large U.S. firms over 1987-1994. We find that computerization makes a contribution to measured productivity and output growth in the short term (using 1-year differences) that is consistent with normal returns to computer investments. (Brynjolfsson and Hitt Abstract page 1)

However, the productivity and output contributions associated with computerization are up to 5 times greater over long periods (using 5-to 7-year differences). The results suggest that observed contributions of computerization is accompanied by relatively large and time-consuming investments, such as organizational capital, that may be omitted in conventional calculations of productivity. The large, long-run contribution of computers and their associated investments that we uncover may partially explain the subsequent investment surge in computers in the late 1990s.”

Schneider Electric Case Study

One of the richest empirical case studies was conducted by Alan Hughes and his colleague Michael Scott Morton (2006) at Schneider National, a US trucking firm. The

authors begin by outlining the industry context. The deregulation of the US trucking industry in 1980 led to a tripling in the number of firms. In parallel the implementation of 'lean production methods' and just-in-time supply chains raised customer demands for on-time and predictable deliveries.

These market pressures created new demands for trucking firms: smaller loads to meet just in time demands which meant running trucks part-loaded; on-time deliveries to enable customers to hold minimum stock levels; reduced deadhead trips (when trucks return empty). Schneider's response was to deploy technology, new work-processes and new decision support software to meet these challenges. The technology began with GPS technology from Qualcomm, which was extended with satellite tracking technology some years later.

For example, Schneider, in implementing its positioning system data in trucks, recognized the value of the information on precise truck location and timing to meeting both drivers' family needs and those of the customer for efficient service – data that Schneider embedded in its decision support system. Schneider was able to exploit a number of these IT based technologies because it worked hard at maintaining deep communication with its drivers and thus had their good will and acceptance of changes in work-practices. Moreover, the effective linking of the data itself to effective decision making required the introduction of supporting internal systems and the open sharing of information and decisions among all categories and levels of the organisation.

Hughes and Scott Morton tease out the complex web of intangible assets which include new working-practices for the drivers, new management information for all levels, and changes for Customer Service Representatives, Service team leaders and dispatchers. In other words, these complementary investments go way beyond the technology itself, and change how the business is managed, the relationships between different departments; the work-processes themselves and the deployment of wholly new employee and management reporting systems. They are able to identify the complementary nature of the newly developed intangible assets and the timetable over which they were developed and deployed which accords with Brynjolfsson's earlier studies. Finally, they summarise the results, which were impressive:

- a. Delivery costs reduced from \$1 per mile to \$0.60 between 1980 and 1988 (in constant dollars).
- b. Internal costs dropped by 24%.
- c. There was a 25% decrease in deadhead miles.
- d. Decision support systems (based on hard data) were provided which enabled managers to decide whether a particular shipment could be delivered profitably.

Critical Review of Brynjolfsson's Complementary Theory

The main challenge to Brynjolfsson's complementarity theory is measurement. Many complementary investments such as brand and channel building, organisational design

and improvement and investment in human capital, are intangible assets which are not capitalised under current accounting practices (Stroll 2021). There also is a second group of complementary investments. These include the documentation and continuous improvement of work activities, employee engagement and the documentation of complementary investments which are essential for successful implementation of the unmeasured intangible assets. But these are not recorded at all, as they are only a part, and sometimes a small part of managerial work. In stark contrast, investments in technology, databases, application software are all classed as measured intangible assets and recorded on the firm's financial balance sheet. This mis-measurement is both endemic and difficult to rectify by National Statistical Offices as reported by Martin (2021). The measured and unmeasured intangible assets topic is more fully discussed in Section 2.2.4, Pages 52 to 53.

The corollary of this almost complete lack of measurement is serious. A great percentage of TFP growth is driven by capital spending on complementary investments (Lev 2001). These investments clearly drive earnings, which drive stock market prices, but as we have seen in the US economy there is a mismatch between TFP growth (less than 50% since 1980) and market prices with 4,000% growth since 1980.

Beyond Technology

In their book, *How Technology will Transform the Work of Human Experts*, Susskind and Susskind (2017). London lawyer Richard Susskind and his son Daniel take a thorough and detailed look at the professions to assess the potential impact of digital technology on them. They examine the four types of capability distinguishing professional workers from the artificial intelligence and machine learning applications which might replace them:

“The first is cognitive capability—the ability to think, understand, analyse, reason, solve problems and reflect. The second is affective capability—the capacity to have feelings and emotions, both introspective and in response to others. The third is manual capability—physical and psychomotor aptitude. And the fourth is moral capability—the faculty to distinguish right from wrong (good from bad, just from unjust and so on), to reason about what right or wrong means, and more than this, to take responsibility for the choices, decisions, guidance, and actions that they take (whose rightness or wrongness we may have weighed).” (Susskind and Susskind 2017 page 277)

Again, the more nuanced view of the capabilities required to perform professional work activities suggests levels of detail that both business managers and human resource personnel must look for and find ways to capture in order to ensure the proper mapping of skills to work activities — and then, in turn, to opportunities to improve firm-level productivity.

Fair Work

In 2021, Colin Lindsay presented the *Fair Work Programme and Research Project* at the Economic Statistics Centre of Excellence (ESCoE) conference in Glasgow (Lindsay, 2021). He identified a large number of workforce problems which he claimed contributed to the UK's twin productivity and workplace puzzles (see Chart 12 below). If the people who are doing the work do not feel that the working conditions are fair, and if they do not feel that their input is valued, productivity can suffer.

- Insecurity (around 20% of labour force)
- Under-employment (8-9% of the labour force pre-pandemic)
- Low pay (14% by hourly pay in 2021) and decline in labour share
- In-work poverty (68% of working age people in poverty in 2021 in working household)
- Limited autonomy (42% little or no autonomy in how they complete tasks)
- Skills underutilisation (1/3 of establishments; 1/3 of workers according to CIPD 2021)
- Employee voice (21% managers don't inform us; 27% managers don't involve us)

Chart 12: Challenges contributing to the UK's twin productivity and workplace puzzles

2.3.8 Management Practices Measurement

Nick Bloom, John Van Reenen, and their colleagues have been measuring management practices for nearly 20 years. Initially working with McKinsey, they studied 700 medium-sized manufacturing firms in the US, UK, France, and Germany. They interviewed plant managers in these firms using a questionnaire with 18 topics, grouped into three broad areas:

- Shop floor operations
- Performance management
- Talent management

Their second study extended the sample to 4,000 companies in the US, Europe, and Asia, and their key finding was that management practices correlated with labour productivity, sales growth, and profitability. Bloom et al also drew attention to the limits of the surveys: they focused on operations and deliberately left out 'strategic aspects of management, such as innovation, pricing, advertising, M&A, leadership, and the decision to enter new markets or shut down existing operations' (Bloom, Sadun, Lemos, & Van Reenen, 2014).

Office for National Statistics (MEPS)

In the UK, the ONS has conducted three surveys on management practices called MEPS to include a section on managerial expectations. The first survey was conducted by Awano and Robinson (2016). In their introduction they stated the problem with great clarity:

“The UK’s recent productivity experience is marked by two ‘puzzles’. First, the UK experienced a growing productivity gap compared with most of the major Group of 7 (G7) advanced economies from 1948 to 1979, with measures of output per hour worked consistently lower in the UK than elsewhere. Secondly, along with some of these economies, the UK has experienced a period of relatively stagnant productivity growth since the economic downturn which started in 2008 – the phenomenon known as the ‘productivity puzzle’.” (Awano and Robinson 2016 page 3)

They surveyed 1,000 manufacturing firms which could be matched to the Annual Business Survey (ABS). They selected eight questions from the management practices part of the survey and the results showed that ‘the average management practice score across all questions is, at 0.51, lowest among small businesses (10 to 49 employment). It increases across the size groups, with the largest businesses (250+ employment) scoring highest at 0.79.’

ONS conducted a second firm-level survey, also focusing on UK manufacturing firms. This study found a correlation between management practice score and productivity level in which higher management practices scores correlated with higher levels of productivity. The study found a 6.7% rise in productivity for each 0.10 increase in management practice score on a scale of 0 to 1.

Extending MEPS to Service Industries EScOE and ONS

Based on the findings of the two manufacturing surveys, ONS in partnership with EScOE, decided to implement a larger survey of 25,000 enterprises, extended to include service industries:

“The management practices score used in the Management and Expectations Survey (MES) has been developed to measure real differences in management practices across organisations. These differences are positively related to measures of turnover, profitability, and productivity (Bloom, Sadun, Lemos, Scur & Van Reenen, 2014) and vary significantly across and within countries. The management practices score captures four dimensions of management:

- a. Continuous improvement, or how businesses respond to problems.
- b. Use of key performance indicators (KPIs).
- c. Use of targets.
- d. Employment practices relating to promotion, training, and employee underperformance”

(ONS 2024b page 3)

The latest ONS update on Management Practices (ONS 2024b page 12) shows that:

“Management practices are a significant driver of productivity and firm resilience to economic shocks. In Chart 13, (shown below) productivity is related with higher management practice scores. A 1% increase in a firm's statistically significant labour productivity is correlated with a 0.02 increase in its management practice score. As a result, it is important to understand what firms were doing to improve their management practices. Management matters to firms; 89% of businesses reported taking some action to improve management quality, 64% of firms consulted employees about areas of improvement, 43% carried out formal training online and 42% carried out training in person. Engaging in government funded training and hiring management consultants (both 13%) were the least common approaches to improving practices”.

The table below provides a summary of results from all MES surveys by industry sector and shows the range of scores from lower scoring firms (which tend to be SMEs with between 10 and 50 employees and higher scoring firms (which tend to be large firms).

Year	Geography	High-level industry	Firms	Mean	P10	P25	P50	P75	P90	90/10 Ratio
2016	GB	Non-Manufacturing Production	1817	0.47	0.09	0.29	0.51	0.66	0.74	7.94
2016	GB	Manufacturing	26844	0.50	0.19	0.33	0.54	0.67	0.76	4.04
2016	GB	Construction	16170	0.43	0.10	0.23	0.47	0.60	0.72	7.17
2016	GB	Distribution, hotels & restaurants	68501	0.48	0.10	0.31	0.52	0.67	0.76	7.33
2016	GB	Transport, storage, & communication	19834	0.51	0.16	0.38	0.54	0.69	0.78	4.75
2016	GB	Business services	44288	0.53	0.20	0.42	0.57	0.69	0.77	3.91
2016	GB	Other services	43556	0.52	0.24	0.42	0.55	0.67	0.74	3.11
2016	GB	Real Estate	5314	0.48	0.04	0.30	0.55	0.69	0.76	18.35
2019	GB	Non-Manufacturing Production	1982	0.47	0.18	0.29	0.52	0.63	0.72	3.93
2019	GB	Manufacturing	24167	0.46	0.15	0.33	0.49	0.62	0.72	4.91
2019	GB	Construction	16369	0.41	0.16	0.21	0.43	0.57	0.68	4.22
2019	GB	Distribution, hotels & restaurants	69347	0.46	0.10	0.29	0.51	0.63	0.73	6.96
2019	GB	Transport, storage, & communication	19952	0.48	0.14	0.35	0.53	0.64	0.74	5.48
2019	GB	Business services	43807	0.51	0.18	0.40	0.53	0.68	0.75	4.13
2019	GB	Other services	48202	0.50	0.20	0.40	0.53	0.64	0.73	3.68
2019	GB	Real Estate	5092	0.47	0.14	0.27	0.50	0.69	0.79	5.69
2020	GB	Non-Manufacturing Production	1982	0.51	0.22	0.36	0.55	0.67	0.77	3.50
2020	GB	Manufacturing	24167	0.49	0.19	0.35	0.51	0.66	0.74	3.85
2020	GB	Construction	16369	0.43	0.13	0.25	0.46	0.59	0.71	5.30
2020	GB	Distribution, hotels & restaurants	69347	0.47	0.14	0.32	0.50	0.64	0.73	5.17
2020	GB	Transport, storage, & communication	19952	0.50	0.14	0.35	0.52	0.67	0.74	5.48
2020	GB	Business services	43807	0.52	0.20	0.40	0.56	0.68	0.76	3.82
2020	GB	Other services	48202	0.52	0.25	0.41	0.55	0.66	0.73	2.92
2020	GB	Real Estate	5092	0.48	0.15	0.31	0.52	0.69	0.80	5.51
2023	GB	Non-Manufacturing Production	2242	0.54	0.24	0.41	0.58	0.69	0.76	3.19
2023	GB	Manufacturing	27362	0.54	0.24	0.43	0.58	0.68	0.75	3.08
2023	GB	Construction	20788	0.49	0.15	0.36	0.53	0.66	0.73	5.00
2023	GB	Distribution, hotels & restaurants	82630	0.52	0.20	0.38	0.55	0.68	0.75	3.81
2023	GB	Transport, storage, & communication	23700	0.57	0.23	0.48	0.62	0.72	0.79	3.37
2023	GB	Business services	55724	0.59	0.36	0.51	0.63	0.72	0.79	2.21
2023	GB	Other services	59843	0.59	0.39	0.52	0.63	0.69	0.78	2.02
2023	GB	Real Estate	7227	0.58	0.28	0.45	0.64	0.71	0.78	2.82
2023	UK	Non-Manufacturing Production	2395	0.54	0.24	0.41	0.58	0.69	0.77	3.23
2023	UK	Manufacturing	28361	0.54	0.24	0.43	0.58	0.68	0.75	3.08
2023	UK	Construction	21480	0.49	0.15	0.36	0.52	0.66	0.73	5.00
2023	UK	Distribution, hotels & restaurants	85746	0.52	0.20	0.38	0.55	0.68	0.75	3.81
2023	UK	Transport, storage, & communication	24280	0.57	0.23	0.48	0.62	0.72	0.79	3.37
2023	UK	Business services	56739	0.59	0.35	0.50	0.63	0.72	0.79	2.28
2023	UK	Other services	61473	0.59	0.39	0.52	0.63	0.69	0.78	2.01
2023	UK	Real Estate	7389	0.58	0.28	0.45	0.64	0.72	0.78	2.82

Chart 13: Management Practices Scores for UK Firms

The MES data reinforces the ONS data on firm GVA (ONS 2024a Op Cit) which shows the long tail of poorly performing firms in the UK with GVA per head below £48,000 and little or no productivity growth.

Critical Review of the Van Reenen's Management Practices

There are two main criticisms of van Reenen's management practices surveys. The first concerns causality versus correlation. Whilst the evidence collected from numerous surveys in many countries shows that higher management practices scores are correlated with higher productivity scores, there may be other confounding variables which must be taken into account. For example, there are many types of complementary investments, some of which may cause increased productivity. It is also known that

large firms spend considerably more per head on IT than SMEs. Equally, large firms have much greater pricing power than SMEs. Lastly all surveys suffer from the lack of continuous data problem – they are snapshots rather than movies.

The second is importance of good quality supervision which is not captured in the van Reenen surveys. As Lazear, Shaw and Sampson (2015) show from their research into the quality of supervisors, the softer aspects of management, such as leadership, organisational culture, and employee engagement, receive comparatively less attention despite their importance. They found that:

“ Replacing a boss who is in the lower 10% of boss quality with one who is in the upper 10% of boss quality increases a team’s total output by more than would adding one worker to a nine-member team” (Page 2).

This echoes the results of the Hawthorne Experiments in the 1930s which first asked employees to rate their supervisors and then developed a desirable set of behavioural skills. Urwick and Brech (1948 page 202) summarised the nine findings from the Western Electric project, all of which are equally valid today.

1. Management is primarily a social skill
2. Good front-line supervision is essential
3. Personnel management must maintain effective two-way communication throughout the organisation
4. Employee consultation is essential and must include all employees
5. Economic incentives are not the most important driver of worker behaviour
6. The Informal organisation of employees must be taken into account
7. Employees are motivated (or not) by the leadership and motivation of their senior managers
8. Employee behaviour must be understood as an expression of underlying discontent or malaise with the working situation
9. Training for management and supervision has been extremely well documented by the Western Electric company

2.3.9 Conclusions from Post War Management Practices

US Management Practices were widely implemented in Western Europe and Japan as part of the Marshall Plan. One of the most important practices – that of work study (also called scientific management and industrial engineering, unexpectedly disappeared during the 1960s to be replaced by “Systems Analysis”. This resulted in the socio-technical approach being simplified to the “Technical Approach”. The application of economics to management practices develops from “Complementary Investments’ thinking which discovered that technology alone did not necessarily increase productivity. This was reinforced by the labour economists with their focus on different types of work and the extent to which technical systems could be used to automate or augment this work. The development of the measurement of “Management Practices” was the third approach to bringing economic measurements into the firm. But post-war management practices thinking added economic measurements to technical systems and left out the social system, which had previously been described and its efficiency

measured by work study engineers. In the next section the author will review the development of macro-economic measurements of innovation, productivity and investment and the extent to which these could be used at firm level.

2.3.10 Fair Work and Management Practices Measurement Research Gaps

1. The early Bloom and Van Reenen management practices surveys focused primarily on Manufacturing Operations but need to be extended to include Marketing and Sales production units.
2. The Bloom and Van Reenen questionnaire can be completed by an SME manager in less than one hour – but the implementation of Digital Management Practices discussed in Chapters 4 and 5 takes several years.
3. The Bloom and Van Reenen management practices survey provides a snapshot of a firm's performance at a single point in time. Because of this, it cannot show an individual firm's implementation progress.
4. As Colin Lindsay (2022) explained at the ESCoE conference in June 2022, there is no way of measuring the productivity impact of Fair Work projects.

2.4 The Development of Total Factor Productivity Reporting

The development of national GDP and productivity reporting accelerated dramatically in WW2 and became standardised in the early 1950s by a sub-committee of the United Nations.

2.4.1 Bureau of Labor Statistics

The brief review of the Marshall Plan summarised the contribution of the US Bureau of Labor Statistics during WW II and the important role it played in the US Productivity Program through its firm level measurements. As Gottwald (1991) explained:

“The Bureau of Labor Statistics, the American organization whose primary purpose was to enable government and private officials to assess US economic performance relative to other countries and to evaluate the competitive position of the United States in international trade. The BLS started making productivity studies in 1894 and by the mid-1940s it had become a 200-man organization pioneering in studying the impact of technological change on productivity.” (Gottwald, 1991, p. 110)

During WW II, as explored by Wasser and Dolfman (2005), Silberman's broad understanding of both the details and the issues in productivity derived from his responsibilities as Director of BLS's Division of Industrial Productivity and Technological Development. His experience was honed during 1,900 personal visits to American manufacturing plants, his knowledge expanded by the 3,000 plant visits made annually by the division's staff, and his access to information collected each year from 20,000 manufacturers.

The differences between attitudes in the US and UK to productivity were not cultural; they were differences about the importance of efficiency measurement at the shop floor within the firm, exactly as Taylor had documented. Both the BLS and leading US Manufacturers had learned from Taylor that you cannot manage what you cannot measure. Their own production experience had confirmed that the details hide the greatest challenges.

By 1948, BLS had had many years of experience in the systematic collection and appraisal of productivity measures covering almost every type of industry in the United States. Each year more than 3,000 American factories were visited, and BLS representatives conferred with plant managers, engineers, comptrollers, and cost accountants, among others. Detailed company output per person hour and production statistics were obtained and factual information obtained regarding the numerous factors affecting operational efficiency. With this experience in the analysis of productivity data, BLS maintained a body of specialised knowledge relating to productivity measurement which could be found nowhere else in the country. Additionally, the BLS technical abstract service, initiated in 1942, had served through the war as the official source of for abstract information on factory equipment and methods.

2.4.2 Development of the System of National Accounts (SNA)

Driven by the need to maximise the production of armaments and the need to redeploy predominantly male factory workers to the Army, Navy, and Air Force both the US and the UK implemented national economic planning institutions to manage resource allocation. This had led to the development of input-output tables which were needed to net out intermediate inputs from final industry outputs. After WW II, this work continued and was taken up by the newly formed United Nations as the System of National Accounts (SNA), it being of benefit to all countries in the UN. The latest version of SNA was edited by Sanjiv Mahajan (2018) of ONS, which is the national statistical agency in the UK responsible for GDP and productivity reporting.

2.4.3 What Determines Productivity?

Understanding what determines productivity is one of the major concerns of macro-economics. Syverson (2011) looks at the state of understanding of the key drivers, which include innovation, Wright's Law, labour quality, management practices, tangible and intangible assets. He points out that the main difficulties in understanding the relative importance of these drivers at both industry and firm level is that the relative weights or importance of each of these factors cannot be determined using aggregate data. One would need firm-level management production unit data, which does not exist. Total factor productivity (TFP) therefore weights each factor and holds these weights constant. If productivity could be measured within the firm at employee, department, and work activity system levels, there would no longer be a need to weight inputs according to a pre-determined index. The actual values of labour and capital could be used to calculate both labour and capital productivity.

2.4.4 The Rise of Intangible Assets

Syverson identified intangible assets as one of the drivers of productivity growth. Starting in the 1990s, a number of authors, including Edvinsson and Malone (1997), Stewart (1997) and Sveiby (1997) discussed what they all called 'Intellectual Capital' and made predictions about its impact and potential importance. Lev (2001) was the first to quantify the impact of this new thinking. He illustrated the growth in innovation by referring to the number of professional creative workers (knowledge workers) in the US economy. During the first seventy years of the twentieth century, that number increased by 2.4 million. In the last 30 years, it has increased by an additional 5 million. Lev calls this 'the ascendancy of the intangibles', which are characterised by fundamental corporate change with:

"an emphasis on innovation, deverticalisation, and intensive use of information technology to create innovation-based intangibles, human resource intangibles, and organizational intangibles."

Lev illustrates the financial consequences of this change by reference to the changes in the price-to-book ratio for S&P 500 Companies from 1977 to 2001. This ratio measures the book value of tangible assets which can be freely bought and sold to the stock market value of the firm. From 1977 to 2001 the ratio went from 1 to a peak of 7 at the height of the dot.com boom before falling back to 5. *Lev's analysis suggests that intangibles accounted for four out of every five dollars of market value* (author's italics).

In 2005, three macro-economists (Corrado, Hulten and Sichel), published a paper describing three categories of Intangible Assets:

1. **Computerized information:** Knowledge embedded in computer programs and computerized databases.
2. **Innovative property:** Knowledge acquired through scientific R&D and non-scientific inventive and creative activities.
3. **Economic competencies:** Knowledge embedded in firm specific human and structural resources, including brand names.

Each of these three categories are then expanded to include the detailed definitions as listed below:

Computerized information

1. Computerised software
2. Computerised databases

Innovative property

1. Science and Engineering R&D (costs of new products and new production processes, usually leading to a patent or licence)
2. Mineral exploration (spending for the acquisition of new reserves)
3. Copyright and license costs (spending for the development of entertainment and artistic originals, usually leading to a copyright or license)

4. Other product development, design, and research expenses (not necessarily leading to a patent or copyright)

Economic competencies

1. Brand equity (advertising expenditures and market research for the development of brands and trademarks)
2. Firm-specific human capital (costs of developing workforce skills i.e., on-the-job training and tuition payments for job-related education)
3. Organisational structure (costs of organisational change and development; company formation expenses)

This came to be known as the 'CHS' intangibles classification, and in 2012 Peter Goodridge and Jonathan Haskel applied this classification to analyse the UK economy. They followed this up in 2014 and 2016 and then in 2018 they handed over this work to ONS, who published their first estimates of intangible assets the following year (Martin, 2019). The most recent version of the UK Intangibles estimates was published by ONS (Intangible Assets & Infrastructure Team, 2024).

There are two important conclusions from these data sources. The first is that the value of intangible assets is now greater than the value of tangible assets in the UK economy. The second is that only one third of these intangible assets can be reliably measured by ONS. These are the intangible assets that are already recognised by International Accounting Standards bodies and reliably recorded in firm balance sheets. Other intangible assets are not routinely accounted for in most statutory accounting systems.

Martin (2021) presented the reasons for the difficulty in collecting accurate data at the ESCoE Conference on Intangible Assets held in London in November 2021. His presentation was titled *The F words: Why Surveying Businesses About Intangibles is So Hard*, and he then went on to describe the four F words. They are 'Forgotten, Framing, Fuzzy, and Frequency'. His main argument was that the survey method used by ONS may be too infrequent and that firms may not themselves have a very good understanding of these assets or what they spent creating them. It may also be that they do not really understand the CHS classification.

At this same conference, the author presented a paper (Stroll, 2021a) setting out an empirical method for collecting data on intangible assets directly from the firm, to which the audience and Martin responded positively. The latest data from ONS (Fotopolou, 2022) for 2020 was somewhat affected by the COVID pandemic, but shows that investments in intangible investments (including training) are still greater than those in tangible assets and highly concentrated in three industry sectors: Manufacturing, Information and Communication, and Financial Services, with strong contributions from Wholesale and Retail and Professional, Scientific, and Technical Services.

2.4.5 Innovation

Syverson also notes that, like intangible assets, innovation is one of the drivers of productivity growth. However, the measurement of innovation also takes place outside

the System of National Accounts. The OECD has long focused on the need for better measures of innovation which resulted in the publication of the first Oslo manual in 1992 which focused on manufacturing. Large scale surveys, such as the European Community Innovation Survey followed, and these contributed to further editions of the Oslo manual, the most recent of which was published in 2005 (OECD, 2005) and which extended the range of sectors and types of innovation.

The 2005 Oslo manual classifies four types of innovation: product; process; market and organisational, which can be: new to the firm; new to the market; or new to the world. In order to deliver these innovations, firms engage in sets of ‘innovation activities’ which may be successful; ongoing; or abandoned. Innovation is measured through community innovation surveys of private sector firms, which are recommended to be conducted every two years by all OECD members. These surveys measure innovation activities, and the results of these in terms of revenue, growth, and profit. In the UK, the community innovation survey is conducted every two years by ONS on behalf of BEIS (2019) and these survey questions are fully documented. It should be noted that there is no direct measurement of innovation within the firm which uses Total Factor Productivity.

2.4.6 GDP and Productivity Measurement in the UK

There is much discussion in government circles about ‘outputs’ and ‘outcomes’. Indeed, the two terms are often used interchangeably. In order to clarify this point, the definitions developed by the UK Office of National Statistics are helpful here. In the ONS Productivity Handbook (Camus, 2007 page 2), productivity is defined as follows:

“The first definition of productivity can be thought of as being about the ability to produce outputs, such as goods or services, taking into consideration the number of inputs, such as raw materials, capital, and labour, used to produce them. High productivity means producing as much output as possible using as little input as possible. The second, economic, definition is a formal quantification of the first:

$$Productivity = \frac{Output}{Input}$$

Productivity is defined as the ratio between output and input. Therefore, increasing productivity means greater efficiency in producing output of goods and services from labour, capital, materials, and any other necessary inputs.”

Labour and Total Factor Productivity

The ONS actually provides *two* productivity measures as part of their quarterly GDP reports: *labour* productivity and *multi-factor* productivity (MFP). It is worth noting that many other organisations and authors call MFP *total factor productivity* (TFP). These different names all refer to the same concept, so this thesis will refer to the two

measures of productivity as *labour productivity* and *total factor productivity* (TFP) for consistency's sake throughout.

Labour productivity reviews the total hours spent by the firm's employees on delivering outputs of products and services at market price. Data is collected from surveys and administrative data, and is reported quarterly (Taylor, 2018).

TFP is more complicated. It involves *three* sets of inputs: labour (for which the preferred measure is hours worked), capital (which is measured as a service charge based on an imputed rental cost), and purchases (energy, materials, and services) (Franklin, 2018b). There are also potentially different output measures. These are usually measured by market prices, but in Franklin's example (a small bakery) TFP output is measured in units (i.e., the quantity of loaves sold). As Franklin says, 'Productivity is simply the rate of conversion of inputs to outputs. The tricky part is measuring the inputs and outputs properly' (Franklin, 2018a).

2.4.7 Why is TFP Needed at Firm Level?

TFP is the internationally agreed measure of productivity. It combines labour productivity reporting with the addition of capital services charges, which represent the depreciation of tangible and intangible assets. The weakness of firm-level recording of intangible assets was discussed in section 2.4.4, and the same is true of innovation expenditures. There is, however, no reason why a complete TFP report cannot be completed at firm level. This would have the great merit of providing much richer and more frequent data for ONS.

From the firm perspective it is clear that additional variables could be provided which would provide richer estimates of nominal TFP. These variables could include additional labour quality measures, department and work activity system level production units, richer information on complementary investments and the allocation of these to intangible assets and capital services charges as well as to innovation activities. These additional variables could then be used to complement and enrich national TFP accounting by ONS in due course.

However, there is an even more important reason for reporting on TFP at the firm level. Most SMEs are unfamiliar with productivity's growth impact on their gross operating surplus, which is roughly equivalent to EBITDA. Many owners and investors are quite happy to grow EBITDA at the same rate as revenue, provided their customers are happy to support them. If TFP could be measured at the production unit level within the firm, it would be possible to assign complementary investments and innovation spending to test the effectiveness of these investments and innovation expenditures and their impact on increasing revenue and TFP.

That ability to measure TFP at the production unit level, though, is another missing piece. When discussing production functions, the main focus of productivity statisticians is on the *inputs* and the *outputs* of the production function. As Chart 14 below suggests, the economists' definition of the production function is mathematical (a suggestion

reinforced by one of the most comprehensive publications on the topic, a 600-page textbook on productivity functions [Sickles & Zelenyuk, 2019] that is entirely mathematical). While such mathematical descriptions of a production function may be useful for economists and statisticians, they will be of little or no use to those managers and employees who have to make a specific production function work in practice.

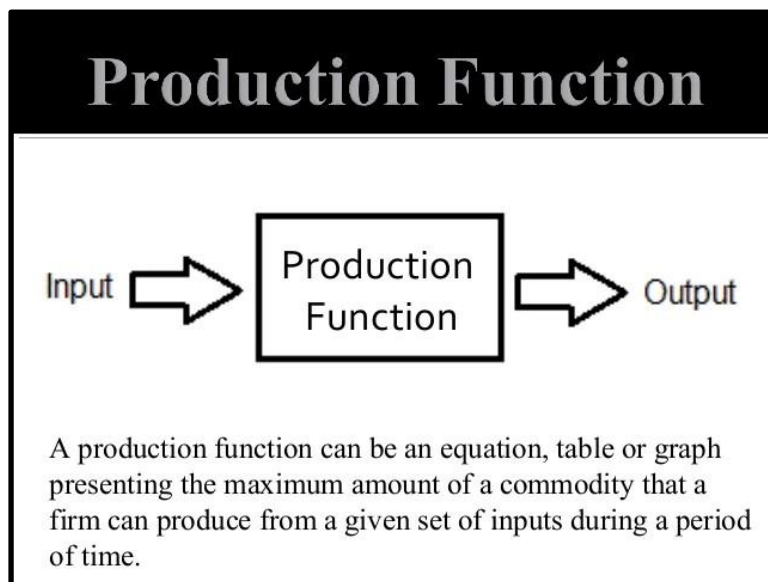


Chart 14: The Mathematical Production Function

In Chapter 4 of this thesis, three production units for Marketing, Sales and Manufacturing are identified together with a set of eight complementary investments which have been found to increase productivity as discussed in Chapter 5. Using the Digital Management Practices platform, which has been further developed during the Case Study, it will become possible to measure labour productivity for each production unit / department within the firm. It then becomes possible, for the first time, to assign investment and innovation spending to each production unit and to test the effectiveness of these investments and innovation expenditures in increasing revenue and productivity.

2.4.8 Measuring Total Factor Productivity within the Firm

It is often claimed that UK firms do not invest at the same level as their competitors in other countries. This might actually be for the very sound reason that firms find it hard to evaluate the impact on revenue growth and profit growth which these investments will deliver. If that specific problem can be solved, managers would be able to present to investors with more knowledge about which investments work, and which did not, boosting investor confidence in the firm and the decisions being taken.

However, there is a more important reason for measuring TFP within the firm. This derives from the old adage that “you cannot manage what you cannot measure.” It is now widely accepted, that the low levels of UK productivity growth since 2008 are a serious, if not the most serious, economic problem faced by the country. Given that private sector firms and public sector enterprises are responsible for the nation’s

productivity growth, it would seem obvious that this should be one of the top objectives, if not the top objective of the nation's Directors and Managers. Both private sector firms and public sector enterprises should therefore be required by the Government, as a matter of urgency, to measure their current productivity levels for labour and capital and produce plans to improve it year on year.

2.4.9 Research Gaps: GDP and Productivity Reporting

Five observations arise from a review of the literature on GDP and productivity reporting:

1. ONS variables for labour quality are implemented at aggregate levels but could also be captured within the firm and extended to provide a more complete set of variables.
2. ONS variables for total factor productivity and capital are only implemented at aggregate level but need to be captured within the firm and correctly allocated.
3. Only one third of intangible assets are measured within the firm, given the importance of intangible assets to productivity growth these must be captured within the firm.
4. Innovation activities are only measured every two years using a weighted survey. These should also be captured within the firm.
5. Whilst the inputs and outputs are measured at firm level, the management production functions which determine *how* inputs are converted to outputs are not measured at all.

2.5 A Brief History of Digitisation (1970 to 2024)

One cannot discuss the characterisation and execution of work activities and work activity systems, on theories of management, even on the diffusion of information and ideas over the past half century without discussing the impact of digital technologies. Their role has been transformative, particularly in the last twenty years during which the evolution of digitisation has been accelerating in eight key areas:

1. **Computers:** Mainframes; Minicomputers; Servers and Cloud Computing
2. **Digital Communications:** Ethernet; Internet; Broadband; 3G; 4G and 5G
3. **User Devices:** Terminals; Personal Computers; Smartphones; Tablets; Robots, Vehicles
4. **Software:** Bespoke; Application Packages; ERP; Apps; A.I.
5. **Cloud Computing:** Infrastructure on demand; Software-as-a-Service
6. **Digital Services:** Books; Music; Movies; TV; Transportation & Accommodation
7. **Enterprise Resource Planning in SMEs**
8. **Artificial Intelligence:** Neural Networks, Problem Solving, Real-World AI

2.5.1 Moore's Law

In 1965, a short publication in *Electronics*, by Gordon E. Moore (1965), gave rise to one of the most famous 'laws' in computing science. In the paper he forecast that the number of components on a single integrated circuit could double each year for the same cost. By 1975 he forecast that a single microchip could contain 65,000 components. In 1971 Intel announced the world's first microprocessor on a chip (the Intel 4004) with 2,500 transistors, which claimed to be as powerful as the first electronic computer built in 1948 (Intel, n.d.). By 2010 Intel had become the world leader in microprocessors and could produce a chip with over 500 million transistors. Another decade on, Moore's law is still working today. The term 'digitisation' is now used to describe the applications of computing, communications, user devices and software to classes of problem solving, work processes, firms, and entire industries.

2.5.2 Computers

Moore's law underpins the evolution of computers from the large mainframe machines which became commercially available in the 1950s which started with valves and mercury delay line storage to the fully transistorised IBM 1401 in the late 1950s and the IBM 360 series in the mid-1960s. By 1971 Digital Equipment Corporation (DEC) introduced its first 16-bit minicomputer and increased computer sales from the hundreds per year to the tens of thousands. A decade later IBM introduced the personal computer which increased sales to millions. As Intel and others developed more powerful microprocessors, during the 1990s minicomputers were replaced by servers. During the 2000s micro-processor-based servers increased in size and capacity and in the most decade these server farms, owned and managed by industry giants like IBM, Microsoft, Apple, and Amazon, provide on-demand computing for a wide range of commercial and government customers.

2.5.3 Digital Telecommunications

Unlike the computer industry, the telecommunications industry had always been regulated in the US, and state-owned in many European countries. Their primary services were voice telephony in local area with separate services for 'long-lines' in the US and international services elsewhere. In order to connect every business and consumer who requested service, these firms made large capital investments in networks and switches with 30-year depreciation schedules. Compared with the extraordinary increase in annual computing capacity, they appeared to be stationary. Even as late as the 1990s, the fastest digital communications on offer to the public was ISDN which offered two 64 kilobit per second channels.

The state of mobile digital communications was even worse: the GSM standard for mobile phones offered only 9,600 bits per second. The bandwidth explosion, when it finally arrived in the early 2000s, was as dramatic as it was delayed. Cable companies and telecommunications providers started to offer retail broadband services at 1 million bits per second, rising by the end of the decade to 10 million and another ten years later to 100 million bits per second for full fibre optic connections.

Whilst the telecommunications industries were going slow in providing wide-area digital networks, the computer industry was active in wide-area networking funded by the US Defense Department (DARPA). The history of the 'Arpanet' from its development in the late 1960s to the transition to the Internet in 1995 is thoroughly documented by Abbate (1999). This led directly to massive investments in digital broadband technology to bring the Internet to businesses and households.

In the early 1980s the computer industry itself was investing in standards and products for local-area networking, primarily between PCs and minicomputers. The first products were introduced by Digital, Intel and Xerox and became widely known as 'Ethernet'. This provided a local area network with 10 million bits per second capacity within a single building.

Not to be outdone, the mobile network providers, followed the lead of the computer industry, started by defining its own standards. Europe led these with GSM in the 1990s, which offered data transfer speeds of up to 9,600 bits per second, which compared favourably with modems for residential land lines offering up to 28,000 bits per second. The extraordinary bandwidth gap (over 300x) between local area networks and wide area network slowed the adoption of networked computer systems and was not fully closed until fibre-optic broadband started to be rolled out from the early 2000s. During the rapid customer expansion in the 2000s, accelerated by the introduction of the Apple smartphone in 2007, the industry developed global standards (2G, 3G and 4G) which were introduced world-wide. The latest standard being rolled out in the 2020s is 5G, which offers speeds matching those of fibre-optic broadband.

2.5.4 User Devices

The first users connected to their computers using cathode ray tubes first developed for radar in WW II. However, the great majority of data input in the 1950s and much of the 1960s used much older technologies — 80 column punched cards, first used by Herman Hollerith in the US Census of 1890. These cards were used for input and output and were complemented by line printers for output and paper tape for input. The first airline reservation system was built by IBM for American Airlines and went live in 1960. It used computer terminals, and these became (and remain) one of the main user devices whenever structured forms have to be completed and checked.

By the late 1970 engineers and hobbyists were building the first generation of personal computers (PCs) which combined computer terminals (keyboard and display) with a microprocessor, random access memory and hard drives. Apple became the first to bring a PC to commercial market success and IBM subsequently decided to enter the market themselves, building a personal computer and bringing it to market in one year. The smartphone and the tablet now co-exist with the PC and laptop to provide access to the Internet and Cloud computing.

Finally, there is another class of end-user devices: these include robots, 3D printers and self-driving vehicles. These devices all take advantage of the reducing costs of computing and telecommunications to replace analogue devices.

2.5.5 Software

For the first thirty years of the computer industry, hardware reigned supreme and much of the necessary systems software was included in the price of the hardware. During that period many firms wrote their own bespoke applications to meet their own unique requirements. Starting in the 1980s a young software engineer realised that whilst software was expensive to write and maintain, it could be produced and distributed very cheaply. By licensing an operating system to IBM for their PC he turned this understanding into one of the world's largest software companies, for it was Bill Gates who provided the software and the licensing terms to IBM.

The rise of the PC also spawned the first market for end-user applications. Word processing was the first of many, closely followed by Dan Bricklin's spreadsheet, presentation software and email. Microsoft's next great innovation was to package a suite of these applications as Microsoft Office, and this remains their second largest revenue stream thirty years later.

The same economics applied to business software. Rather than every manufacturer writing their own bill of materials processor, shop floor scheduling, payroll, and billing applications they purchased them from specialist software firms. In the 1990s this process accelerated with the development of enterprise resource planning (ERP) applications which could be used to automate an entire enterprise.

The next big shift in software was the development of applications for the smartphone market. Apple started this followed by Google and together they have implemented a global duopoly. Software publishers write apps which they offer to one or both platforms and the resellers take a share of the revenues.

Another recent trend is the rise of 'software as a service'. Adobe, whose software is used for all types of design and publishing led the market in subscription pricing and were followed by Microsoft and Google. As a mode of delivery, it had a significant impact, facilitating the roll-out of patches and software updates in ways that were not possible when software was delivered via physical disk. It also lowered the cost of software distribution and contributed to the rise of cloud computing.

Much attention is now being paid to the next generation of software collectively known as Artificial Intelligence, or AI for short. Whilst machine learning has gained most of the publicity with computers outplaying grand masters in chess and Go, it is also being deployed in facial recognition, medical image diagnosis and a whole host of other applications. One can also expect to see the revival of an earlier generation of AI known as expert systems where the knowledge of expert users is programmed in such a way that it can assist or augment human decision makers.

2.5.6 Cloud Computing

This is one of the newest and fastest growing parts of the IT industry. In the early days of the industry firms purchased computers from a relatively small number of suppliers

and housed, supported, and maintained them on their own premises. Following the widespread deployment of broadband internet offering speeds of 50 + megabits per second the economics shifted dramatically in favour of computing services following the introduction of Amazon Web Services (AWS). Amazon took its own extensive computing infrastructure and made part of the infrastructure customer facing, enabling firms of all sizes to rent whatever capacity they needed, without any capital expenditure. This shift was particularly attractive to SMEs as it reduced the need for capital investment in IT hardware and specialist IT support staff. Romanko (2024) surveyed the growth of cloud adoption in the UK and found adoption rates in SMEs (10-250 employees) starting at 5% in 2010 growing to over 45% in 2020.

2.5.7 Digital Services

In some industries, digitisation has replaced the original analogue products, first with new digital products and then with digital services. For example, the recording industry, which for many years delivered music on vinyl records, first replaced records with compact discs (CDs), which stored the music in digital format. CDs were then replaced by Internet accessible stores run by Apple and others, which enabled the customer to 'download' the digitised music to a device upon which the music could be played directly. The fact that a Smartphone could enable one to make phone calls *and* play this digitised music was another reason for owning one.

The latest shift is from Internet stores to 'subscription streaming services' like Spotify. These make millions of recordings available for a monthly subscription. As network speeds have increased, so has the range of digital entertainment services. Videotapes and their rental (Blockbuster) have been replaced by streaming services like Netflix and Disney+. The trend is for a small number of large firms to develop 'digital platforms' which can scale to deliver services in every country and region of the world. This new business model is well documented by McAfee and Brynjolfsson (2017), and its economic, 'winner takes all' effects have been captured by Andrews, Criscuolo, and Gal (2019) in a more recent paper.

2.6 ERP Software for the Large SME sector

SMEs vary widely in their use of digital technologies and their in-house resources and competencies. This thesis focusses on SMEs with between 20 and 249 employees and Neatsmith fits nicely into that size category with 80 employees. According to Statista (Chart 2) these firms employ 5.41m workers and large firms (250 employees and above) employ 15.21 million. Chart 15 below summarises the author's view of the different levels of IT Maturity. Neatsmith was at Level 2 at the start of the Case Study and has evolved to Level 3 but are not yet prepared to invest in their own in-house IT department.

Levels of IT Maturity

- | | |
|---|--|
| 1 | Spreadsheets and email – no IT department |
| 2 | Discrete applications: e.g. website, finance, CRM, etc – no IT department |
| 3 | Discrete applications plus customised integration - outsourced IT department |
| 4 | ERP implementation – medium IT department |
| 5 | Bespoke applications – large IT department |
| 6 | Enterprise architecture – large IT department |

Chart 15: Levels of IT Maturity

One additional clarification to this chart needs to be made. These categories apply to firms who use IT to support products and services which are not themselves digital. Neatsmith is a good example of this because their output is wardrobes. More Yoga, another firm with which I have worked, delivers Yoga classes. There is however an important class of Firms who create digital products and services. They will often fall into category 5 because, in order to be competitive, they are compelled to build bespoke applications, rather than purchase off the shelf ERP applications.

In order to get a better understanding of the use of ERP applications in Large SMEs, there is a need to look at IT spending in comparable European countries to get an idea of market sizes. One must then take a look at software spending as a part of IT spending and look at ERP applications as part of total software spending.

2.6.1 IT Spending in five European Countries

In Chart 16 below, Saggaw and Calio (2023) provide an overview of IT spending broken down into four categories: Public Cloud (10%), which replaces IT hardware which used to be inside the firm; Software (20%), which includes Productivity and Enterprise; Application Development and Systems Infrastructure (19%); Hardware which includes PCs, Phones, Data Centres including network infrastructure; and lastly IT services (51%) which include IT Consulting and Implementation, Business Process and IT Outsourcing, Support and Deployment and IT Training and Education. Percentages are for the UK data in 2021.

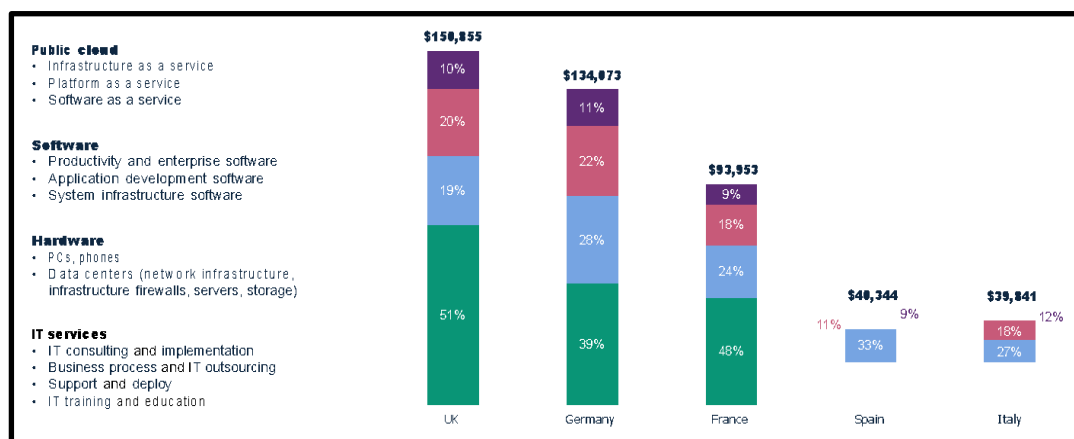


Chart 16: IT Services represents the largest share of technology investments in the UK in 2021 (in US dollars)

Given that the UK is always stated to have much lower investment than other G7 countries, it comes as surprise that the UK invests more than Germany and France, both of which have achieved better productivity growth since 2008 than the UK.

The second important lesson from the data is that IT services constitute more than 50% of all IT spending. This suggests that both medium and large firms are relying on outside services to complement their own in-house IT departments, where they exist, and to provide specialised capacity to medium sized firms without IT departments.

One further point to note is that the definition of Software includes the following types:

1. Productivity and Enterprise Software
2. Application Development Software, and
3. System Infrastructure Software

Chart 17 below shows that spending on software will continue to increase in the UK for all sizes of firm.

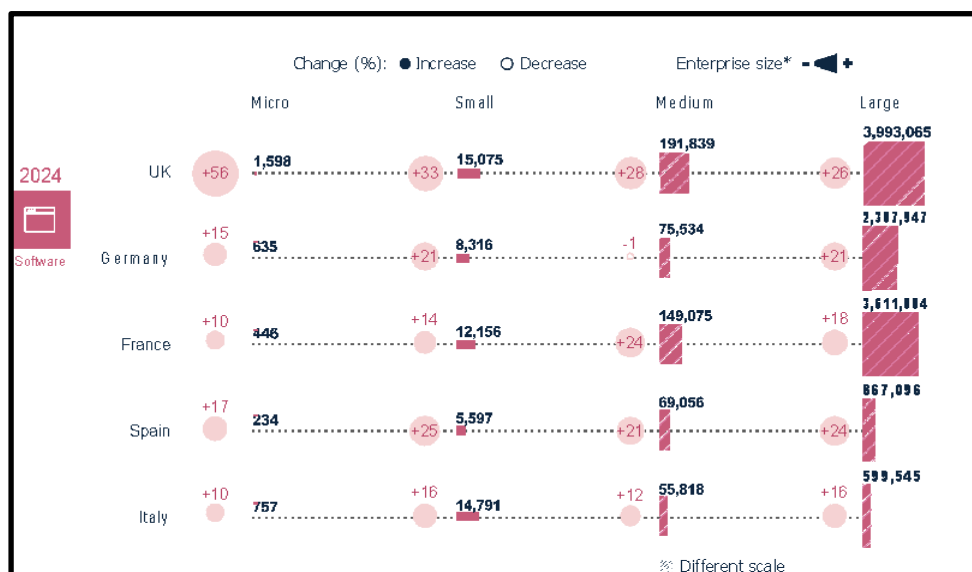


Chart 17: Average software spending per company in the UK, with increases compared to 2021 (in US dollars)

Chart 18 below drills down into the software spend category to look at one specific segment: Enterprise Resource Planning (ERP).

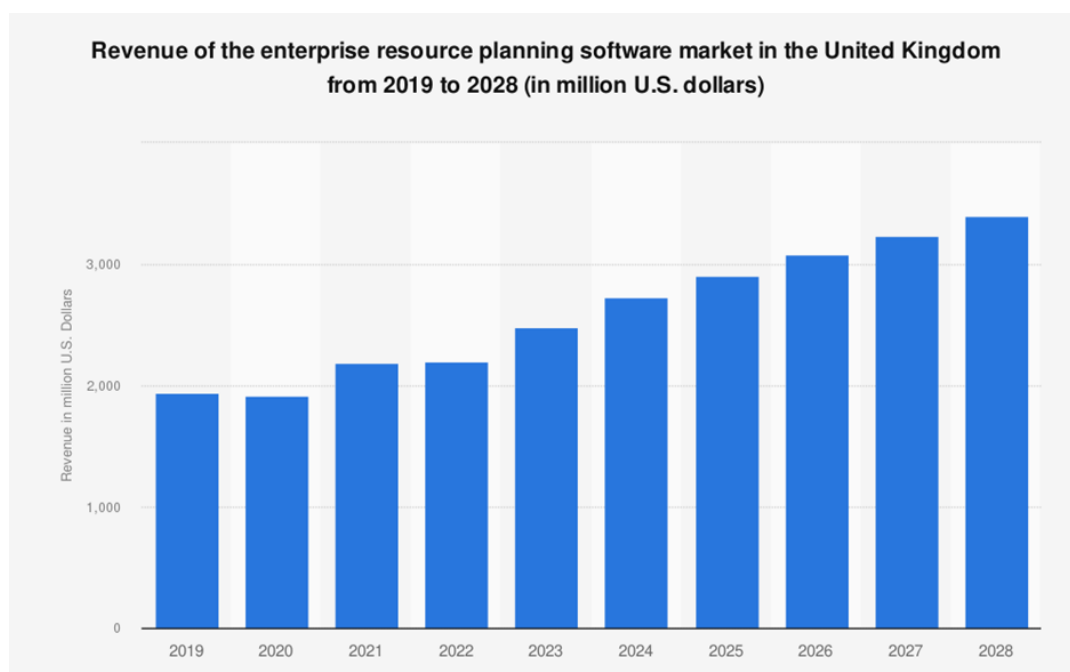


Chart 18: The ERP software market in the UK (2019 - 2028) (Statista, 2023b)

ERP is the most complex type of application software, having been pioneered in the 1990s by Oracle and SAP and joined in the 2000s by Salesforce.com, who pioneered cloud-based ERP software. Numerous smaller software companies have entered the market but for large firms SAP and Oracle still dominate. One of the main reasons for this is the cost of implementing and customising ERP software is much greater than the software itself (by a factor of up to five) and this spending shows up in the IT Services

category. In larger firms external spending is complemented by an in-house IT department which is not shown in the Statista surveys.

Number of people employed in the private sector in the UK 2024, by business size		ERP Potential
Number of people employed in private sector businesses in the United Kingdom in 2024, by employment size (in 1,000s)		
With no employees (unregistered)*	3,154	
With no employees (registered)	1,285	
1	275	
2-4	2,132	
5-9	1,798	
10-19	1,944	
20-49	2,373	
50-99	1,764	
100-199	1,427	
200-249	486	3,677
250-499	1,457	
500 to 999	1,459	
1000 or more	8,199	11,115
Total Private Sectors Firms who are potential ERP buyers		14,792

Chart 19: Private sector employment by business size BIS 2024.

In order to calculate spending on ERP as a percentage of software spending in both large and medium sized firms, some additional analysis is needed. Chart 19 above shows the number of employees in medium sized SME (50-249 employees) as 3.677 million and for large firms (250 employees and above) this number rises to 11.15 million (BIS 2024). Statista reported that total software spending in the UK was just over \$30 billion in 2021, of which ERP applications represented \$2.1 billion or 7% of total software spend. Statista do not provide a breakdown of ERP software by size of firm but they do provide a breakdown of average spending on all IT spend which is \$191,831 for medium size firms and \$3,993,065 for large firms. It is not possible to drill down any further given the available data, but it is likely that most large firms will have implemented ERP by now, whereas most SMEs, given their lack of IT departments and their relatively low level of IT maturity, have not. Apart from the unaffordability of ERP applications there is a problem: they are not designed to measure productivity or to help managers improve it.

2.7 Artificial intelligence (A.I.)

The development of A.I. platforms and applications has expanded rapidly in the last few years with major contributions from leading US tech companies. Just as office applications in 1980s and ERP applications in the 1990s were first adopted by large firms and followed some years later by SMEs, it is likely that AI adoption will follow a similar pattern – starting first in large firms and only later becoming cost-effective for SMEs. A.I. investments will also face the same TFP measurement challenges

2.8 Why Don't SMEs measure Productivity

There are four main reasons why SMEs don't measure productivity which are discussed below:

2.8.1 Lack of Statutory Reporting Requirements

SMEs are required by law to submit annual financial reports to Companies House under the Companies Act (1966). These requirements include profit and loss accounts for the year, balance sheet for the year, number of shares issued and names of Directors. No productivity measurements are required. Given the UK's weak productivity performance since 2008 and the OBR's identification in 2024 (2024b) of the need for a 2.5% annual TFP Growth rate to fund climate change and an aging population, it is surprising that no government has mandated productivity reporting to be added to the Statutory Accounts.

2.8.2 Lack of Understanding of the Impact of Productivity on Earnings and Valuation

There is a second reason which only became clear towards the end of the case study. There is little or no understanding of the impact of productivity growth (and TFP in particular) on the firm's earnings or its valuation. If managers understand their profit and loss and can grow their business within their capital constraints there is no need to worry about productivity, they are already achieving their goals. It might be assumed that those firms with external investors, typically Venture Capital for SMEs, would be pushing firms to report productivity as a means of increasing the firm's valuation, but they do not. Their focus is on growing revenues by adding new customers and progressively reducing the cost of acquisition (CAC) and increasing the long-term value of these customers by adding additional products and services (LTV). Their preferred measure is EBITDA (Earnings before Interest, Taxation, Depreciation and Amortisation). For very large firms who might be listed on the London Stock Exchange, perhaps the Government might require them to report on both their labour productivity and their capital productivity, but there are no such requirements. In fact, the most important changes for firms listed on the stock market over the last 10 years is to report their ESG standing as a supplement to their financial reports. ESG refers to Environmental, Social and Governance concerns.

2.8.3 Lack of TFP Reporting Specification

As the earlier discussion on TFP Reporting within the firm has established, there are already large and well-known reporting gaps for unmeasured intangible assets in the UK which have concluded that some 60% of these investments are not correctly categorised for TFP Reporting. There is a second problem, which was reported in the Big Innovation Centre publication "Intangible Gold" (2017) for which the author conducted a detailed investigation of the accounting rules which prevented the unmeasured intangible assets from being included in Statutory Accounts. The case study discovered a third problem which is that in addition to the unmeasured intangible assets there were additional investments (which are called Complementary Investments in this thesis) which were not recorded at all. An important contribution of this thesis is to describe the full set of complementary investments and to provide an initial assessment of cost and value.

2.8.4 Lack of TFP Reporting Software

The fourth reason is entirely practical – there does not appear to be any TFP Reporting software on the SME market. The review of ERP applications showed that their focus was on providing a rich suite of customisable applications for all the departments in the firm and providing a single database to enable the integration of these departments and their applications. The majority of UK firms cannot afford ERP systems so must buy department specific applications including Websites and Accounting software as the bare minimum and make do with Excel spreadsheets and email to manage the rest of the business. The development of a comprehensive TFP Reporting suite of software for SMEs is discussed in Chapter 8 – Future Research.

2.8.5 Consequences of Lack of TFP Measurement

The lack of TFP measurement for SMEs shows up quite clearly in the GVA tables and Management Practices scores maintained by ONS. From reviewing their data and Haldane's work it is quite likely that most SMEs have no or negative productivity growth. From a UK perspective this is a serious economic problem, because, in addition to Medium and Large SMEs (5.1m employees) there are two more sectors where there is no productivity measurement. These include the public sector with 5.77m employees, and Micro SMEs and Sole Traders with 6.39m employees. A total 15.57m employees are, to the best of our knowledge, not reporting TFP. That leaves 15.2m employees (46% of the total) in large firms to deliver all the TFP growth for the UK.

2.8.6 Mind the Gap

When the national figure is decomposed in this way it suggests that the UK's weak productivity growth is almost entirely down to these three sectors and that these large firms (who as discussed earlier invest a lot more in technology) are delivering almost all the UK's TFP growth. The OBR target of 2.5% TFP growth for the whole economy is what they estimate is needed to pay for existing public services without further increasing taxation as a percentage of GDP or national debt.

The gap between actual TFP growth at 0.07% and 2.5% is 1.8%. Given the nominal GDP for the UK in 2024 is estimated by IMF at \$3,588 billion which converts to £2,870 billion (at a sterling / dollar exchange rate of 1.25.) The OBE 2.5% target is £71 billion, the OBR forecast of 0.07% is £21 billion, which leaves a TFP gap of £50 billion every year. This gap must be paid for either by increased taxation or increased debt.

2.9 Economic Impact of New Technologies

As the chart below shows, Brett Winton at ARK invest (Winton, 2024) is confident that a new set of technologies will have a more dramatic impact on GDP growth than the steam engine.

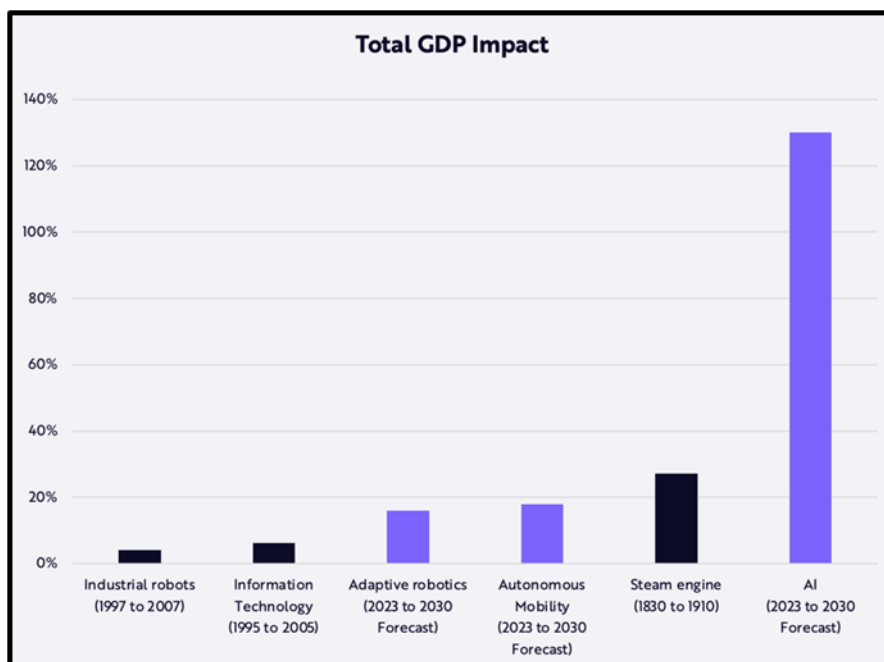


Chart 20: GDP Impact of New Technologies, © Brett Winton

While forecasting the future growth of GDP is fraught with difficulties, which is why most economists avoid it, Winton argues that the impact of these new technologies will support real GDP growth of 7%, which is the fastest rate since the 1950s.

The UK's Office for Budget Responsibility, which is charged with providing five-year forecasts of productivity growth to the UK Treasury takes a much more conservative view (March 2024):

"Our forecast for average trend productivity growth over 2024 to 2028 is largely unchanged at 0.9 per cent. Productivity growth is composed of capital deepening – proxied by the change in the capital stock per hour worked – and total factor productivity (TFP) – the economy's efficiency at combining capital and labour to produce output: Capital deepening contributes 0.2 percentage points to average annual productivity growth over 2024 to 2028, broadly unchanged from November. TFP contributes 0.7 percentage points to average productivity growth over 2024 to 2028, also unchanged from November."

Given that productivity growth is a good proxy for GDP growth (Syverson, 2024), UK growth will at no time in the next five years meet the new Labour Government's target of a rate surpassing that of the G7 as documented in their Mission Statements. (Labour Party, 2024, p. 13).

"Mission 1: Kickstart economic growth to secure the highest sustained growth in the G7 with good jobs and productivity growth in every part of the country making everyone, not just a few, better off."

Given that US growth rate in 2024 is expected to reach 2.8%, this would require the UK to deliver 2.9% rather than the 0.9% forecast by OBR.

Can A.I. Applications increase SME productivity?

A small number of very large US firms are spending trillions of dollars on A.I. applications. As noted in the literature review there are three main types of A.I. application: those which automate human activity (self-driving cars; general purpose robots), those which are embedded in existing applications of all kinds (process automation), and those which augment human work activities. One of the greatest barriers to adoption of the new technologies by the long tail of low productivity SMEs is the lack of in-house IT skills and a low understanding of the work activities to which A.I. can be applied.

Why is the USA's productivity and GDP growth four times that of the UK?

The Productivity Commission sets out three reasons for the UK's poor performance in their November 2023 report (Coyle, van Ark, & Pendrill, 2023 page 9):

“ONE: Chronic and broad-based under-investment in the UK economy

TWO: Inadequate diffusion of productivity-enhancing practices between firms and places

THREE: Institutional fragmentation and lack of joined-up policies”

A contrary opinion is presented by Andrew Leicester (Leicester, 2024). He argues that the failure is not due to lack of investment but to the lack of diffusion of these innovations into UK firms.

The author's opinion is even simpler: without exception, all the public sector enterprises and private sector firms in which he has participated in research projects *have no interest in productivity growth or any practical knowledge of how to accomplish it*. In the last 20 years of research, the author has found only two exceptions to this. In the first case the two senior managers who actually did want to increase productivity were overruled by their superiors and then their successors. In the second case, only one of the two owners wanted to increase productivity, while the other was uninterested.

Furthermore, the historical review of UK productivity growth following WW2 and the Marshall Plan suggests that at no time did the UK Government implement a conscious and deliberate 'Mission' to increase productivity, even though they acknowledged its importance. There has never been any institutional support for productivity growth in the UK Treasury, which is concerned solely with government income and expenditure. Even now, after the Brexit referendum in 2016 promised that the UK would take control of its borders, the UK imports labour at higher rates than before the referendum. The OBR does report the latest estimates for immigration and its impact on the labour force, but does not provide any supporting analysis of the cost of immigration in terms of

housing, hospitals, transport education and law and order, in other words, immigration is treated as a free good but it clearly has an effect (if not properly quantified) on government spending.

The UK Productivity Puzzle has much deeper roots than are acknowledged by the Productivity Institute. When Rostas (1943) published his analysis of manufacturing productivity in the USA, Germany and UK in 1938, the results came as a shock, with US output per worker in manufacturing twice as high as the UK or Germany. When Silberman (Gottwald 1991) presented his case study of the productivity of 30 firms in the UK and France to Cripps in 1947, he found that conditions in the factories he visited were comparable to those existing in the USA in 1900. This was after the greatest economic mobilisation of the UK in history between 1939 and 1945. The truth is that the UK had lost productivity leadership to the USA before 1900, five generations ago. It would therefore be naïve to think that this deep-seated historical problem can be fixed within a single Parliament.

2.10 Summary: Literature Review Research Gaps

The literature review has identified 25 Research Gaps grouped into five topics:

- Division of Labour
- Management Practices Measurement
- Lack of Effective Diffusion
- National Productivity Measurement
- Information Systems

2.10.1 Division of Labour Gaps (5)

1. Work activities are not documented for all departments and levels of work in the firm.
2. Input-->Conversion-->Output production units are not captured, tracked, managed, reported or updated.
3. For non-office employees real-time To-Do lists and daily updates and reports delivered to frontline employees via smartphones, tablets, laptops, and PCs would facilitate the completion and tracking of work activities.
4. Complementary investments are important drivers of productivity growth but these cannot be measured at the production unit level.
5. SME Managers do not fully understand the distinction between revenue-driven profit growth and productivity-driven profit growth which makes it hard for them to justify investment in digital management practices.

2.10.2 Management Practices Measurements Gaps (5)

1. Fair Work Projects are valued, but, as Lindsay (2022) explained, there is no way of measuring the labour productivity impact of these projects.

2. Productivity growth is influenced by marketing & sales strategies, but the Bloom and Van Reenen management practices surveys focused primarily on manufacturing operations and did not include marketing & sales.
3. The Management Practices questionnaire can be completed by an SME manager in less than one hour, but the problem is not one of measurement. GVA per head is actually a better measure. What firms need is to learn how to grow productivity year on year
4. Management Practices surveys (with the exception of MEPS in the USA) may not be conducted annually so longitudinal growth is hard to measure
5. Management Practices surveys could be digitised and reported on a quarterly basis, the Management Practices score could then be correlated with GVA and TFP growth.

2.10.3 Lack of Effective Diffusion Gaps (4)

1. Historically the UK is much weaker at diffusing best-in class productivity practices than its rivals, as demonstrated by the results of the Marshall Plan
2. The UK's productivity problem is that it has much longer tail of poorly performing firms than its European or American competitors with the 50% of firms below the mean contributing only 9% of UK labour productivity growth
3. UK Governments rely on private sector firms to deliver productivity growth and assume they can and will. Given that this assumption has proven to be incorrect since 2008, there is a serious national policy disconnect which needs to be addressed
4. Public sector productivity has been ignored but they employ the same number of people as SMEs with 20 to 250 employees.

2.10.4 National Productivity Measurement Gaps (6)

1. ONS reporting of GDP uses aggregated data and surveys to measure GVA and TFP growth.
2. ONS variables for labour quality and labour services are weak.
3. ONS variables for unmeasured intangible assets are not reported at firm level
4. Innovation activities play an important role in productivity growth but innovation surveys are only conducted every two years for a selected sample of firms
5. National ONS variables for TFP do not include labour quality, unmeasured capital investments and innovation as documented above.
6. Firms are not required to provide statutory reporting of GVA growth, TFP growth, Unmeasured Intangible Assets or Innovation Activities

2.10.5 Information Systems Gaps (5)

1. IT costs are too high for SMEs and productivity growth functionality is non-existent
2. Digitisation is encouraged to drive productivity improvement, but SMEs cannot afford to spend the 10x more to meet the level of spending in large firms
3. Application and process integration is critical to productivity improvement, but the majority of SMEs do not have an IT department and cannot afford to integrate their office systems and their department-specific software applications.

4. Real-time performance and productivity data in digital marketing is now mandatory, but few SMEs can afford marketing data collection and analytic applications.
5. Low productivity SMEs will not have the in-house technical skills or knowledge of the work activities to benefit from A.I.

2.11 How does the Research Question answer these gaps in knowledge?

This thesis answers these gaps in knowledge by developing a clear distinction in the Methodology Chapter between the social institution entity, its organisation structure, its production units and its work activities and the properties of the social institution entity which include measurement of finances, profits, GVA and TFP and supporting Information Systems. The Theoretical Framework provides a new way of looking at the social institution as an engine of total factor productivity growth, as well as an engine of profit growth. The case study explores the implementation of the theoretical framework in a manufacturing SME with 78 employees and implements a new software platform and new GVA and TFP growth reporting to complement their existing financial reporting.

3 Methodology

3.1 Introduction

The purpose of a PhD is to contribute to scientific knowledge, this is why Methodology is so important because it must demonstrate why both the methodology used to conduct the research and its findings are scientifically valid. In the author's case there is a second reason, which belongs to the discipline of piecemeal social engineering. This is the second part of the research question: "How can Small and Medium Enterprises (SMEs) solve the UK Productivity Puzzle?"

Popper (1959) lays out the now widely agreed definition of scientific knowledge which is the creation of scientific hypotheses, their empirical testing and their falsification, known as the Hypothetico-Deductive Method. But there is a second Popper (in the same way there was a second Schumpeter), which is explored in *Poverty of Historicism* (1959). In this book, Popper's focus is not on the philosophy of science, but the importance of piecemeal social engineering as a scientific discipline:

"Just as the main task of the physical engineer is to design machines and to remodel and service them, the task of the piecemeal social engineer is to design social institutions, and to reconstruct and run those already in existence." (Popper 1959 page 64)

Popper includes a wide variety of social institutions, including businesses from small shops to large companies, and likewise public institutions like a school, an educational system or a police force. He also points out that:

"Only a minority of social institutions are consciously designed while the vast majority have just grown but the social engineer will view them from an instrumental position as means to an end and as systems that can be improved." (Popper 1959 page 65).

This thesis builds on Taylor's work study, Jaques' levels of work and ontology, the new micro-economics of the firm (Autor, Levy and Murnane 2004), the new macro-economic focus on intangible assets, (Corrado, Hulten and Sichel 2006) and Popper's piecemeal social engineering applied to a real social institution, Neatsmith Ltd, a UK Small and Medium Enterprise (SME) based in Watford.

The thesis then reviews how Neatsmith solves their own productivity puzzle by measuring their labour productivity and TFP for the three years before the case study began (2019, 2020 and 2021), measuring it during the Case Study (2022, 2023 and 2024) and reviewing their own productivity forecast for the next three years (2025, 2026 and 2027). It also examines how a range of complementary investments have been implementing during the Case Study years and how Total Factor Productivity can be reported on a monthly basis.

3.2 Ontology

The literature review showed the growth and importance of technology, particularly information technology and how the socio-technical approach included it as a key variable of economic growth. However, two systems of measurement operated in parallel until the early 2000s. The two systems were statutory accounting which requires all UK firms to report Profit and Loss and Balance Sheet information every year and macro-economic Total Factor Productivity reporting which operated at national level in most economies, providing aggregated data on economic growth including labour and capital productivity. However, during the 2000s one group of economists (Autor, Levy and Murnane Op Cit) started to focus on how information technology worked within the firm and the economic consequences for wages and occupations. In parallel, a second group of economists, (Corrado, Hulten and Sichel Op Cit) started work on the impact of a new types of intellectual property which they called “Intangible” assets and their impact on the national economy. These new economic measurements also need to be understood at firm level because that is where the complementary investments are made.

These developments lead directly to the need to extend the socio-technical view of the firm to include the micro-economic of complementary investments impact on labour, capital and total factor productivity. This extends the firm to become a socio-economic technical system, to which Jaques’ ontology is directly relevant.

3.2.1 Jaques’ definition of Entities, Properties and Quantification

Jaques engaged in the study of social institutions from 1948 onwards, starting with the Glacier Metal Project in the late 1940s and continuing until 1964. As Professor of Social Sciences at Brunel in 1964 his primary focus shifted to social institutions in Health Services. After Brunel, he continued work with a number of social institutions, including the US Army Research Institute. In his book, *The Form of Time*, Jaques (1982) explained the difference between entities, properties, preferences and quantification as applied to social institutions (Jaques 1982 pages 178-179):

“I propose therefore to use the following terms. I am using the term entity, to comprehend objects, fields, events, episodes, including statements, which are objective in the sense of socially shareable.

I shall shorten the phrase ‘objectively defined property’ to property to refer to objectively specifiable features of an entity. These features, such as length or hardness of a things, or level of work, or length (temporal) of a contract, are objective in the sense that the way they can be observed, and eventually measured in magnitude, can be stated using a socially established instrument which permits of social agreement regarding the data in the sense that everyone using the instrument will arrive at the same measured quantity. Such properties give the appearance of being independent of people and consequently inherent in the entity; but in fact, they arise from people’s interaction with the entity, observation of

objectifiable data, and organization of the data in terms of constructs called properties.

The phrase 'individual judgements and preferences about entities' (including utilities, attitudes and values) will be shortened to preferences to refer to the different opinions which different individuals might have about an entity, such as beauty, or benefit, or usefulness, or other valuation as compared with other entities, in terms indicating which is preferred. Preferences are thus individual and personal feelings about an entity. They can never be the subject of objectifiable social norms shared by everyone, but only of norms which are individual. Their outstanding characteristic is that they vary from person to person, and in the same person from time to time, in accord with personal feeling. I shall continue to keep the concept of probability separate from preferences, including utility, although I shall not deal with probability at any length.

I shall use quantification to refer to the general process of assigning numbers to entities, to properties, to preferences and to probabilities. I shall then adopt the usage: counting the number of entities, measurement of the objectively defined properties of entities, rating by individuals of the preferences (or utility) that they assign to entities, and quantified judgement of the probability of the outcome of the yet unknown."

The author has found this a very helpful ontological guide because it clearly separates the social institution and its entities from the measurements and quantification of these entities. This is an important distinction because improvements cannot be made by changing the measurements but only by changing the entities. It also provides for the entities to have properties. One emerging property which Jaques did not include, but which the author discussed with him at length in the early 1980s, was technology. At that time the author was working in the USA on office technology for Digital Equipment Corporation and it was quite clear that new technologies such as email, word processing, and document filing would be useful in any office, so the proposed ontology includes three parts: the social institution and its entities (Organisation Structure, Work Activities, Production Units and Complementary investments), the Total Factor Productivity of this social institution and the technologies (IT and others) which support the social institution to increase their productivity.

It's important to remember that technologies are not a new concept. The big breakthrough at Cromford Mill in the 1770s were new machines which could both spin and weave cotton. In the 1980s the new machines included word processors, minicomputers, personal computers, networking and applications software and these can and did support and transform all types of office work.

This socio-economic-technical system is the new construct in which the Social Institution is the main focus, and to which Measurements (Financial, KPI and TFP) and Technologies (Information Systems, A.I. and others), are applied. The Ontology proposed below explains how a Social Institution (the entity) can be fully described,

how it can be measured and how bespoke software can be used to increase the institution's Total Factor Productivity (TFP).

3.3 Proposed Ontology

Chart 21 below summarises how the author has used the Jaques' definitions with the addition of technology to provide a guiding ontology.

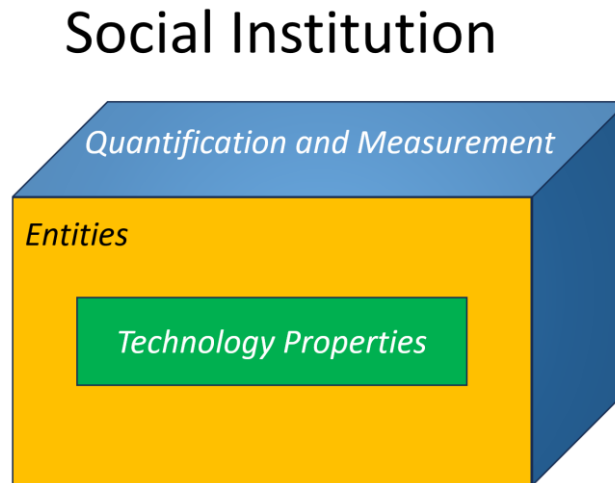


Chart 21: The Social Institution Entity with its Quantification & Measurements and Technology Properties.

The blue box focuses on the quantification and measurement of the social institution. The amber box shows the social institution as the entity and the green box in the middle shows the technology properties which are used by the social institution to support the delivery of the work activities and work objects.

3.3.1 Social Institution: Brief Summary of Entities

Based on the author's research work at Donegal (documented in Appendix 2) and Case Study research, the list below summarises the entities which enable a full description of the work of a social institution to be constructed.

1. Organisation Structure
2. Managerial relationships
3. Work-Process / Production Unit
4. Work-Activity ID
5. Work-Activity description
6. Work-Object
7. Work-Object Type: Material, Social and Informational
8. Work-Object Cases
9. Work-Activity Groups
10. Work Activity Reporting
11. Work Object Reporting (KPIs)
12. Roles and Posts

13. Working-relationships
14. Counterparty role/position
15. Working-relationship properties
16. Customers
17. Governance
18. Managerial Problems / Challenges

3.3.2 Social Institution: Quantification and Measurement

The growth in US productivity since 1900 was documented in the literature review and this growth was firmly based on the observation and documentation of the properties of work focusing on what we now call labour productivity. Frederick Taylor (Taylor, 1903) used indirect observation of what we would now call the individual work-activity level for factory workers. But the Gilbreths, (Gilbreth & Gilbreth, 1921) building on Taylor's work, introduced process descriptions which could be derived from direct observation and also developed a rich language for describing physical movement, which is still in use today.

Henry Gantt (Gantt, 1918), who worked with Taylor, was particularly interested in the quantification and measurement of time and resources, and the chart which bears his name is still the foundation of project and programme management today. Bedaux who packaged and popularised work study in the USA and UK in the 1920s and 1930s was particularly concerned with the financial properties, developing the concept of standard times for particular levels of effort. (Weatherburn, 2014)

Quality was introduced after the Second World War by Joseph Duran and W. Edwards Deming but was famously ignored by American industry. It was in post-war Japan, where both Deming and Duran's thinking and methodology were widely adopted in the 1950s and these contributed in no small measure to the Japanese industrial miracle, during which Japan grew to become the world's second largest economy. Thirty years later, popularised by MIT's studies of the Toyota Production System (Ohno, 1996), the US then imported many these ideas and LEAN Six Sigma became of major importance in the 1980s and 1990s.

1. Quantification: Productivity – pre WW1 Taylor, Gantt and later Gilbreths
2. Quantification: Financial – pre WW1
3. Quantification: Time – pre WW1
4. Quantification: Capital – pre WW1
5. Quantification: Standard Time: Bedaux 1920s
6. Quantification: Quality – 1946 Deming et al in Japan
7. Quantification: Total Factor Productivity: Solow 1957
8. Quantification: Intangible Capital – Corrado, Hulten & Sichel 2006
9. Quantification: Innovation – OECD Oslo Manual 2012

3.3.3 Social Institution: Technology Properties

Information Technology can make a significant contribution to fully understanding how the inputs of labour, purchases and capital are converted into outputs by capturing the dynamic nature of work at the work activity level. This requires knowing all the work activities which are required to deliver the outputs and capturing the date and time of their completion and the employee who did the work. This can deal with one of the drawbacks of traditional work study. Work study engineers focused on describing the work and measuring outputs on a weekly basis, which required the creation of a large department to capture, record and tabulate the data for the calculation and payment of bonuses. It should be noted that whilst the descriptions of work are static, all work is actually dynamic; there is no such thing as static work.

As Zuboff showed, technology both augments work and infomates it which provide managers with a view of work which was not available before. When the work is with materials (like manufacturing or construction) or with people (like education and healthcare), the object of the work is still visible. When the work is informational, the work objects can disappear.

3.4 Epistemological Discussion

As part of the literature review, the author began with the sociological epistemological approaches documented by Burrell and Morgan (1979 page 124). These include Scientific Management, the Hawthorne Studies, the post-war development of Socio-Technical Systems theories, and the replacement of Work Study and O&M by Systems Analysis.

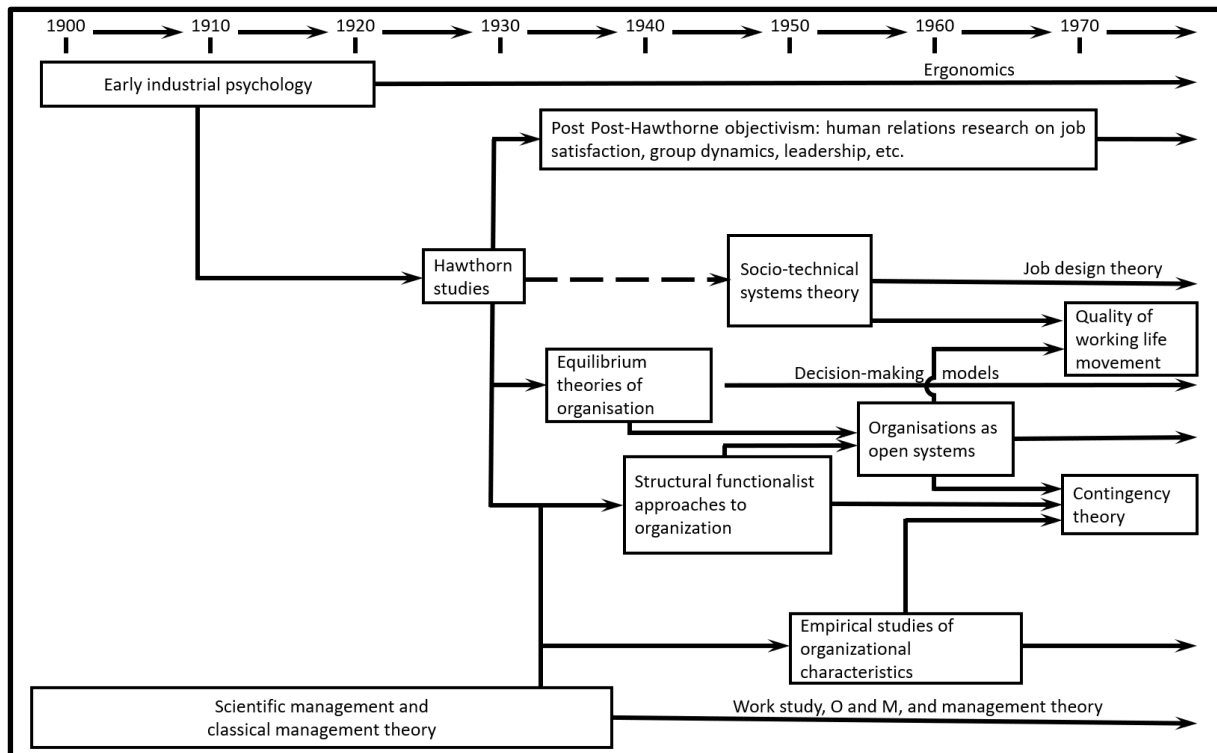


Chart 22: Epistemological Overview Burrell and Morgan (1979)

Whilst Burrell and Morgan do an excellent job of describing the sociological epistemologies several major developments have occurred since their work was published in 1979. Chart 23 below highlights the importance of the end of Work Study, the enormous impact of Hawthorne on supervisor training in WW2 (and its importance to post war socio-technical thinking) and the disappearance of work as reported in Zuboff's case studies from the 1980s.

	Status	Contribution of this Thesis
SOCIOLOGICAL		
Burrell and Morgan Work Study	Replaced by Systems Analysis during 1960s	Work Study Practices are even more important than they were in the 1950s and 1960s
Hawthorne Studies	Supervisor Training TWI Implemented in WW2	Employee Engagement, Work Description and Supervision need to be re-invigorated
Empirical Studies	Disappearance of Work due to computerisation in the 1980s	Work disappeared in the 1980s, 90s and Noughties and must be made visible again
ECONOMICS		
Solow Growth Theory	This introduced technical change and measured it as a residual at national aggregate level,	Firm level Financial Reporting and KPIs are not sufficient for TFP measurement
TFP Reporting	Aggregate TFP reporting has been extended to include unmeasured intangible assets	Unmeasured intangible assets may be of much greater importance to TFP growth than hitherto understood
Complimentarities	Led by Brynjolfsson, Technology, Innovation and Intangibles drive growth at aggregate level	Enable Production Function Managers to choose and measure the best recipes for Complimentary Investments
TECHNOLOGY		
Moore's Law	Moore's law (1970) forecasts that number of transistors on a single chip will double every two years	Numbers of transistors on a single chip has increase by 13.5 million since 1970 both increasing power and reducing cost of computing
ERP Applications	Enterprise Resource Planning applications have been deployed in all large firms and an increasing number of SMEs	These applications contribution to US TFP growth in the 1980s and 1990s but this growth was not achieved in Europe and has slowed in the 2000s
Global Internet	Since 1995 the Internet has been available for commercial use in almost all countries in the world	This led to dramatic reduction in transaction costs and supported the implementation of globally supply chains (outsourcing)
Mobile Communications	The Apple Smartphone in 2007 started the second communication revolution and has led to a proliferations of "apps" with a strong focus on ease of use	Smartphones doubled the number of internet uses and fuelled digital marketing and social networks (along with global disinformation)

Chart 23: Updating and Extending the Epistemology

3.4.1 Innovation in Economics and Technologies

Chart 23 also highlights two additional groups of epistemologies that are required, the first of which is economic measurements. This group is important because in the 1950s Governments introduced national income accounting and in the late 1950s Solow worked out how to include technical change in these. As this Nobel prize-winning breakthrough was progressively implemented in national income accounting, further research work stressed the growing importance of what are now called 'intangible' assets, including research and development, software and databases and different types of innovations in marketing and branding, human capital development and organisational capital development. This latter group are hard to measure for national accounts but can be measured inside the firm.

Since 2000 there has been considerable research in how these innovations and expenditures in tangible, intangible and unmeasured intangible assets have impacted on

labour productivity growth, capital productivity growth, wages and occupations as well as 'Total Factor' productivity growth.

Technology Innovations

The reason that technology is important and needs to have an epistemology is because it is one of the biggest drivers of change in the workplace. Large firms, beginning in the 1980s and accelerating in the 1990s and 2000s have made very high levels of investment in IT applications, particularly applications which span not only the entire firm but their supply and demand chains as well.

Smartphones are the most recent technological innovation. Since their introduction they have more than doubled the number of internet users and made it possible for firms to outsource much of their clerical work to Smart Phone 'Apps' and get their customers to do the work. They have also driven social networking, digital marketing and global misinformation. A.I. is the next wave of technology, and it too will change work and working arrangements in ways that are only just being understood. The only certainty is that technology will continue to drive workplace change.

3.5 Linking the Epistemology to the Ontology

As discussed earlier, the primary unit of analysis in this dissertation is a small and medium enterprise (SME), a social institution with four levels of work. We follow the socio-technical epistemology in separating the social institution from the technologies used by it. Scientific management and its subsequent evolution into work study and O&M historically provided a systematic way of observing, describing and measuring the work of the social institution. These techniques also measured the efficiency of work at the shop floor and documented them for the first and second levels of management in order for them to increase productivity, increase wages for employees and managers, increase returns to shareholders and lastly increase the quality and reduce the costs of the firm's products and services.

The replacement of Work Study and O&M by the new discipline of 'Systems Analysis' in the 1960s led to a serious loss of systematic and codified knowledge about the nature of work and the tasks which informed work. Systems analysis facilitated the development of new applications, but at the cost of a deeper understanding about the work that the applications were supplementing or replacing – including an understanding that informed the definitions of the qualifications required by employees and supervisors who were still tasked with accomplishing the work.

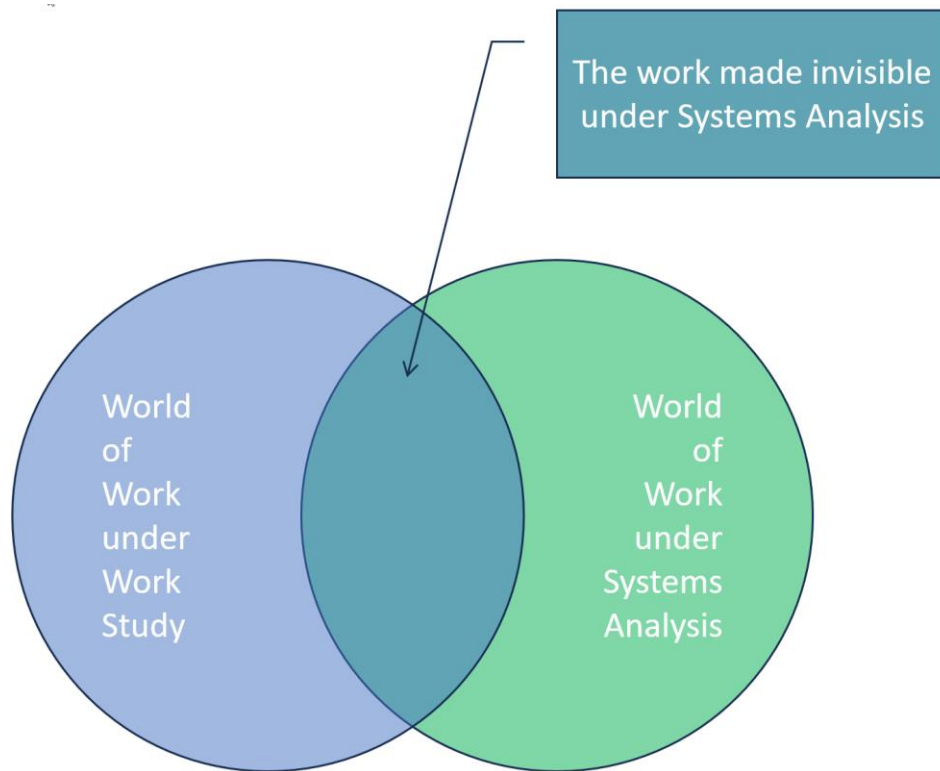


Chart 24: Work objects understood under work study can disappear under systems analysis.

Another unexpected consequence of this was that the curricula which had been taught in technical colleges and provided recognised qualifications to employees, first level managers (supervisors) and second level managers disappeared.

3.5.1 Methodological Considerations

It is now time to turn to a discussion of the Methodology to be used in the research project.

Bringing back the Social Institution and its Work Activities as the Unit of Analysis

The challenge of bringing back the social institution as the unit of analysis involves several tasks:

- Re-introducing the socio-technical approach by clearly separating the social institution from technologies of all types
- Introducing levels of work-complexity to the social institution
- Identifying the production units which convert inputs of labour and capital to outputs (at both intermediate and market prices)
- Re-introducing the social analytic method for the observation and documentation of social institutions
- Providing a Digital Management Practices platform to support senior managers and their production unit managers in their focus on productivity measurement and productivity improvement

- Dealing with the *infomating* of work, as described by Zuboff, by making information systems visible through work activity maps of the firm and work-activity reporting for the production units within the firm and all its employees

The benefits of achieving these changes are the new ability to measure productivity of both labour and capital at the production unit / department level within the firm as well as at firm level.

Focusing on the Description of the Work

The Research History section which can be found in Appendix 2 reported on the project work conducted at Donegal County Council between 2003 and 2012. This project found that there was a strong need to deal with the observation, description and measurement of work because it appeared to be completely lacking from managerial discussion. In the social sciences, unlike the natural sciences, it is possible to ask the person being observed to describe the work they are being asked to do. Three approaches to observation can be used:

Direct observation

This the closest possible to the reality where the employee reports what he/she actually does as fully as possible, and this is either recorded by the employee or recorded by an observer whose written description is agreed by the employee to be an accurate version. It should be noted firstly that the more experienced the observer, the better the description in terms of it being detailed and complete.

Indirect Observation

This is performed by an observer who views the work being performed, often with a particular interest in mind (e.g. to observe the number of operations, the elapsed time, the use of machines, the layout of the shop or office) and then documents the results of these observations. This may result in one or more facets of the work being described, quality being just one example. The narrative is not checked with the employee and is therefore at one remove from the work hence the term 'indirect observation'. This describes the primary method used by the work study practitioners beginning with Taylor.

Work Activity Reporting

This is the observation of 'working' which uses information technology to capture the performance of pre-determined work activities by an employee. This data can be captured in three ways: the employee can update the work activity directly on a PC, the employee can update his or her daily work activity list from a Smart Phone or Tablet and lastly the data can be extracted from an existing ERP application.

Work Activity Reporting also provides data which enables labour productivity to be calculated for each role and post and reported weekly and monthly. This data reports

the number of work activities completed (Quantity), the number of work activities which must be repeated which is a measure of quality (Quality), the average time taken for each work activity (Duration) and the average cost of each work activity (Cost). These measures of labour productivity can be implemented in both public and private social institutions.

Aligning Firm Level Measurements with National GNP, GVA and TFP measurement

The UK 'Productivity Budget' of 2015 recognised that that weak total factor productivity (TFP) growth was becoming a serious national challenge. More recent publications, including the paper by OBR (September 2024), have gone further and projected the consequences of weak TFP growth on national income and debt. Unfortunately for the Government, the social institutions directly responsible for converting inputs into outputs – Small and Medium private sector firms and public sector enterprises – do not measure TFP at the firm level and have no tools for increasing it. This creates a rather serious disconnect between the social institutions and the Government.

Positioning Innovation within a set of Complementary investments

The announcement of the new ISO Standard for Innovation (ISO 56001) was made by the British Standards Institute (BSI) in September 2024. One of the weaker parts of the standard are the measurements of innovation, which given that the UK Government spends some £9.3 billion a year through UKRI (who manage Innovate UK) is quite an important consideration (UKRI 2024). Innovation measurements are fully specified by OECD and BEIS (Innovation Surveys) but the data is collected every two years for a carefully weighted sample of firms and there is no linkage between this data, the actual implementation of these innovations, the resulting stock of complementary investments or their impact on firm level TFP.

3.5.2 Methodology

Looking back at the Socio-Technical studies which spanned from the 1950s to the 1980s, as well as to the Socio-Analytical projects of Jaques and his colleagues, two things become apparent. The first is that both sets of researchers believed that they were creating scientific knowledge and published these research findings. Second, they were engaged in solving real-world problems in social institutions. Jaques' longitudinal study at Glacier Metal lasted from 1948 to 1960 and reports of findings were published regularly. Socio-technical projects examined UK coalmines, Swedish car manufacturers, Norwegian hydro-electric plants and Digital Equipment Corporation (DEC) computer system configurations (including one of the world's first-generation AI applications). All have been carefully described and have indeed increased our stock of scientific knowledge.

Longitudinal Case Study or Action Research?

The original Donegal project started in 1997 and used the Social Analysis method and Levels of Work complexity framework originally developed by Jaques and Rowbottom

at Brunel. The use of social analysis in these earlier projects is documented in Appendix 2, but Rowbottom's definition of social analysis may be helpful here.

"Social Analysis is an activity devoted to (1) gaining scientific understanding of, and, thereby (2) facilitating enacted change in (3) social institutions, through (4) collaborative exploration by those actors immediately concerned in their working, and an independent analyst."
(Rowbottom, 1976, p. 21)

The author has not used Revan's Action Learning (2011) which was developed after both the Socio-Technical and the Brunel schools, but having reviewed it, it seems to have a lot in common with Deming's PDSA, particularly Revan's use of a scientific management framework (Revan page 13).

Moen (2009 op cit), who had worked with Deming on projects in the automotive industry between 1981 and 1993, was quite clear that PDSA followed the scientific method. The chart below shows the relationship between PDSA and the Scientific Method.

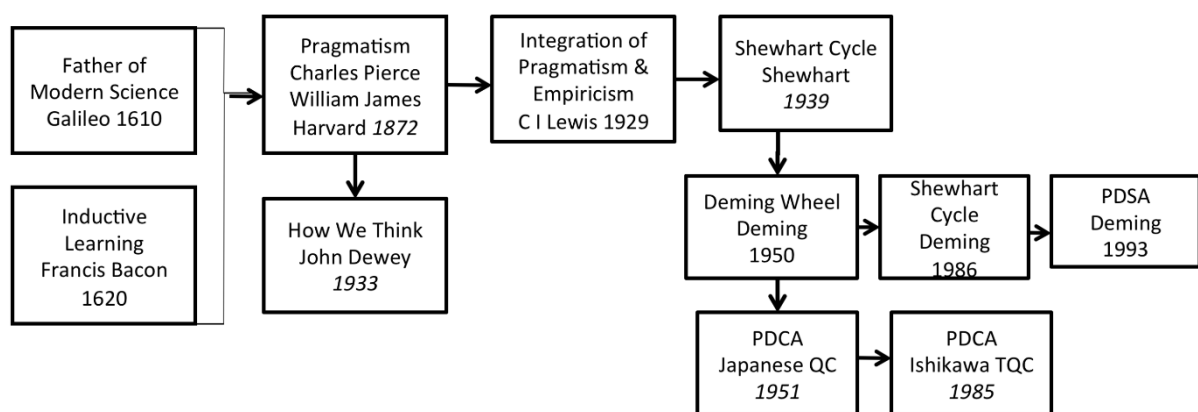


Chart 25: The evolution of Deming's PDSA (Moen & Norman, 2009)

An Inductive or Deductive Approach?

Since the widespread acceptance of Popper's hypothetico-deductive method as the gold standard for scientific method, it could be argued that the knowledge created by any other method is not scientifically valid. However, as was argued in the introduction to this chapter, in selecting the research question there were two distinct objectives: the first was to contribute to scientific knowledge and the second to solve the piecemeal social engineering problem for SMEs.

The earlier research described in Appendix 2 made two helpful contributions. The first was the development of a language which could be used to describe work activities and work processes within a social institution. The second was the development of work activity reporting for the most complex work process within that institution (the Purchasing Process).

During the Neatsmith case study, it became clear that the initial version of work activity reporting was insufficient. In the firm's showrooms, salespeople performed work activities for specific customer engagements, and they needed to be able to report on progress for each step of the sales engagement. This required the development of a customer database which could store the results of each work activity which contributed to the overall work object which was the proposal and quotation to the prospective customer.

This need to respond to the problems experienced by the case study COO and the production unit managers defined the approach as being instrumental. While the COO of Neatsmith has been very interested and committed to supporting the research, his priorities lie in increasing his firm's productivity, profitability and revenue growth. Those priorities defined the series of problems that the research could address. Provided the problem could be solved cost-effectively for the COO, the next problem could be worked on and dictated that the approach be an inductive one. The approach followed the sequence below:

Decide on the next Problem → Document it → Review Alternative Solutions → Decide Whether to Fund a Solution → Implement the Solution → Collect and Document Feedback → Measure Labour Productivity Impact → Measure Capital Productivity Feedback (ROI) → Measure TFP Impact

The case study was not a tabula rasa, it required piecemeal social engineering, where research progress arises in pursuit of solutions to the problems of a real-world social institution. So, the choice between an inductive and deductive approach was easy: It could only be inductive.

A Qualitative or Quantitative Approach?

A second question which arises for all Case Studies is whether they are Qualitative or Quantitative. The research question provides a quick answer to this question. If SMEs are going to solve the productivity puzzle, they will have to report their solution quantitatively. In fact, they will have to provide evidence of labour productivity and capital productivity over a minimum of a 24-month timeframe: at least one year of historical productivity growth and one year productivity growth during the Case Study.

This thesis will include three years of productivity growth data from the period preceding the commencement of the case study and three years of productivity growth data from the period during which the case study was conducted. It will also have a three-year post case study productivity growth forecast, providing nine years of data in total. The construction of this time series has required a significant amount of software development and testing because the firm level data must be sourced from existing ledgers (payroll, purchases, sales and balance sheet) so that the results can be independently audited.

An Instrumental or Intrinsic Approach?

These choices are about the purpose of the study which are also driven by the research question. As noted earlier the social engineering challenge is to solve the productivity puzzle within a single SME but for there to be new scientific knowledge, it is necessary to go beyond a single case study in a single firm and apply the new knowledge to a number of firms. In order to implement this new scientific knowledge in a larger number of firms it will have to be packaged into a software platform that can be implemented cost-effectively in any SME. So, from the outset the Case Study has been instrumental because the desired outcome goes beyond solving the productivity puzzle at a single firm to solving it at multiple firms.

Realism or Interpretivism?

Delanty and Strydom (2003 page 10) identify four epistemic shifts in the twentieth century which led to the demise of positivism. They call these "the logical turn; the linguistic turn; the historical-cultural turn and finally the knowledge cognitive or epistemological turn."

Bryman and Bell (2011 pp16 and 17) define realism and interpretivism in this way:

"[It is] a belief that the natural and social sciences can and should apply the same kinds of approach to the collection of data and to explanation, and a commitment to the view that there is an external reality to which scientists direct their attention.

Interpretivism demands that a strategy is required that respects the differences between people and the objects of the natural sciences and therefore requires the social scientist to grasp the subjective meaning of social action."

This distinction has very important practical implications for a Case Study and requires an empirical approach to understanding the problems with which the COO is faced by taking these problems at face value. In other words, that these particular problems are actually the ones that the COO says they are. There might of course be many other problems of which the COO is aware but has no desire to discuss with the author. The COO might not understand all the problems that he and his social institution face, or the COO might not explain or communicate these problems very well.

An interpretive approach would lead the author to be sceptical about the COO's problem statements, perhaps to examine them critically, and to decide that they were not real problems or were not well expressed. However, the author's approach has been to take each problem at face value, to document it, and to capture what actions or investments were needed to solve the problem. As noted earlier, because the case study is measuring labour productivity and total factor productivity on a monthly basis it will become possible to analyse the impact of these managerial decisions on the productivity growth numbers and therefore test the validity of the COO's assertion that these are indeed the right problems.

Reliability

Reliability is concerned with the question of whether the results of a study are consistent and repeatable (Bryman and Bell 2007). The introduction identified three dimensions each of which needs to be repeatable: these the organisation structure and levels of work, the work-activity maps for the COO, the production units and the support activities. These descriptions can be found in most firms, but they need to be made explicit so they can be repeated. The second dimension is the set of complementary investments which are required for all improvement projects. The set and the definitions of each component in the set are explicit and can therefore be repeated. The third dimension is the Total Factor Productivity Reporting, which is also explicit and is based on statutory accounting data (profit and loss and balance sheet) which all firms must provide. The fourth dimension which ensures repeatability is that the first three dimensions are implemented in a software architecture which itself can be fully specified using widely available 'Enterprise Architecture' tools.

Replication

This topic examines the extent to which the study is capable of being replicated. Before answering this question, it is important to distinguish between the case study during which the theoretical framework and bespoke software platform were further developed and the results quantified, and a new customer.

Unlike the case study a new customer will not be interested in the development of the theoretical framework or the bespoke software platform, they will be interested in how the software platform will help them to increase their TFP growth, how long it will take to do this, how large an increase in TFP be, how large an increase in EBIT will there be, how much will the whole project cost and what level of risk will they be asked to take.

So, in order to be repeatable, it must be possible to create a set of descriptions, specifications and reporting for the general class of social institutions called 'Medium Sized SMEs', which can be applied to any member of that class and wherever possible make use of their existing investments in application software, including ERP systems.

Components for description of a Large SME Social Institution

1. The **Organisation Structure** which defines the number of levels of management within the firm and their responsibilities
2. The **Work Activity Map** which describes the management work activities and the work of converting inputs to outputs for each production unit / department within the firm and lastly any supporting work activities which are not included in the production units.
3. **Work Activity Reporting** which provides dynamic reporting on the performance of all work activities within each production unit / department.

Future Research Projects for Specification, Reporting, Investment and Innovation of a Large SME

The Work Activity Map and Organisation Structure is the first future research project. This is required to put back what was lost with the demise of work study, which is a managerial view of all the work activities in the firm, which can be socially shareable with all the employees and managers within the firm.

Total Factor Productivity Reporting will be the second future research project. This will provide quantification and measurement of the firm's TFP performance which will include the unmeasured intangibles for Research and Development, investment in human capital knowledge, skills and training, investment in building brands and marketing these strategically and lastly investments in organisational capital, which are reported by Complementary Investment Management outlined below.

The **Complementary Investment** application and database is the third research project. This will record and report on the actual investments made in each work activity, the costs of these investments, the production unit to which they were applied and the go-live date in that unit. This is often referred to as 'the Cube' because the face of the cube shows the Work Activity Map and the Organisation Structure, the top of the Cube shows the categories of complementary investments and the side of the cube shows the monthly TFP Reporting and growth trends. A full description of the Cube can be found in Future Research (Chapter 8.2, pages 169 to 171).

The final future research project will review those large SMEs who have the need to implement specific **Innovation Projects** at Level 4 to develop new products, markets, processes and organisations. These projects will require the appointment of a Level V CEO to manage both the existing production units (themselves grouped into Directorates and the stream of innovations, which, once completed, will update or replace the firm's existing production units.

3.5.3 Validity

Measurement Validity: do the measures really reflect the concepts?

The main reason for choosing to use Total Factor Productivity measurements is that these are the ones which are used to report all national economies. By implementing TFP measurement at the firm and production unit level within the firm we enable firm data to be aggregated to national data which is not currently possible. Given that firms are the social institutions which are responsible for TFP growth it makes good sense to align their measurements with national measurements.

Internal Validity: does a conclusion that incorporates a causal relationship between two variables hold water?

The case study does show that a number of complementary investments in three production units does increase labour productivity and TFP growth. What the study

does not show is which recipes (i.e. mix of investments) are more effective than others. Ideally, we would be able to measure the causal relationships between all eight complementary investment variables and labour and TFP productivity for each production unit. This is covered in Chapter 8. Future Research.

External Validity: To what extent can the results of the study be generalised beyond the specific research context

There is a high probability that the results of the case study can be generalised. The primary reason for this is that the method is actually fully specified and implemented in software and includes fully defined databases schemas for each of the three dimensions (Work Activity Map, Complementary Investments and TFP Reporting). Once the Future Research is completed, it will be helpful to test this hypothesis by using off the shelf Enterprise Architecture tools to specify all three dimensions.

4 A New Theoretical Framework

The evidence from the literature review would suggest that the UK's productivity performance was much weaker than the USA from 1900 to 1945 and then fell behind our European competitors between 1945 and 1979. There was a brief period between 1980 and 2007 when the UK caught up with the productivity growth rates of the G7 but since the 2008 financial crisis UK productivity growth has not recovered and the UK is once again lagging behind. Four conclusions can be drawn this analysis. The first, is that outside a small number of frontier firms, the majority of UK firms are actually bad at productivity growth. The second, is that the input-equals-output convention, adopted by National Statistical Offices, actually makes matters worse, because 20% of the UK Economy is dedicated to providing public services which means the remaining 80% of the economy in the private sector has to increase productivity just to stand still. The third finding is that the USA, by implementing the world's most advanced suite of management practices, including Scientific Management, Training Within Industry (TWI), factory level production measurement and best practices reporting by the Bureau of Labour Services, raised their productivity growth to an even higher level than pre-war. The fourth and final finding is that the US also developed input / output table to provide productivity reporting at national level thereby creating the world's first National Productivity feedback loop.

As was discussed earlier, the abrupt end of TWI at the end of the war and gradual disappearance of work study in the 1960s removed two core management practices. In the 1980s the Bureau of Labor Services discontinued factory visits and Zuboff reported that the implementation of IT applications in the 1980s resulted in the disappearance of most of the artefacts of the analogue office environment, including filing cabinets, photo copiers, in trays, bundles of documents which would have been familiar for most of the twentieth century world of work by the digital one.

Lastly, the new management practices developed after WW2 which include socio-technical systems, the task-based approach, levels of work, fair work and continuous improvements all have to be supported

4.1.1 Introducing the Theoretical Framework

Paradoxically, it was long after work study and TWI had disappeared that Bloom and van Reenen re-introduced the "Management Practices" name, not as a set of practices, but as a set of structured questions which could be used to create a management practices score. Numerous surveys by Bloom and van Reenen, the US Census Bureau, ONS and ESCoE have been conducted, but the outputs of these surveys are not management practices themselves, but their measurement, and the correlation of these measurements with the firm level productivity. In other words, there is a danger of confusing the measurement of management practices with the management practices themselves.

Table 26 below lists the components of the Theoretical Framework, each of which will be described in this chapter.

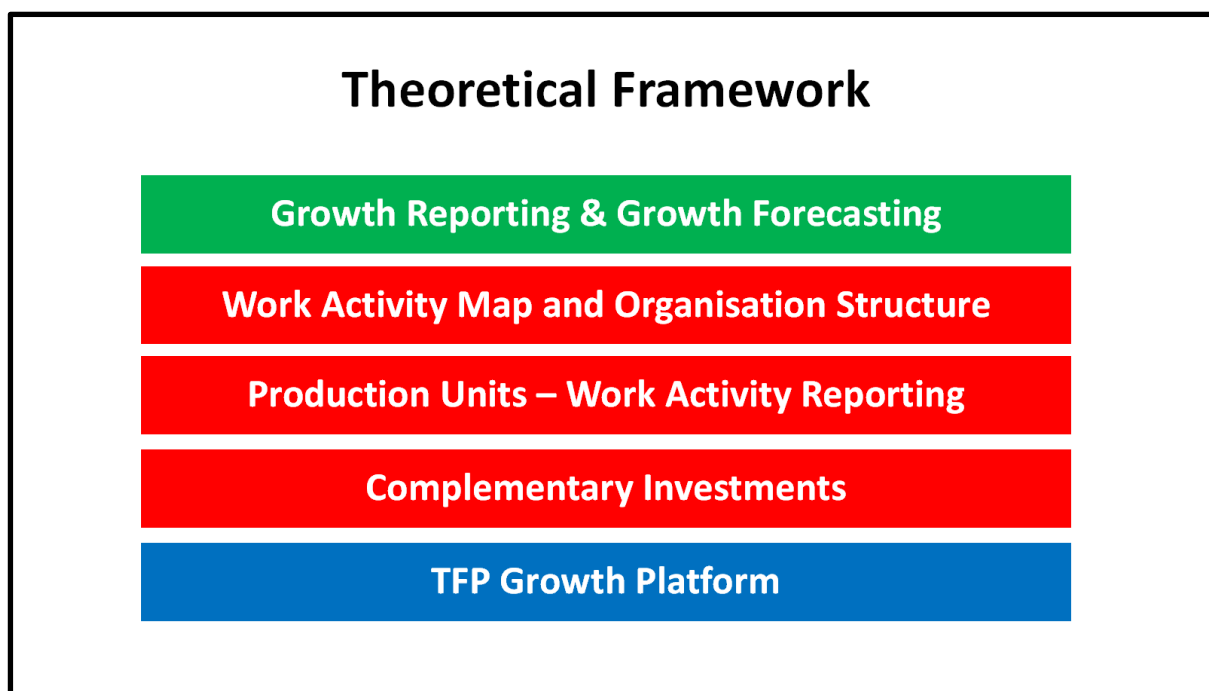


Table 26: Theoretical Framework

The Theoretical Framework can be viewed as a set of Digital Management Practices which aligns them with a rich academic and management literature. The five components of the framework are the TFP Growth Reporting and Forecasting – which is shown in green because it is a property of the social institution as explained in the Methodology chapter. The Social Institution shown in red has three parts: the digital Work Activity Map and Organisation Structure which define the work of the firm; the Production Units which describe how inputs are converted into outputs and how they are reported on. The third part of the social institution are the Complementary Investments which management will use to increase GVA, EBIT and TFP growth. The final part of the framework is the software which supports the implementation and operation of the framework and the digital management practices themselves.

4.1.2 Social Institutions are responsible for TFP Growth

Chart 27 below shows the different levels of work complexity found in social institutions, first implemented in the late 19th century. The grey part of the chart shows the Small and Medium Enterprises which are the focus of the thesis.

Levels of Work Complexity, Innovation and Measurement in Social Institutions					
Timespan *	Complexity	Organisation Level	Levels of Innovation & Units of Analysis	Measurement Methods for National Statistics	US Military Ranks
50 Years	VIII	Space X, Tesla Auto, Tesla Energy, Tesla A.I.	New General Theories New Macro-Economic Paradigms		Five Star General War-time only
30 Years	VII	Global Multinational	Disruptive Innovations GPTs and Industry Substitution Curves	International Surveys OECD and United Nations	Four Star General Army, Navy, Airforce
20 Years					
17 Years	VI	Multi-Divisional Corporation CEO	Disruptive Innovations Global Supply Chains TFP Feedback Loops	National GDP & TFP Reporting Inputs / Output Tables Investments & Consumption TFP Feedback Loops	Three Star General Corps, Fleet, Air Force
13 Years					
10 Years					
8 Years	V	CEO Large Firm / Divisional Subsidiary	TFP Growth Structural Innovations	TFP Reporting Innovation Activities Reporting	Two Star General Division
6.5 Years		Public Service Enterprise	Productivity Growth Location Expansion	Complementary Investment Rept. Growth Balance Sheets Employment Contracts	
5 Years					
4 Years	IV	TFP Innovation System Manager	TFP Growth System	TFP Reporting Complementary Investment Rept. Growth Balance Sheets Employment Contracts	One Star General Brigade
3 Years					
2 Years					
20 Months	III	General Manager & Chief Specialists	Production Units e.g. Marketing, Sales Manufacturing; Continuous Improvement	TFP and KPI Reporting Labour Productivity Reporting Capital Productivity Reporting Employment Contracts	Battalion Commander
16 Months					
1 Year					
9 Months	II	Departmental Manager & Junior Specialists	Work Activity Groups First Level Managers Continuous Improvement	KPI Reporting Work Activity Reporting Labour Productivity Reporting Employment Contracts	Captain
6 Months					
1 Month	I	Shop and Office Floor	Work Activities Continuous Improvement	KPI Reporting Work Activity Reporting Labour Productivity Reporting Employment Contracts	Private Solder
1 Week					
1 Day					

Chart 27: The levels of work, units of analysis and data collection methods.

4.2 TFP Growth Reporting and Growth Forecasting

The first of the digital management practices is TFP reporting and growth forecasting. These are the *measurement properties* discussed in the Methodology Chapter. The requirements for this were developed during the case study and will be further developed in Future Research (Chapter 8). It has long been known that the data to measure firm level productivity is already available from the firm's administrative systems, specifically, purchase ledger, sales ledger, and payroll systems. However, for

this data to be useful in reporting on the firm's econometric inputs and outputs, the data must be consolidated and transformed. The software platform will include a utility that can import data from the firm's administrative systems, and an allocation utility enables managers to identify the relevant data to be stored in the growth database. Once updated administrative data has been loaded into the growth database, the platform can be used to produce three TFP Reports:

- 1 TFP History
- 2 TFP Productivity Journey (the Case Study)
- 3 TFP Forecast (the next phase of the Productivity Journey)

The key measurements of the TFP Report and Forecast are documented below.

Sales – this is the firm's sales as reported by its sales ledger

Revenue – this is the firm's revenue as reported in its annual accounts and quarterly VAT returns

Purchases – all expenditure on purchases is captured and classified into Energy, Materials and Services

GVA - this is calculated by removing all purchases of energy, materials and services from the firm's revenue. All national productivity statistics rely on GVA at the firm level and usually provide both nominal and inflation adjusted data.

GVA per Head – this is a simple calculation which divides GVA by total headcount and provides a simple measure of labour productivity for the firm. This is a useful metric because national productivity statistics provide it for each industry sector, so it enables a firm to compare itself with others in the same sector.

EBITDA (Revenue Driven) – this thesis will argue that there are two different types of EBITDA. The first one, which is most widely used, assumes that revenue is driven by sales and marketing investments but that the conversion ratio of inputs to outputs is one.

EBITDA (Productivity Driven) – as soon as managers implement first growth scenarios and start to play around with productivity as a variable, they quickly understand that impact of increasing labour productivity stands out very clearly when they increase headcount at a lower rate than revenue. Since TFP can be improved for all production units (not just manufacturing) this Productivity Driven EBITDA can be quite considerable.

Fair Growth

Historically in the UK one of the biggest barriers to increasing labour productivity is the lack of reward for employees. If the firm is growing productivity, it can share some of this growth with employees, customers and investors. For many US firms this is done through share options and discounted share purchases, because US firms are measured on earnings per share and therefore wish to grow their share prices by increasing profit

per share. In the UK this is less common, because the stock market is much smaller, firm valuations are much lower and TFP growth is much lower.

The monetary value of the distribution of some or all productivity driven EBITDA growth to **Employees, Customers** and **Shareholders** should be captured in TFP Growth Reports.

Capital Services Charges

The Growth Balance sheet records the firm's investments in **Tangible Assets, Measured Intangible Assets** and **Unmeasured Intangible Assets**. The monthly depreciation of these capital services charges is recorded in the TFP report. Innovation can also be measured using the OECD Innovation classification (Oslo Manual 2005)

EBIT Earnings before Interest and Taxation

The firm's EBIT is calculated by removing Capital Service charges from EBITDA to reflect the cost of capital invested.

Revenue EBIT

In order to calculate the proportion of EBIT which derives from revenue growth and matching purchases, labour services and capital services inputs, the base year EBIT is increased by the annual rate of revenue growth to calculate Revenue EBIT which assumes that inputs and outputs have scaled linearly.

TFP EBIT

Total Factor Productivity EBIT is caused by increases which are non-linear where Outputs grow more rapidly than Inputs. This non-linearity is driven by increasing the inputs of purchases, labour and capital at a lesser rate than the increases in revenue. As at national level, firm level TFP is also a residual. Unlike national level, individual firms can take managerial action to increase TFP EBIT by setting productivity growth goals for each production unit and by investing in complementary investments.

Enterprise Value

Every firm has a value, whether it is quoted on the stock market or not. For smaller SMEs there is an active Venture Capital marketplace in the UK which brings investors together with SMEs at different stages of growth. These investors have good estimates of enterprise value for SMEs and will share them to ensure that the firms' managers are properly aligned with their investors. As a general rule, firms which increase both revenue and productivity EBIT have higher valuations than firms which only increase revenues. This can be expressed in a simple formula: "Revenue EBIT + TFP EBIT x Industry Multiplier = Firm Valuation". Each industry sector will have its own multiplier which is used by investors to provide their valuation. For Neatsmith the multiplier is six time EBIT but this can be increased to seven if the firm can be completely specified.

4.3 The Work Activity Map and Organisation Structure

The second part of the new theoretical framework is the Organisation Structure and Work Activity Maps. These describe the social institution and its entities. Most firms will have an organisation chart which set out the different levels of management and

describes who reports to who. What the organisation chart does not specify are the work activities for each level of managerial and front-line work. The literature review has described the history of the work activity map since the first “division of labour” chart in 1776 to Babbage’s update in 1832, Taylors shop floor management in 1905 and the Gilbreth’s process charts of 1921. Since the advent of digitisation these work activity maps have also been known as BPMN diagrams, but they all have one thing in common: they all describe the work activities to be performed at each level of the organisation.

Growth Strategy, Complimentary Investments & Total Factor Productivity (TFP) Reporting - Level IV														
CEO / COO	Import Historic Data	Create Historic TFP Reports	Create Monthly TFP Reports	Hold Strategy Workshop	Understand Drivers & Problems	Document new Drivers & Problems	Create Growth Forecasts and Scenarios	Save Growth Scenarios	Decide on Complimentary Investments	Update Growth Strategy with CIs	Assist in Capital Raise	Allocate CIs to Intangible Assets	Allocate CIs to Tangible Assets	Allocate CIs to Umeasured Intangible Assets
	Allocate CIs to Innovation	Create Growth Balance Sheet	Update Growth Balance Sheet	Create Stakeholder Reporting										
Productivity Growth Management - Level IV														
CEO/COO	Create Firm Work Activity Map	Set Up Work Activity Database	Allocate Work Activity to Levels of Work	Import Work Activity Maps	Implement Work Activity Reporting	Prioritise Work Activities	Write Work Activity Descriptions	Coach Front Line Employees	Clarify Work Objects	Decide on Work Object Databases	Implement Work Object Databases	Implement Fair Work	Implement Fair Growth	Implement Management Practices
	Implement Continuous Improvements	Document Continuous Improvements	Measure Work Activity Improvements	Update Growth Balance Sheet	Update Human Capital	Provide Implementation on Reporting								
Marketing / Management Production Unit - Level III														
Marketing	Strategy Creation	Media Plan	PR Planning	Photo Shoot	Advert Creation	Poster Creation	Brand Bible	Brochure Creation	Business Card	Client Imagery	Client Photo	Update Costs	Social Measurement	Social Ad Measurement
	Google Ad Measurement	Website Updates	Monthly Reports	Weekly Reports										
Sales / Management Production Unit - Level III														
Showrooms Level II Managers Sales	Chelsea	Hampstead	Hampton Hill	Brentwood	Hampton Hill	Guildford	Tunbridge Wells			Channels Greycaine				
	Enquiry Month	1st Contact	Appt Booked	Showroom Meeting	Quote Sent	24h Chase	Follow Up + Revisions	Deposit Taken	Book Survey	Files to Head Office				
Manufacturing Operations / Management Production Unit - Level III														
Planning Level II Manager	Sale Date	# Days to fit	Calendar Entry	Site Visit Date	Site Dims Received	Visuals / Quote	Lead Time Given	Order Qual Check	Drawings Done	Cut Sheet Check	Doors Ordered	Doors Del Date	Doors Received	Glass Ordered
	Glass Del Date	Glass Received	Internals Ordered	Internals Received	Rodman Ordered	Add prod ordered	Add prod received	Snag List Fitter						
Shop Floor Level II Manager	Receiving Deliveries	Cleghorn	Hoffman	Antik-Fid-Vel	Hafele	Others	Glass	Aluminium	Handles	Hafele	Daro	Small Suppliers	Mawby	Golden Glass
	Planica	Stocktake	Wood	Drawers + Divs	Beam Saw	Table Saw	Rafix etc	Red List	Shoe Drawers	Angled Shoe Shelf	Pull Out Shelf	Cloister Doors	Series 1 + Aria	Reflex Doors
	Load Vans	Unload Vans	Maintenance	Cleaning Schedule	Blade Sharpen	Frameless Glass	Angled Corners	Drawer Boxes	Mirrors and F Shelves					
Installation Level II Manager	Prepare Area	Measure Space	Check Material	Prep Carcasses	Scribe EP + Externals	Fit Internals	Clean Internals	Scribe + Fit Header	Hang Doors	Clean Wardrobes	Photos	Sign Off Sheets	Remove Tools from Site	Remove Waste from Site
Support Services Level II Manager	Accounts	Estates	Fleet	H & S	HR	Maintenance	Sustainability							

Chart 28: Neatsmith Work Activity Map

This chart shows the Work Activity Map for the Case Study. The requirements for the fully digitised version of the map can be found in the Future Research Chapter.

The first two sets of work activities belong to the COO who is responsible for setting the TFP growth objectives and growth strategy for the firm (top box) and then managing the complementary investments (second box) into the firm’s three production units (third, fourth and fifth boxes). This role requires Level IV capability because the occupier needs to be able to think through alternative ways of improving each of the production units to drive TFP growth. The firm’s organisational structure sets out the managerial relationships between the level IV roles and the level III roles and then between the level III roles and the level II roles and lastly the relationships between the level II roles and the front-line level I roles.

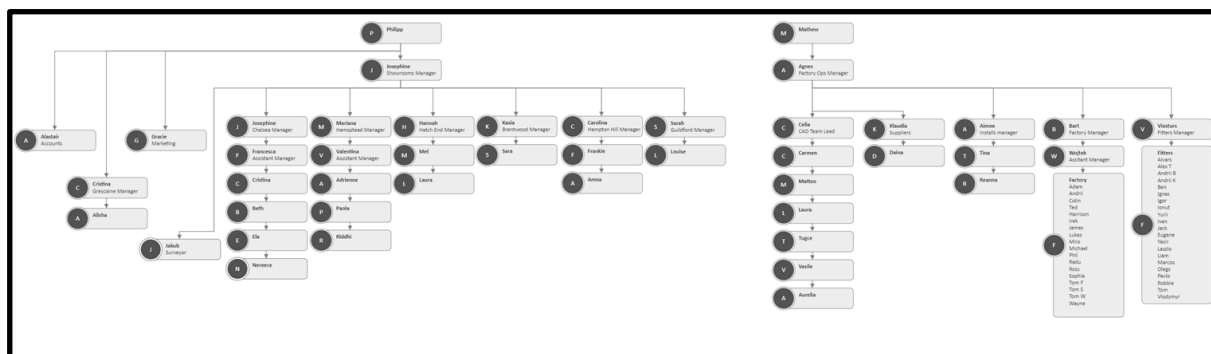


Chart 29: Neatsmith Organisation Chart

The Neatsmith organisation chart is shown above, and this will be aligned with the digital Work Activity Map.

4.4 Work Activity Reporting: The Production Unit

The third component of the new theoretical framework are the newly identified 'Production Units' which describe how firms convert inputs into outputs. Given that productivity growth in the USA and other G7 economies has been declining steadily since 1948 (Hulten, 2009) and given the importance of productivity growth within all economies, one might have expected that economists would have addressed this problem extensively, but this does not appear to be the case. Productivity is the study of the efficiency of how inputs are converted into outputs, and as has been seen earlier, the conversion part can be described as an 'equation, table or graph' as shown in the chart below. Abbott (2013)

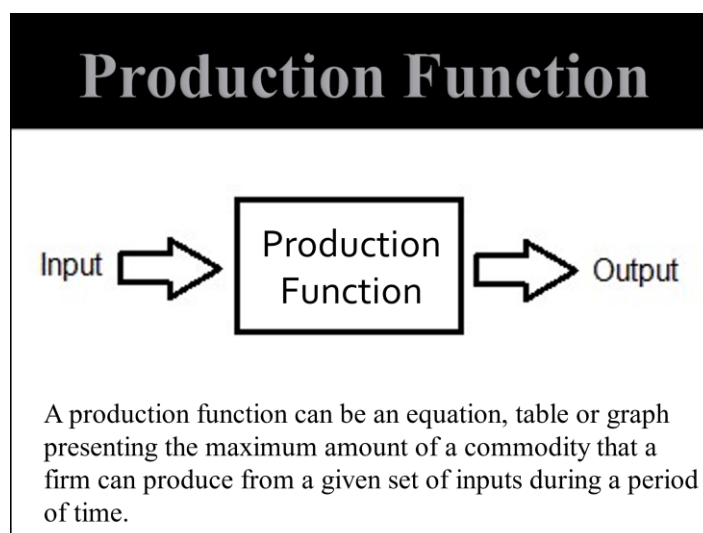


Chart 30: Mathematical Production Function (Abbott & Sur, 2013 p4)

<https://www.slideshare.net/slideshow/production-function-15871760/15871760#4>)

Sickles and Zelensky (2019) provide a full book of equations, tables and graphs for mathematical production functions, but our interest is not in the formulae but in how managers and their employees convert inputs into outputs, how they measure the efficiency of this conversion and how they improve the efficiency of the production unit whether to produce more output with the same inputs, or the same outputs with fewer inputs.

Economists who focus on this topic include David Autor and his colleagues in the USA who have focused on the 'task-based approach' and the substitution of computer capital for labour. In the UK, research has focused on extending 'Management Practices' surveys beyond manufacturing to include the services economy to provide management practices scores for different samples within multiple industry sectors. These scores are then correlated with sector productivity measurements collected by ONS. Neither of these approaches provide direct assistance to those managers who need to know HOW inputs are converted to outputs, HOW to measure productivity and HOW to grow productivity. The charts below summarise this challenge.

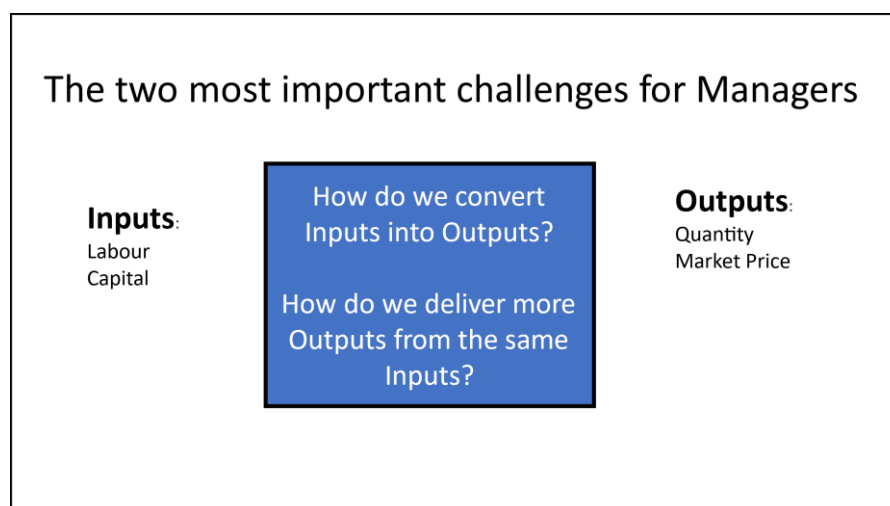


Chart 31: The Most Important Challenges for Managers

What is needed therefore is a Management Production Function which replaces the equations with the descriptions of the work and its working arrangements, which specify how these inputs are converted into outputs for each production unit.

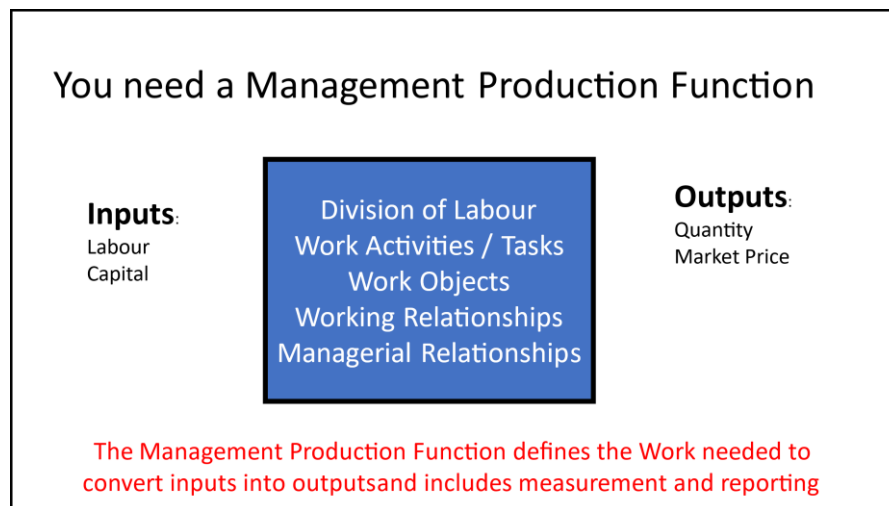


Chart 32: The Management Production Function defines and measures the Work

This new Management Production Function includes some familiar concepts: The 'Division of Labour' comes from the very beginning of economics and the implementation of the Factory System. Tasks were actually defined by Levy and Murnane (2004) in their book the 'New Division of Labour'. Both were colleagues of David Autor and his 'Task Based' approach (Autor, 2003). Work Activities come from the authors' own research, as do Working Relationships, but have also been documented by Work Study engineers since 1921 as 'Gilbreth Process Charts' which have been updated for the digital age in the form of BPMN charts White and Mears (2008). Organisation structure and hierarchical managerial relationships have an even longer history dating back to the Pennsylvania Railroad in the 1880s (see Appendix 1).

Given the ability to measure the inputs and the outputs and the ability to implement the Production Function as a Level III organisational construct, henceforth called the '*Production Unit*', quick progress can be made to better understand what firms need to do to increase productivity. First, managers have to be convinced that this is an important priority, and second, they must know how to do it, which presents a number of hurdles to be overcome:

- 1 Firms do not know why *they* need to measure productivity – it is something that economists and governments talk about.
- 2 Firms do not know *how* to measure productivity – it is not required by statutory accounting standards.
- 3 Firms do not know how to *improve* productivity – the specialised knowledge and supporting software not yet widely available.
- 4 Firms do not understand *the benefits and impact on profits* of increased productivity.
- 5 Many of the terms used by economists, such as production functions, complementarities, dispersion, diffusion, unmeasured intangible assets, innovation, and human capital are economic constructs, *which are unfamiliar to most SME managers*.

- 6 There is, as yet, no Government TFP Growth Plan which explicitly states that productivity growth is a social good and sets out a 10-year investment programme to deliver this social good across all sectors of the economy.

However, despite all these hurdles, firms can decide that they do want to increase their TFP growth and grow the firm's profitability at a faster rate than its revenues. One of the most important decisions that any firm must make is its choice of product/market strategy. In practical terms this means that the management team has to decide what products or services to provide, to which group (s) of potential customers, and at what prices. To do this, they must develop a good sense of 'the market'. Once the product/market strategy is agreed, the management team must then design the organisation to deliver this strategy.

Every organisation design is constrained by the cost and availability of labour with the necessary knowledge and skills to do the work, so firms have to decide quite early which competencies they will bring in-house and which they will buy-in or outsource. If the firm plans to grow, it requires a growth strategy. Management can benefit from the creation of a three- to five-year growth forecast by testing out a number of scenarios using different values for key parameters such as revenue growth, productivity growth, purchases, and wages before deciding upon and implementing a Growth Plan.

4.5 Complementary Investments for TFP Growth

The fourth component in the theoretical framework is Complementary Investments which are required to deliver TFP growth.

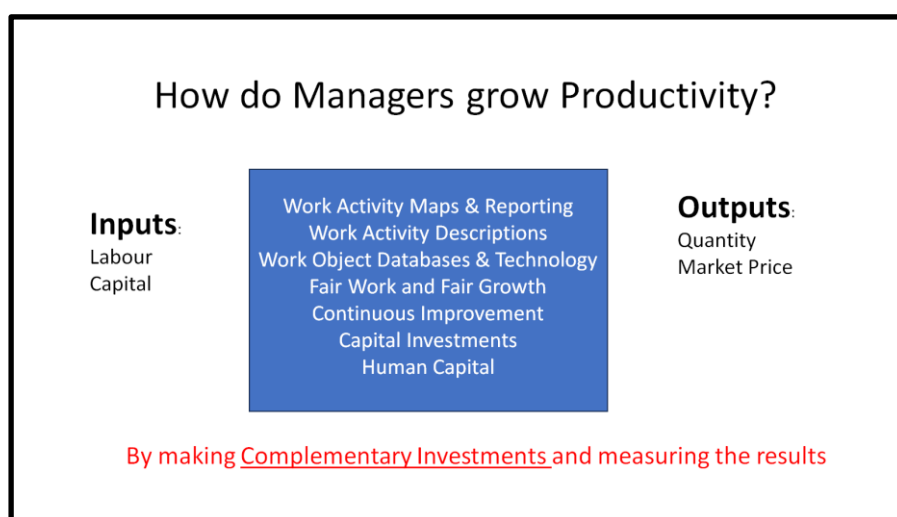


Chart 33: Complementary Investments Grow Productivity

The chart below sets out the eight types of complementary investments which have been documented in the Case Study (Chapter 5).

1. Work Activity Map Managerial Work: Growth Strategy, Reporting & Forecasting Managerial Work: New Management Practices for Productivity Journey Production Units: Marketing Production Units: Sales Production Units: Manufacturing Production Units: Geographic Expansion Production Units: New Products & Channels	4. Work Object Databases & Technology Work-Object Type - Material Work-Object Type - Human Work-Object Type - Digital User Interface Work to Convert Inputs to Outputs Outputs Databases Commercial Applications ERP Bespoke Software LLM Real World A.I. Machinery Humanoid Robots	6. Continuous Improvement Increase Value to Customer Continuous Improvement Elimination Customerisation Outsource Insource Upskill / Deskill Increase Quality Augmentation / Digitisation Automation Optimisation using LLM and Real World AI
2. Update, Reporting & Measurement Real Time Work Activity Update and Reporting Daily To Do List Performance Targets Update Frequency: Daily, weekly, monthly, quarterly, annually, multi year Reporting Unit: Work-activity, Role, Post, Department / Location, MPF Reporting Parameters: Work Activity Quantity Work Activity Quality Work Activity Cost Work Object Unit Cost Work Activity Duration Work Activity Labour Hours Department Labour Productivity Trend Department KPIs Management Production Function KPIs Management Production Function Labour Productivity Trend	5. Fair Growth, Fair Work & Management Practices Team Cohesion (FW) Job Requirements Fit (FW) Channel for Suggestions (FW) Target Review (MP) Problem Response (MP) Staff Turnover (MP) Staff Promotion and Training (MP) Fair Growth Distribution - Employees Fair Growth Distribution - Customers Fair Growth Distribution - Shareholders Management Practices Scores (ONS)	7. Capital Investments Human Capability Investment Tangible Capital Intangible Capital (Measured) Intangible Capital (Unmeasured) Innovation Investments Location Expansion
3. Work Activity Descriptions Employee Description of Work Activities Location User Interface to Work Activity DB Job Description Procedure Manual Allocation to Roles & Posts Working Relationships Managerial Relationships (Organisation Chart)		8. Human Capital Person Specification Level of Capability Mode Skills Experience Education & Qualifications Knowledge (Industry / Profession) Emotional Intelligence Physical Abilities Ethics and Trust Well Being

Chart 34: Complementary Investments for TFP Growth

Chart 34 above documents the eight types of complementary investment which can be used to increase the productivity of production units. The requirements for the digitised version of this can be found in Future Research in Chapter 8. The eight complementary investments are described in detail below.

4.5.1 Complementary Investment 1: Work Activity Maps & Organisation Structure

As discussed earlier the Work Activity Map and the Organisation Structure are the two views which define the work of the social institution. This specification is required by all social institutions irrespective of size or whether they are public or private institutions.

4.5.2 Complementary Investment 2: Work Activity Update, Reporting & Measurement

Once the work activity map has been defined there is a need to provide reporting and measurement of the current performance of each production unit to understand how effectively the inputs of labour and capital are converted into outputs before making any changes. This follows the best practice developed by Deming and Japanese manufacturers in the 1950s as documented in the Literature Review. A good example is provided by the purchasing application which is used by many larger SMEs and almost all large firms. The work activities are shown on the horizontal axis and the unique work-objects (in this instance, the names of the suppliers for each purchase) called *cases* are shown on the vertical axis. Each work object case is identified uniquely and is usually given reference number and a name. As each work activity is completed, the purchasing database is updated with the required information and the case proceeds to

the next step. There may of course be more than one type of purchase which can be identified each of these may require a different sequence of work activities.

Whilst the work activity map and organisation structure are static, in that they only change following a conscious decision by the Level IV manager, the work activity update, reporting and measurement is dynamic, and changes minute by minute. By implementing a simple Red, Amber, Green reporting notation, production unit managers can see the real-time status of the whole production unit and intervene in cases which are shown as either red or amber.

Case ID	Case Name	Step 1 : Raise PO	Step 2 : Approve PO	Step 3 : GRN	Step 4 : Register Supplier Invoice	Step 5 : Pay supplier invoice
240407853	TOBINS SERVICE ...	2011-04-01 70009578	2011-05-01 70009578	2011-05-01 70009578	2011-05-01 70009578	2011-06-01 70009578
240407854	OWEN FERRY	2011-04-01 70009604	2011-05-01 70009604	2011-05-01 70009604	2011-05-01 70009604	1970-01-01 70009604
240407855	GILMORES KINGS...	2011-04-01 70009570	2011-12-05 70009570	2011-12-05 70009570	2011-12-05 70009570	2011-08-06 70009570
240407856	JOHN CUNNINGHAM	2011-04-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-07-01 70009592
240407857	BALLYGOWAN	2011-04-01 70009572	2011-07-01 70009572	2011-05-01 70009572	2011-07-01 70009572	2011-11-01 70009572
240407858	MICHAEL LYNCH	2011-04-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-07-01 70009592
240407859	MARGARET CONA...	2011-04-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-07-01 70009592
240407860	ROSE O DONNELL	2011-04-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-05-01 70009592	2011-07-01 70009592
240407861	EIRCOM	2011-04-01 70009604	2011-05-01 70009604	2011-05-01 70009604	2011-05-01 70009604	2011-07-01 70009604
240407862	EIRCOM	2011-04-01 70009571	2011-06-01 70009571	2011-04-01 70009571	2011-06-01 70009571	2011-07-01 70009571
240407863	EIRCOM	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571
240407864	EIRCOM	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571
240407865	NORTHWEST ANIM...	2011-04-01 70009641	1970-01-01 70009641			
240407866	EIRCOM	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571
240407867	D&M ENVIRONME...	2011-04-01 70009590	1970-01-01 70009590	1970-01-01 70009590	1970-01-01 70009590	1970-01-01 70009590
240407868	EIRCOM	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571
240407869	EIRCOM	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571
240407870	LENNOX SUPPLIES	2011-04-01 70009576	1970-01-01 70009576	1970-01-01 70009576	1970-01-01 70009576	2011-01-02 70009576
240407871	EIRCOM	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571
240407872	PAUL O DONNELL	2011-04-01 70009604	2011-05-01 70009604	2011-05-01 70009604	2011-05-01 70009604	1970-01-01 70009604
240407873	DIVERS HARDWARE	2011-04-01 70009626	1970-01-01 70009626			
240407874	JOHN BROWNE	2011-04-01 70009612	2011-05-01 70009612	2011-05-01 70009612	2011-05-01 70009612	2011-07-01 70009612
240407875	EIRCOM	2011-04-01 70009595	2011-04-01 70009595	2011-04-01 70009595	2011-04-01 70009595	2011-07-01 70009595
240407876	CHEMFLOC INTER...	2011-04-01 70009577	1970-01-01 70009577	1970-01-01 70009577	1970-01-01 70009577	1970-01-01 70009577
240407877	DONEGAL STATIO...	2011-04-01 70009645	1970-01-01 70009645	1970-01-01 70009645	1970-01-01 70009645	2011-01-02 70009645
240407878	A & C COMPONENT...	2011-04-01 70009570	1970-01-01 70009570	1970-01-01 70009570	1970-01-01 70009570	1970-01-01 70009570
240407879	TH METALS	2011-04-01 70009606	1970-01-01 70009606	1970-01-01 70009606	1970-01-01 70009606	1970-01-01 70009606
240407880	JOHN CALLAGHAN	2011-04-01 70009626	1970-01-01 70009626			
240407881	WATSON HIRE	2011-04-01 70009626	1970-01-01 70009626			
240407882	BHT GROUP LTD	2011-04-01 70009578	2011-08-02 70009578	2011-07-02 70009578	2011-08-02 70009578	2011-09-02 70009578
240407883	LATCH LTD	2011-04-01 70009660	2011-05-01 70009660	2011-05-01 70009660	2011-05-01 70009660	2011-02-02 70009660
240407884	MTM IRELAND	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571
240407885	MACS NEWSAGEN...	2011-04-01 70009572	1970-01-01 70009572	2011-12-01 70009572	1970-01-01 70009572	1970-01-01 70009572
240407886	HEGARTYS AUTO ...	2011-04-01 70009570	1970-01-01 70009570	1970-01-01 70009570	1970-01-01 70009570	1970-01-01 70009570
240407887	DR JOHN DOWLING	2011-04-01 70009571	2011-07-01 70009571	2011-04-01 70009571	2011-07-01 70009571	2011-11-01 70009571

Chart 35: An illustration of a purchasing production unit with the process steps on the horizontal axis and the individual work object cases (purchases) on the vertical axis.

4.5.3 Complementary Investment 3: Work Activity Descriptions

Creating work activity descriptions is one of the most important responsibilities for managers at all levels. This investment has a red bar to show that the necessary information is likely to be already available, from three possible sources. The first comes from the work activity map (if the firm has implemented these). The second comes from job descriptions and person specifications created by HR, or in smaller firms the senior managers themselves. The third is an informational discussion an employee in which the manager asks the employee to describe his or her work in as much detail as is thought necessary.

Work activities are often tacit and, as a result, not well described. By asking the employee to describe his or her work, the manager gets a description of the work —

and, more importantly, the employee feels acknowledged or listened to which was one of the most important learnings from the Hawthorne experiments. (Adair 1984). In addition, there are other reasons for describing work activities, the most common being the need to have a clear description of the work for recruitment and selection of new employees and apprentices. Close behind is the need to have descriptions which can be used for the management practices which deal with continuous improvement, innovation, and human capital management. While some roles require the performance of only one work activity, others will require the performance of multiple work activities, and these must be matched to the roles.

4.5.4 Complementary Investment 4: Work Objects & Databases

An important part of the description of each work activity is the *output* of that activity, which can be captured in a suitable Work Object Database. There are three types of work object: Material; Digital and Human. In the Purchasing example the work object is of the digital type, and all the work activities deal with the same type of purchase.

In those situations where is a variety of purchase orders to be processed additional or replacement work activities may also be required. This creates heterogeneity of work object types. A second type of heterogeneity may arise where there are a variety of materials and specialised equipment needed to be dealt with by successive work activities, as is often the case in manufacturing or construction which deal with Material work objects. The output of each activity provides a good guide to the level of complexity of the work.

‘Material’ work objects are well understood in manufacturing production functions because individual work activities often require specific parts or components as inputs, together with machines of different types to produce the outputs. The ‘Bill of Materials’ traditionally contains descriptions of all the components and parts needed, and these components are mapped to the individual work activities. However, there is no reason why the same Bill of Materials concept cannot be used for ‘digital’ work objects, which now represent a large and growing percentage of economic outputs.

4.5.5 Complementary Investments 5: Fair Growth, Fair Work & Management Practices

Fair Growth

The US Productivity Program implemented as part of the Marshall Plan in post-war Europe and Japan was intended to help US allies deliver strong economic growth to pay for the reconstruction of their cities and infrastructure and to provide jobs for their workers. It was based on New Deal principles which were tested during WW2 and found to be successful. The Marshall Plan was astonishingly successful, but concerns arose that the distribution of the benefits from productivity growth were not being shared between employees, customers and shareholders. As Silberman (1992) wrote:

“In the first phase of the Marshall Plan, it was tacitly agreed that the benefits of productivity increases would be shared among owners (in the form of higher profits), workers (in the form of higher wages) and the consuming public (in terms of lower prices). When the program was continued and expanded in 1953, the U.S. Congress required that a formal agreement be signed between the recipient government and the Marshall Plan and eventually between the government and the participating enterprise. This was intended to prevent a repetition of early patterns of industrialization in Western Europe, which had achieved their ends by mechanizing production, limiting output, maintaining prices and firing surplus workers, a process the unions were determined not to repeat.” (Silberman, 1992, p. 8)

An alternative approach was put forward by Milton Friedman (1970) in his influential article, ‘The Social Responsibility of Business is to Increase its Profits’ in the New York Times. This article was an attempt to influence Wall Street firms and investors to set aside the New Deal principles of sharing productivity growth between employees, customers and investors and replace them with shareholder primacy. This was supported by Republican Presidents Nixon and Reagan and largely adopted in the UK by Margaret Thatcher’s government in 1979. Before 1980 employees and investors had shared productivity growth between them; after 1980, investors appropriated all the benefits of productivity growth leading to a dramatic increase in US share prices which continues to the present time.

Fair Work

As noted in section 2.3.10, the Fair Work programme research presented by Colin Lindsay (2021) and colleagues at the ESCoE Glasgow conference in 2021 pointed to the need for employee engagement when operationalising efforts to increase productivity. When employees experience job insecurity, under-employment, or exhaustion, when employees feel they have limited or no autonomy or that their experience and/or voices are either ignored or undervalued, productivity will suffer. In a podcast from the Productivity Institute (van Ark, 2021), Professor Cary Cooper drew attention to the positive impact of employee engagement and job crafting and its history in other European countries and, in a recent announcement (April, 2023), The Productivity Institute highlighted ‘worker skills, engagement and well-being’ as the second of their five drivers of productivity.

Management Practices Reporting

More granular management practices reporting is both possible and necessary once the Productivity Management database is implemented. This database will store descriptions and status updates for all live work activities, and it will be updated monthly with all growth investments and their supporting documentation. A monthly report can be provided which shows the completion status of every work activity. Given that the number of work activities is known, and the number of growth investments can also be fully documented it becomes possible, for the first time, to provide senior

managers and production unit managers with the productivity improvement status of each work activity.

4.5.6 Complementary Investment 6: Continuous Improvements

Once work activity reporting has been implemented, it is both possible and desirable to implement a continuous improvement programme. This programme focuses on specific work activities, and specific employees, and asks them what changes could be made to improve productivity for that work activity. This knowledge is captured as part of the Work Activity Description. These improvements can then be implemented and will, over time, contribute to improving departmental productivity. Ideally the Work Activity Description can also be updated at that time. The important point about continuous productivity improvement is that no additional investments are needed beyond the time spent by the employee and manager, but the results show up in the weekly work activity reports and contribute to the growth of organisational capital.

4.5.7 Complementary Investments 7: Capital Investments

Capital investments have long been a key driver of productivity growth. A 2024 report from the World Intellectual Property Organization (WIPO) shows that intangible investments are now much greater than tangible investments and intangible investments were at the same level of \$100 billion in 1995 but by 2023 tangible investments had grown to \$150 billion but Intangibles had grown by \$60 billion more to \$230 billion. (World Intellectual Property Organization, (WIPO) 2024).

An example of tangible investments at Neatsmith includes an automated saw (capital cost £170,000) which can be pre-programmed to cut different sized parts from the same large board. A second type of tangible investment is the opening of a new sales showroom for which £200,000 is budgeted.

An example of a measured intangible investment is the development of bespoke Bill of Materials (BOM) database for Manufacturing at Neatsmith. Every bespoke wardrobe is made up of a pre-defined set of parts, each one of which has to be ordered from a range of suppliers, held in stock, and made available to the Factory for the manufacturing work. The BOM itself is quite complex with 12 levels of data to be stored. departmental applications like BOM can reduce the time taken for one or more manufacturing work activities. Again, the results show up in the work activity reports. The work activity description is updated when the continuous improvement has been completed.

Finally, an example of an unmeasured intangible asset is the continuous improvement work undertaken by a senior manager over a three-year period. This work requires input and discussions between front-line employees and the senior manager responsible for the production function. This expenditure contributes to the stock of organisational capital which can be depreciated like any other asset.

Managing Investments in Tangible, Measured and Unmeasured Intangible Assets

As discussed in the literature review, over the last 20 years economists have drawn attention to the importance of intangible assets in driving growth, claiming that in large firms up to 80% of the firm's valuation was driven by these. The problem is that these assets are not fully documented by firms and hence ONS records are incomplete. There is a second problem at firm level, which is that there is no way of knowing which of the firm's growth investments also contribute to their stock of either tangible or intangible assets. The practical consequence of this lack of information is that firms can neither track the performance of their unmeasured assets nor understand the return on investment for each one.

It is, however, both possible and necessary for firms to be able to allocate complementary investments across both tangible and intangible asset categories because in the US 90% of the value of large firms derive from them. Those that are successfully allocated to capital stocks on the firm's growth balance sheet can also be depreciated through capital services charges, which enable the correct level of capital productivity growth to be calculated.

A method of classifying investments has already been prototyped and implemented, and both the methods and tools have been documented. Given the importance of innovation as one of the key cross-firm management practices, it is clear that classification, recording, and depreciation of these assets are of great importance to all growth firms.

Growth Accounting Balance Sheet

As mandated by the UK Companies Act (2006), all UK firms are required to produce and file a financial balance sheet. However, there are no requirements, as yet, to produce an analogous 'growth accounting' balance sheet. A growth accounting balance sheet would strengthen managerial understanding of the firm's investments and the recipes which they have found to be effective in practice. It would also underpin their Productivity reports by enabling investors and others to examine the stock of investments and how they contribute to productivity growth over time. If the firms have also done the analysis of future human capital potential, this important measure can provide assurances to investors that the levels of growth investment can be maintained and even expanded in future.

Those firms who are prepared to do the hard work of understanding, documenting, and allocating their growth investments in tangible and intangible assets, innovation and human capital, could complete this work by constructing, creating, and updating such a balance sheet. This will show, in an easily readable form, the capital investments and the depreciation of these investments represented as capital services charges. The Growth Balance sheet will implement the Corrado, Hulten and Sichel (2006) categories documented in the literature review.

4.5.8 Complementary Investment 8: Human Capital

As noted in the discussion about extended management practices human capital is also a key concept which managers need to understand when hiring employees and assigning them to particular roles. Of course, human capital is not like tangible or intangible investment capital, because it is owned by the person who possesses it. In this respect it is completely different from tangible and intangible capital which can be bought or sold on the market, although it is often argued that some types of intangible capital are hard to separate out from the entity which owns them and is not therefore freely tradeable.

Human Capital can be described using ten descriptions, all of which need to be fully documented and understood by managers:

1. Person Specification
2. Level of Work (Capability and Mode)
3. Skills
4. Experience
5. Education and Qualifications
6. Knowledge (Industry / Profession)
7. Emotional Intelligence
8. Physical Abilities
9. Ethics and Trust
10. Well-Being

The first description is the person specification which, in larger firms, would be maintained by the HR Department and in smaller firms by the CEO or COO.

The second description is Level of Work, which captures the level of work which an employee can perform at any given time. The second aspect of that characteristic, Mode, describes an individual's future growth potential. The potential for future growth is important for all organisations to understand, but the one which has implemented the most systematic approach to understanding and documenting future potential is the US Army. Unlike most private sector organisations, the US Army has clearly documented the need for eight levels of work in wartime, ranging from private to five-star general. Not only does the US Army select individuals for different career paths, but it also actively organises their education and experience to ensure that the required set of skills and knowledge are accumulated along the way.

Becker (1993) and others analysed the economic benefits of college education in the US and found that 'the average money rate of return on capital on a college education is between 11 and 13 per cent'. Some years later a UK Prime Minister promised to raise the number of college graduates in the UK which reached 38 percent by 2021, the latest year for which data is available (BBC, 2021). Information about an individual's education and qualifications would be captured in description five (Education and Qualifications).

Understanding and accounting for the third description of human capital, Skills, is probably as important as education. Many sectors lack employees with relevant skills, and a commonly reported problem is that when firms invest in upskilling their employees, the employees can easily leave the firm and take the skills with them.

Industry and professional knowledge is the sixth description of human capital, and while it does rely to some extent on education, it can also be developed by employees and firms as an investment in human capital. For example, Nonaka (1994) drew attention to the practices of some Japanese firms of deliberately encouraging and supporting employees to change departments – perhaps from accounting to sales, or marketing to R&D – to give the employees a better understanding of how other departments and functions worked and to encourage cross-departmental project teams. As the earlier example of Agile development suggested, multi-disciplinary working is no longer just a good idea, it is rapidly becoming essential.

Emotional Intelligence is characterised by a number of different qualities. For example, one would hope that a nurse would be ‘caring’ whilst an engineer would be ‘disciplined’. Some work activities call for high levels of emotional intelligence whilst others call for manual dexterity.

The last three characteristics under Human Capital are often overlooked. Some roles still require a level of physical dexterity which cannot easily be provided by machines. Ethics and trust are not just a nice to have but an increasingly essential quality for employees and managers. Lastly, employee well-being is a key part of the Fair Work initiative which was reviewed earlier.

Senior managers therefore appear to have three important responsibilities: The first is to document the human capital descriptions associated with (or required by) each work activity. The second, is to develop a comprehensive view of each employee’s characteristics so that they can be correctly applied to a work activity (or set of work activities) to be performed in a given role. The third, is to have a clear view of the levels of work which will be needed as the firm grows, in order to ensure that well-qualified human capital is available at the right time.

4.6 The Software Platform

The final component of the new theoretical framework is a software platform which implements the management practices in digital form. Many firms will be familiar with Enterprise Resource Planning applications which have been widely implemented in most large firms, public sector enterprises and larger SMEs. The new software platform helps senior managers and production unit managers to focus on growing the firm’s Total Factor Productivity. The platform complements existing ERP systems because its primary purpose is to support managers and employees in delivering TFP growth, which is quite different from the purpose of ERP applications.

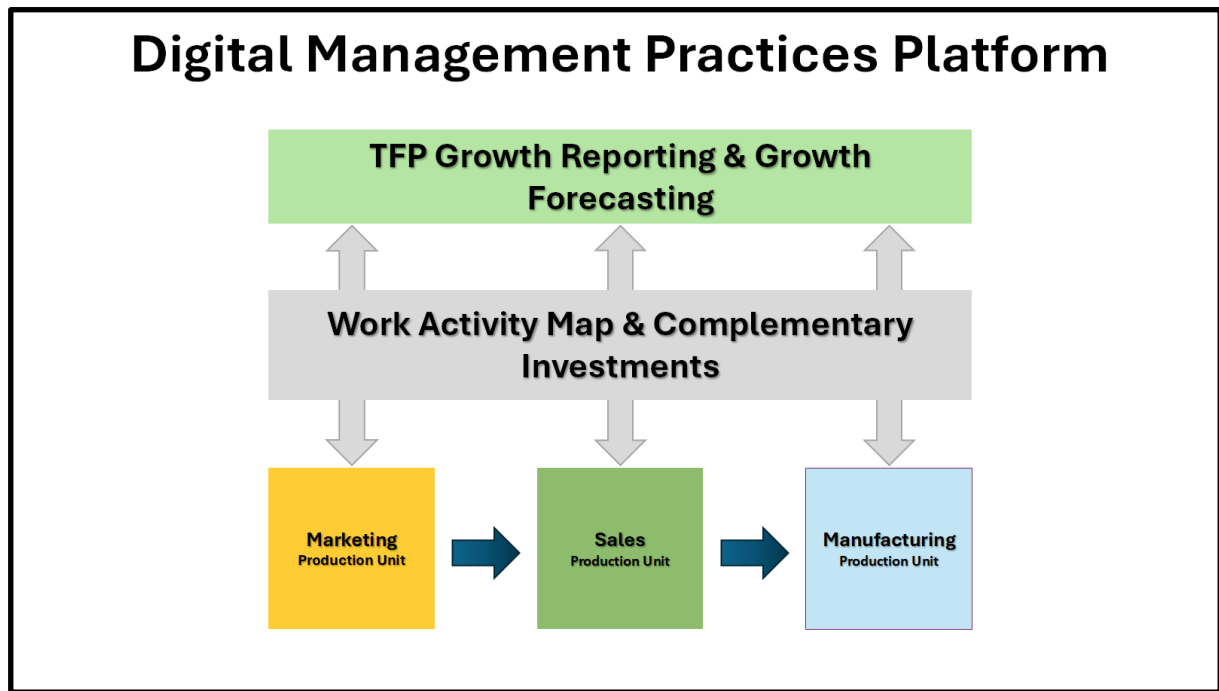


Chart 36: The Digital Management Practices Platform

The Digital Management Practices Platform (illustrated in Chart 36 above) consists of a suite of applications software and databases that enable senior managers in medium-sized SMEs to implement the four management practices to grow revenue and TFP. It incorporates in digital form the pillars of the US Productivity Program (see section 2.1.1) including work-study and implements post-war developments including Trist and Emery's socio-technical systems, the post-Hawthorne Human Relations school, Engelbart's Human System / Tool System, as well as Jaques' social analysis and levels of work. It also includes van Reenen's management practices measurements, and Autor, Levy and Murnane's tasks.

5 The Neatsmith Case Study

During 2020 the author was actively looking for a live case study to complement the historic case study of the Purchasing Work Process that had been developed for Donegal County Council (see Appendix 2). By that time, the author had formed a new company (Opagio Ltd) with colleagues and was looking for commercial opportunities to bring their software platform market. A number of possible clients in the hospitality industry were being considered, but none of them were sufficiently interested to commit to a case study project. In talking to a number of firms it became clear that productivity measurement and improvement was not actually very high on their managerial agenda. For most of the firms in the hospitality industry during that time, surviving the various Covid lockdowns was their over-riding priority. This experience led to the selection criteria for a suitable case study which should:

- Fall into the 20-250 employee category
- Does not have an IT Department
- Does not have an ERP System installed
- Is in a major Industry Sector with productivity growth potential
- Is interested in increasing productivity
- Is prepared to invest in increasing productivity
- Is prepared to commit to a longitudinal case study

The case study selected by the author (Neatsmith Ltd) fitted the selection criteria extremely well. Neatsmith is a London-based manufacturer and installer of premium wardrobes. The firm works in some of London's most prestigious addresses and has a reputation for selling beautiful bespoke wardrobes, dressing rooms and home offices, ideal for both historic and contemporary homes. During the introductory meeting the author learned that the COO was already tracking the work activities in his Manufacturing department using an Excel spreadsheet.

This spreadsheet contained roughly 50 columns (each one representing a single work activity) and tracked some 800 orders, each associated with a single customer. However, each customer order might include items to be built for more than one bedroom or study, so the total number of rows in the spreadsheet, once the number of rooms to be built were added, was closer to 2,000. Every one of the work activities associated with each of the individual items (known as cases) needed to be tracked and reported on — more than 100,000 work activities per year.

It looks just like Purchasing!

The author knew immediately that Neatsmith's Manufacturing spreadsheet could be implemented using the same software that had been developed for the Purchasing Work Process at Donegal. To deliver that implementation, the author worked with a software engineer to implement around 20 work activities and 30,000 purchase orders (cases) using a rich SQL database. A method of importing Payroll data into the SQL database from an existing finance application was developed and tested. This enabled

the project team to allocate employees to work activities and then track and report on the performance of every work activity for every case.

Like most SMEs, Neatsmith does not have, and cannot justify the cost of, a dedicated IT department. However, if Neatsmith engaged Opagio as a technology partner during the case study, the firm would gain access to the IT services required to help it overcome the challenges it was encountering in its own efforts to improve productivity. Concurrently, this would provide the author with an opportunity to further develop and refine the software platform to implement the Theoretical Framework discussed in Chapter 4 and put it to the test. Neatsmith was agreeable because of the synergies involved and their desire to increase productivity.

In July of 2021, Neatsmith engaged Opagio Ltd. to help it increase sales revenues and productivity and, as of the time of writing, this engagement continues to deliver benefits to both parties. As this Case Study will illustrate, the development of the Theoretical Framework which clarified the unique work activities of the COO and the importance of the production units, the deeper understanding of the role of Complementary Investments together with the software platform has helped Neatsmith to deliver measurably greater labour productivity growth and even higher EBIT growth.

About Neatsmith

As noted, Neatsmith is a London-based manufacturer and installer of premium wardrobes. Founded in 2005 by Andrew Nagel and his sons, Philipp and Mathew, the family has always prioritised design, quality, and exceptional service. The firm has five standalone London showrooms—in Chelsea, Hampstead, Hatch End, Hampton Hill, and Brentwood as well as a new showroom in Guildford. It operates out of a 22,000 square foot production facility in Watford. In 2024, the firm employed 78 people, including 22 in Marketing and Sales and 56 in Manufacturing and Customer Installation. Since its inception, Neatsmith's revenue has grown steadily year on year and has gone from £1.85m in 2011 to £10.7m in 2024.

5.1 Implementing Digital Management Practices

When Opagio started working with Neatsmith, the company had a clear idea of its two main functions, Marketing and Sales (led by Philipp Nagel) and Manufacturing Operations (led by Mathew Nagel). There was an understanding that a knowledge of work activities was important and that there was a flow process driving the manufacturing and installation sides of the business. There was an also understanding that a funnel-based process dominated marketing and sales side of the business, though that term was not part of the managerial vocabulary. It was understood that data generated by sales and marketing flowed into manufacturing and installation, but efforts to streamline the flow of data from one side to the other were fraught with difficulties.

Neatsmith's own efforts to facilitate the operations of both the sales and marketing and manufacturing/installation functions relied on the use of Microsoft Excel spreadsheets.

Marketing and Sales personnel would capture data in Excel about customer leads and prospective orders. As leads moved further into the funnel, the personnel would capture more information and preserve it in Excel. Preliminary order specifications would be priced out and quotes would be sent via email to the customer. Once a quote was approved, this was recorded in Excel. A contract would be sent, signed, and returned, and then the order would be passed to manufacturing.

Manufacturing had its own set of Excel spreadsheets, and these spreadsheets did not automatically draw information from the spreadsheets maintained by Marketing and Sales. A single order from the perspective of Marketing and Sales might actually consist of furniture to be custom built for as many as three separate rooms, and from a manufacturing perspective that represented three separate work cases, each of which involved a distinct bill of materials and potentially distinct sets of work activities.

The manufacturing planning manager had to manually deconstruct each customer order into its individual work cases and create the individual bills of materials and plans of work for the various factory departments and installer teams. As jobs proceeded through manufacturing, information about orders would be updated, but that information was not reflected in any spreadsheet managed or maintained by Sales and Marketing. Indeed, there was not even a common or shared spreadsheet containing information about customers; customer information was maintained separately by the Marketing/Sales and Manufacturing/Installation teams. The reasons for this were not exclusionary or because of a sense of data ownership, it was simply that the Excel-based workflow in place did not lend itself to this kind of shared data use.

It is further worth noting that throughout each of these workstreams as described, it was effectively impossible for anyone other than the owner of an individual spreadsheet to gain real-time insight into the status of a given lead, order, or job in production because there was no provision for shared real-time reporting. An individual could print or email a copy of a spreadsheet, which would share the status of a lead/order/job at the time the email was sent, but that report would be outdated as soon as the owner made a change to the spreadsheet. Some managers tried to keep a central spreadsheet that would be updated manually as information was received, but that process was cumbersome, subject to human error, and not always as up to date as management would like.

Neatsmith executives wanted to continuously improve the customer journey from first contact through project installation and sign-off. It wanted staff from the Marketing/Sales, Manufacturing Planning, CAD, Shop Floor and Customer Installation teams to be able to interact with and update the customer's order at every stage of the journey, adding relevant data along the way but never entering the same data twice.

With all this data captured in a single system, Neatsmith executives believed that the firm could improve productivity, profitability, and the customer experience by facilitating the following:

1. Generating orders for suppliers.
2. Developing a plan of work for the various factory departments.
3. Devising an installation calendar.
4. Providing a real time view of what was being done in each department.
5. Enabling the firm to improve the customer's experience with timely updates throughout the process.
6. Populate key reports automatically and in real time to dramatically reduce manual effort.

Neatsmith also wished to deploy a mobile 'app' which would enable data to be entered by staff who were not in the office or near a PC. This group includes 10 factory staff, 10 delivery drivers and 20 wardrobe fitters, who together, account for two thirds of the firm's headcount.

Prior to engaging Opagio, Neatsmith looked at two options to replace its Excel-based workflow: a bespoke solution custom-built to meet its needs and an off-the-shelf CRM/ERP suite of apps (from Odoo). The bespoke option would have cost £150,000, but without a clear framework upon which to base it, the executives at Neatsmith considered it too great a leap of faith. The cost for the off-the-shelf option was £15,000, with additional costs for application tailoring and support.

5.1.1 The Neatsmith Work Activity Map

Opagio worked with the Neatsmith COO to develop a more extensive map of all the Work Activities and Work Objects in Manufacturing. These maps were developed with the intention of better understanding what continuous improvements could be made for each one. The COO encouraged the employee responsible for each work activity to draw up a description of the Work Activity and to define the following:

- The output to be produced from the Work Activity.
- The performance standards that could be delivered.
- The training that would be required to prepare a new employee or apprentice to perform the activity to the aforementioned standards.

With work activity maps drawn up by those who perform the work and know it best, Neatsmith and Opagio could develop solutions that would more effectively improve productivity and profitability at Neatsmith. All Continuous improvements are documented on the Growth Platform.

The Neatsmith COO had created a map of the work activities performed in Manufacturing from the point at which a confirmed order was received, but had not mapped the work activities taking place in Marketing and Sales. After discussions with Opagio, the COO agreed that the work activity maps should be extended to document the work activities taking place in other Neatsmith departments, including Marketing, Sales, Manufacturing, Shop Floor, Customer Installations, Finance, and other support functions. The latest Work Activity Map in Chart 37, below, was drawn up by the COO and the author in September 2024, and reflects his view of the firm's work activities

after three years of work with the Growth Platform. It also reflects the new work of the COO for Growth Strategy and the management of complementary investments in the three production units.

Growth Strategy, Complimentary Investments & Total Factor Productivity (TFP) Reporting - Level IV														
CEO / COO	Import Historic Data	Create Historic TFP Reports	Create Monthly TFP Reports	Hold Strategy Workshop	Understand Drivers & Problems	Document new Drivers & Problems	Create Growth Forecasts and Scenarios	Save Growth Scenarios	Decide on Complimentary Investments	Update Growth Strategy with Cis	Assist in Capital Raise	Allocate Cis to Intangible Assets	Allocate Cis to Tangible Assets	Allocate Cis to Umeasured Intangible Assets
	Allocate Cis to Innovation	Create Growth Balance Sheet	Update Growth Balance Sheet	Create Stakeholder Reporting										
Productivity Growth Management - Level IV														
CEO/COO	Create Firm Work Activity Map	Set Up Work Activity Database	Allocate Work Activity to Levels of Work	Import Work Activity Maps	Implement Work Activity Reporting	Prioritise Work Activities	Write Work Activity Descriptions	Coach Front Line Employees	Clarify Work Objects	Decide on Work Object Databases	Implement Work Object Databases	Implement Fair Work	Implement Fair Growth	Implement Management Practices
	Implement Continuous Improvements	Document Continuous Improvements	Measure Work Activity Improvements	Update Growth Balance Sheet	Update Human Capital	Provide Implementation Reporting								
Marketing / Management Production Unit - Level III														
Marketing	Strategy Creation	Media Plan	PR Planning	Photo Shoot	Advert Creation	Poster Creation	Brand Bible	Brochure Creation	Business Card	Client Imagery	Client Photo	Update Costs	Social Measurement	Social Ad Measurement
	Google Ad Measurement	Website Updates	Monthly Reports	Weekly Reports										
Sales / Management Production Unit - Level III														
Showrooms Level II Managers Sales	Chelsea	Hampstead	Hampton Hill	Brentwood	Hampton Hill	Guildford	Tunbridge Wells		Channels Greycaine					
	Enquiry Month	1st Contact	Appt Booked	Showroom Meeting	Quote Sent	24h Chase	Follow Up + Revisions	Deposit Taken	Book Survey	Files to Head Office				
Manufacturing Operations / Management Production Unit - Level III														
Planning Level II Manager	Sale Date	# Days to fit	Calendar Entry	Site Visit Date	Site Dims Received	Visuals / Quote	Lead Time Given	Order Qual Check	Drawings Done	Cut Sheet Check	Doors Ordered	Doors Del Date	Doors Received	Glass Ordered
	Glass Del Date	Glass Received	Internals Ordered	Internals Received	Rodman Ordered	Add prod ordered	Add prod received	Snag List Fitter						
Shop Floor Level II Manager	Receiving Deliveries	Cleghorn	Hoffman	Antik-Fid-Vel	Hafele	Others	Glass	Aluminium	Handles	Hafele	Daro	Small Suppliers	Mawby	Golden Glass
	Planca	Stocktake	Wood	Drawers + Divs	Beam Saw	Table Saw	Rafix etc	Red List	Shoe Drawers	Angled Shoe Shelf	Pull Out Shelf	Cloister Doors	Series 1 + Aria	Reflex Doors
	Load Vans	Unload Vans	Maintenance	Cleaning Schedule	Blade Sharpen	Frameless Glass	Angled Corners	Drawer Boxes	Mirrors and F Shelves					
Installation Level II Manager	Prepare Area	Measure Space	Check Material	Prep Carcasses	Scribe EP + Externals	Fit Internals	Clean Internals	Scribe + Fit Header	Hang Doors	Clean Wardrobes	Photos	Sign Off Sheets	Remove Tools from Site	Remove Waste from Site
Support Services Level II Manager	Accounts	Estates	Fleet	H & S	HR	Maintenance	Sustainability							

Chart 37: The complete Neatsmith work activity map (Source Neatsmith Ltd)

The colour-coding is very simple:

Green	Identifies those work activities and departments that have implemented work activity reporting (all drawing from common databases that facilitate real time insights and reporting).
Amber	Indicates that some work has been done (mostly in the form of work activity reporting and work object databases). Most recently a new smartphone user interface is being tested for use by the installation teams.
Grey	Identifies work activities that remain to be addressed.

The Work Activity Map includes the three production units — for Marketing, Sales and Manufacturing Operations, first documented in the Theoretical Framework. The Map also includes the managerial work needed to implement the Growth Strategy, Growth Investments and Growth Reporting application as well as the Productivity Management applications both of which constitute Future Research projects.

5.2 Overview of the Neatsmith Case Study

One of the characteristics of a case study is that it is impossible to know at the start exactly how, or in what direction, the project will progress. But the great advantage of looking back is that the main themes of the study become quite clear and provide us with the presentation logic for reporting on the Case Study. Neatsmith focused on the manufacturing production unit first, and then the project continued with sales and, finally, marketing. The theoretical framework also drew attention to the set of complementary investments which could be made to increase productivity. The rest of this chapter documents in detail how these complementary investments have been applied to each production unit and concludes with a summary of the investments to date and the impact of these investments on revenue and productivity growth.

5.3 Manufacturing Operations

5.3.1 Work Activity Reporting: July 2021

The first business challenge Neatsmith wanted to address was to provide better support for the work of the Manufacturing Planning department, which used an Excel-based work activity tracking system. As noted, it was very hard to share data between different departments, such as sales and manufacturing, which led to a great deal of duplication in entering data. While it provided some users with a real-time view of the state of all activities, it did not provide any reporting. Without an underlying database that all users and applications could access it would not be possible for others to gain real-time insights, plan manufacturing jobs, or coordinate installations more effectively.

Because Neatsmith had already documented the Manufacturing Planning work activities in its Excel-based workflow system, it required little effort to import the critical details into the Opagio Digital Management Platform. Neatsmith prepared three parameter files using data from their existing work activity spreadsheets and a template provided by Opagio, and then imported those work activities into the Opagio Digital Management Platform without incident. They stopped using their old Excel system on Friday, the 23rd of July, 2021, and began using the Opagio Digital Management Platform on the following Monday, the 26th of July, orchestrating their Manufacturing department work activities via the KnowledgeGrid user interface shown in Chart 38 below which provides employees with real-time insights about every case and every work activity.

New Case

Case ID: 3944 Case Name: Case Type: Type or select from list

Case Type: Manufacturing Show Archived Cases

Case ID	Case Name	Step3: EPI	Step4: Sale	Step5: no of days	Step6: Calendar entry	Step7: Site Visit Date	Step8: Site measurements	Step9: Visits + Quote	Step10: Lead time given
2361	Adston UK Limited	17/03/22	SUPPLY ONLY	17/03/22	Josephine	17/03/22	36/04/22	Visuals updated on 22.08.2022	12 wks (22nd November)
2362	Hirschfeld, Jonathan	17/03/22	3 days (HARD)	17/03/22	Josephine	17/03/22	11/04/22	Visual updated on 22.04.2022 Visual	12-14 wks (23rd June)
2366	Jules, Joanna - Ma	17/03/22		18/03/22			18/03/22	ASAP	
2405	Ethos Development	24/03/22	22/09/22 9 hard	24/03/22	05.07.2022 (SV) Hannah	26/07/22	Visual updated on 10.09.2022 Visual	12 wks (27th September)	
2406	Ethos Development	24/03/22	22/09/22 1	24/03/22		26/07/22	Visual updated on 26.10.2022 Visual		
2407	Ethos Development	24/03/22	11/06/22 1 hard	24/03/22		26/07/22	26/07/22		
2408	Ethos Development	24/03/22	22/09/22 1 easy	24/03/22		26/07/22	Visual updated on 26.07.2022		
2409	Ethos Development	24/03/22	22/09/22 2m	24/03/22		26/07/22	Visual updated on 10.08.2022		
2424	Nandra, Deval - Dsu	24/03/22	11/06/22 1 h	24/03/22	30.03.2022 (SV) Kaia	08/04/22	08/04/22		10-12 wks (22nd June)
2425	Nandra, Deval - Dsu	24/03/22	11/06/22 2 h	24/03/22		08/04/22	08/04/22		
2426	Nandra, Deval - Dsu	24/03/22	11/06/22 1 h	24/03/22		08/04/22	08/04/22		
2427	Nandra, Deval - Dsu	24/03/22	11/06/22 workshop	24/03/22		08/04/22	08/04/22		
2440	Kicci, Elton - Dress	26/03/22	12/06/22 2 m	26/03/22	07.04.2022 (SV) Zaynah	08/07/22	08/07/22		14-16 wks (28th July)
2441	Kicci, Elton - Entry	26/03/22	12/06/22 1 m	26/03/22	08.10.2022 (2nd SV)	15/12/22	15/12/22		14-16 wks (Entrance + Guest Room)
2442	Kicci, Elton - Guest	26/03/22	12/06/22 1 m	26/03/22		15/12/22	15/12/22		
2443	Kicci, Elton - Oliver	26/03/22	12/06/22 2 h	26/03/22		11/07/22	11/07/22		
2463	Collard, Rebecca	30/03/22	04/04/22 5 hard	30/03/22	07.04.2022 (SV) Jacqueline	26/04/22	Visual updated on 18.05.2022 Visual		14-16 wks (28th July)
2476	Fincham, Rebecca	31/03/22	12/06/22 2 h	31/03/22	14.05.2022 (SV) Francesca				14-16 wks (3rd September)
2477	Fincham, Rebecca	31/03/22		31/03/22					
2478	Fincham, Rebecca	31/03/22	12/06/22 0.5	31/03/22					
2479	Fincham, Rebecca	31/03/22	12/06/22 1 h	31/03/22					
2480	Fincham, Rebecca	31/03/22		31/03/22					
2481	Fincham, Rebecca	31/03/22	12/06/22 1 m	31/03/22					
2482	Fincham, Rebecca	31/03/22	12/06/22 2 m	31/03/22					
2483	Fincham, Rebecca	31/03/22	12/06/22 2 m	31/03/22					
2484	Leigh ref. Sachdev	8 wks ON HOLD from 02.08.2022 04	12/06/22 4 h	31/03/22	30.05.2022 (SV) Mariana	04/07/22	Visual updated on 09.09.2022 Visual		12-14 wks (10th October)
2485	Leigh ref. Sachdev	8 wks ON HOLD from 02.08.2022 04	12/06/22 0.5 h	31/03/22		04/07/22	Visual updated on 02.08.2022 Visual		
2486	Leigh ref. Sachdev	8 wks ON HOLD from 02.08.2022 04	12/06/22 0.5 h	31/03/22		04/07/22	Visual updated on 02.08.2022 Visual		
2487	Leigh ref. Sachdev	31/03/22	12/06/22 2 m	31/03/22		04/07/22	04/07/22		
2488	Leigh ref. Sachdev	31/03/22	12/06/22 1 h	31/03/22		04/07/22	04/07/22		
2489	Leigh ref. Sachdev	8 wks ON HOLD from 02.08.2022 04	12/06/22 2 h	31/03/22		04/07/22	Visual updated on 09.08.2022 Visual		
2490	Leigh ref. Sachdev	31/03/22	12/06/22 1 m	31/03/22		04/07/22	04/07/22		
2512	Doumond, Andrew								

Chart 38: The KnowledgeGrid User Interface

Because the KnowledgeGrid interface looks like Excel, Neatsmith's employees in the Manufacturing planning department were able to begin using the new system with no formal training and with no downtime. They simply picked up where they had left off with Excel the previous week. At the same time, because all the information related to work activities, planning, and updates are maintained in a shared database, Neatsmith was immediately able to implement Work-Activity Reporting on a weekly basis for the department.

5.3.2 Labour Productivity Reporting

In addition to the Red, Amber, Green reporting of the state of each case the software also produces comprehensive labour productivity reporting for Manufacturing Operations. Because the completion of every work activity is tracked it become possible to provide a rich set of parameters for labour productivity. Once this tracking is extended for use by the employees in the Factory and Installation teams it will be possible to provide monthly labour productivity reporting for the entire production unit.

Month	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22
Work Activity Quantity : Total	1064	1064	1064	1223	1223	1223	980	980	980	941	941	941
Work Activity Quality : Red	1	1	1	1	1	1	1	1	1	8	8	8
Work Activity Quality : Amber	140	140	140	127	127	127	108	108	108	127	127	127
Work Activity Quality : Green	922	922	922	1095	1095	1095	871	871	871	805	805	805
Work Activity : Average Cost	21.33	21.33	21.33	18.55	18.55	18.55	23.14	23.14	23.14	24.04	24.04	24.04
Work Activity : Standard Cost	24.60	24.60	24.60	20.72	20.72	20.72	26.04	26.04	26.04	28.19	28.19	28.19
Work Activity : Rework Cost	3.27	3.27	3.27	2.17	2.17	2.17	2.90	2.90	2.90	4.15	4.15	4.15
Work Activity : Average Duration	1.96	1.96	1.96	1.7	1.7	1.7	2.12	2.12	2.12	2.2	2.2	2.2
Work Activity : Average Labour Productivity	0.51	0.51	0.51	0.59	0.59	0.59	0.47	0.47	0.47	0.45	0.45	0.45
Labour Services Inputs : Headcount	12	12	12	12	12	12	12	12	12	12	12	12
Labour Services Inputs : Hours	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080	2080
Labour Service Inputs : Payroll	22690	22690	22690	22690	22690	22690	22690	22690	22690	22690	22690	22690

Chart 39: Labour Productivity Reporting: Manufacturing Operations

5.3.3 Customer Installation Manager: January 2022

Within the Manufacturing Operations at Neatsmith, one of the largest departments is Customer Installation, which employs the fitters who are responsible for installing the wardrobes and other furniture in customers' homes. These fitters must be extremely well trained and must work to very high standards of behaviour, as they are not only working inside peoples' homes, but they are also working in the most private rooms of these homes. The Neatsmith COO found that with 20+ fitters he was having difficulty delivering satisfactory training, feedback, and engagement to individual employees.

In January of 2022, the COO of Neatsmith made a significant investment in human capital to address this issue. He appointed one of Firm's most experience senior fitters to be the new manager of the Installation department. Initially, promoting the most experienced fitter to a management role reduced department output and productivity. The new manager was no longer able to deliver the installation services at which he excelled. However, the expertise of the manager has actually led to an increase in the levels of on-the-job training and a sharper focus on employee engagement. An analysis of fitter performance in 2022 showed an 18% increase in installations over 2021.

5.3.4 Apprenticeship Programme: October 2021

The COO took a second decision in 2021 to create and implement the Neatsmith Apprentice program. This programme required the development of a training curriculum which mapped the work activities and work activities systems for a typical installation job. These same work activity maps were used by the new manager to supervise the new employees during their apprenticeship year.

The apprentice programme formally started in October of 2021. The first two apprentices joined the firm in November of 2021 and graduated in October of 2022 as fully trained fitters earning £35,000 a year. A second intake of four apprentices started in November 2022, and they will graduate in October 2023.

5.3.5 Upskilling Factory Employees

Neatsmith wanted to make its factory staff better at their jobs so that the customer would have a better overall experience. If factory employees completed their jobs correctly the first time, quality would increase, as would customer satisfaction. There would be less rework, the employee would be able to produce more, and Neatsmith would be able to pay them more money.

5.3.6 Upskilling Drivers

As the effects of Covid started to wind down there was a massive increase in demand for drivers which resulted in both wage pressure and scarcity. By offering to train drivers to add site preparation to their existing delivery responsibilities, the COO was able to increase pay and recruitment for new drivers despite the national scarcity.

5.3.7 Updating the Bill of Materials

Neatsmith had long faced challenges updating its Bill of Materials (BoM). This too had been implemented in Excel and had been maintained by the Manufacturing Planning department. The data would be useful for both the Sales and Shop Floor teams but was not easily shared in Excel.

The success of the implementation of work activity update and reporting system prompted the COO to engage Opagio to develop a Bill of Materials (BOM) application with a database that would contain information about materials and suppliers. This could then be used as a starting point for supply chain management.

The new database was implemented in early 2022. Not only did it support the process of developing a BoM for manufacturing individual cases, but it also enabled Neatsmith's Sales personnel to access the latest supplier prices when preparing customer quotations. When inflation grew unexpectedly in 2022, the ability to access up-to-date information in the shared BOM database significantly reduced work time for both the Sales and Manufacturing teams. Supplier prices were moving weekly, but real-time access to data reduced the need to go back and forth with customers as prices moved.

5.3.8 Updating the Bill of Materials (v2)

The initial version of the BOM application was very successful at helping Manufacturing Planning keep supplier prices up to date and at helping Sales provide customers with correct price quotes. But there was a problem: Sometimes Sales configured and sent quotes to customers for items that could not actually be manufactured. However, until the order was received and checked by manufacturing, this was not apparent. This led to embarrassing conversations between sales and customers, the need to rework and requote the order, and sometimes to delivery delays since manufacturing started later than the customer had expected.

The Neatsmith COO asked Opagio to enhance the BoM application with a rules engine. This enhancement would enable a sales quotation to be checked for manufacturability *before* it could be submitted to the customer. The completion of the Rules-based BOM application, though, led to the need for a new Sales Quotation application that would follow the logic inside the new BoM. The creation of the new Sales Quotation application was undertaken as a growth investment by the Sales department and is documented in the discussion of the Marketing and Sales Production Unit.

5.3.9 Releasing Customer Orders to Manufacturing

Following the implementation of rules-based BoM and the new Sales Quotation application (described later in section 5.4.4), the established procedure in Sales was to transfer a signed order to Manufacturing. However, because Sales deals with customer orders that may encompass multiple rooms and Manufacturing deals with individual rooms (each one of which is treated as a unique case with its own set of work activities) there was also a need to break an order into individual cases. Before Opagio automated

the transformation of customer orders into individual cases it took around a third of the Manufacturing manager's time to enter and correct the order data. Because this was a manual process, errors were inevitably introduced.

Now, all customer and order information is stored in a shared database. All the customer details that had been maintained separately by Sales no longer need to be re-entered by Manufacturing. Similarly, because the case level data now resides in the shared database (which previously had been accessible only to Manufacturing), Sales no longer needs to try to maintain a separate account of order data. Both departments — and more importantly both production units — can work with the same data.

5.3.10 Managing the 13-Week Operational Schedule

One of the main tasks in the Manufacturing production unit involves maintaining the 13-week Operational schedule. In the past this was done using an Outlook calendar which could be viewed by staff in the Manufacturing department, in the Factory, and in the Customer Installations departments. The aim was to make sure that each department could ensure that the correct parts were ordered from suppliers, that these parts could be used by manufacturing to fulfil customer orders, and lastly that the bespoke furniture could be delivered and installed at the customer's address on the dates promised.

However, Outlook was not an ideal mechanism for tracking the progress of an order. Though all parties could see a schedule, it was difficult to adjust the timeline of an individual order. Outlook was also not designed for reporting on the status of case manufacturing over time, so it was cumbersome to extract and share insights about the state of orders in the pipeline. One example suffices: Neatsmith executives wanted to see a report illustrating the sterling values of each week's customer installations. Using Outlook, this had to be created manually (and redone manually by someone in the accounts team as the list changed). The report was laborious to produce, but management considered it vital.

Once the customer orders were digitised through the use of the Sales Quotation application (see section 5.4.4) in coordination with the BoM application (see section 5.3.7), they could be broken down into individual work cases and managed accordingly. Since the work activities in manufacturing are already documented in the firm's Work Activity Map, and since that map was one of the first objects incorporated into the Opagio digital management platform, it became easy to prepare a schedule that takes each case and plots its progress through manufacturing over the next 13 weeks. This schedule can then be reviewed by all department managers to optimise the use of resources in each department. Because the sterling value of the orders can also be pulled from the database, creation of the weekly pipeline report for Neatsmith executives (see Chart 40, below) is instantaneous and can be accomplished by clicking a button. Indeed, weekly production of the report is now automated, and the COO always has a clear view of installations, and revenue, going forward.

Report					
Case Type Manufacturing		Start Date 24/04/2023	End Date 30/06/2023	Show Report	Expand/Collapse All
Case ID	Case Name	Days	€	Installation Status	Job Difficulty
2023 Week: 17					
	(60 Cases)	82	€225,362.00		
2023 Week: 18					
	(54 Cases)	69	€194,819.00		
2023 Week: 19					
	(33 Cases)	46	€183,126.00		
2023 Week: 20					
	(54 Cases)	62	€255,519.00		
2023 Week: 21					
	(25 Cases)	7	€112,132.00		
2023 Week: 22					
	(34 Cases)	11	€175,122.00		
2023 Week: 23					
	(32 Cases)	4	€202,291.00		
2023 Week: 24					
	(31 Cases)	2	€167,462.00		
2023 Week: 25					
	(68 Cases)	11	€395,265.00		
2023 Week: 26					
	(39 Cases)	2	€215,520.00		

Chart 40: Manufacturing's 13-Week Schedule (Source Neatsmith Ltd)

Because of the optimisations enabled by the digital growth platform, Neatsmith no longer needs to use the manual Outlook calendar and no longer needs to task personnel on the accounts team with the tedious task of manually creating these reports. It has enabled Neatsmith to reduce headcount in the accounts team (which in turn has increased the productivity of the team). In time, the COO expects that this will enable him to better understand the capacity of the Manufacturing Production unit so that investments can be balanced between sales growth and operations growth.

5.3.11 Rework Reporting

As noted earlier, there were two significant problems with processing completed customer orders from Sales. The first was that these orders had to be manually re-entered into the Excel-based system use by manufacturing, which took time and introduced additional errors. This was addressed once the digitised sales order could be passed directly into the Manufacturing work activity reporting application. The second problem for the Manufacturing department, though, was that quite a high percentage of these orders had to be reworked by Manufacturing – many because of undetected configuration errors created by Sales. Opagio has created a rework report that can track these incidents more closely. The COO is optimistic that quality can be improved quarter on quarter now that the information is available to all departments.

Report						
WAG Manufacturing		Start Date 01/01/2022	End Date 24/04/2023	Quarterly	Show Report	Export
Name	Qtr 1 (January - March) 2022	Qtr 2 (April - June) 2022	Qtr 3 (July - September) 2022	Qtr 4 (October - Dece	Qtr 1 (January - March) 2023	Qtr 2 (April - June) 2023
Completed %	66	75	78	72	78	83
Quality/Crisis %	34	25	22	28	22	17

Chart 41: Rework report step 11 in manufacturing (Source Neatsmith Ltd)

The new rework reporting application went live in April 2023. Chart 41 shows the most recent five quarters. In the first period of the report, 34% of all sales orders had to

reworked by Manufacturing. In the most recent quarter, the number had halved to 17%. This directly improves labour productivity by reducing the total number of work activities that have to be performed by the department.

5.3.12 Implementing the Fair Work project

As mentioned earlier the author had met Colin Findlay, one of the leaders of the Fair Work project, at an ESCoE / ONS conference in Glasgow in June 2022. Colin was looking for additional participants for his research project and also for help in measuring productivity within the firm. The author reported back to the Neatsmith COO and he agreed that this could support and reinforce the employee engagement approach. Neatsmith's COO embraced the concepts expounded in the Fair Work project and understood the importance of providing staff with feedback and enabling them to innovate in their own roles. The work activity descriptions outline the work they do and give them a starting point to improve upon. The Neatsmith COO reported that the results of the Fair Work project conducted by Colin Lindsay and his colleagues was very valuable and that two things stood out.

The first was the idea of job crafting, that employees could, and should, solve problems on the frontline themselves, and create efficiencies that can then be shared with colleagues. The second was the importance of feedback by staff on what could be done better. This has focused the COO's mind when thinking about Neatsmith's work activity reporting, as everybody wants to know how they are doing!

By working with employees to carefully document their work activities and quantifying expected daily output quantities, Neatsmith has achieved measurable productivity increases and been able to implement simple bonus / reward systems to distribute the gains:

- The beam saw operative has been able to double his daily output and increase his wages.
- The delivery drivers have been able to increase their output and increase their wages by over 40%.
- Four of the senior factory staff have been put on a bonus structure that allows them to increase their weekly wage by up to 16%.

All these improvements are documented in the Continuous Improvement Log which will become part of the Complementary Investments Database in due course.

5.3.13 Management Practices Questionnaire

Neatsmith did complete a Management Practices questionnaire from which a Management Practices Score could be calculated. However, what is missing is any linkage between these management practices questions and what actual managers need to do to improve their scores. If robust links between the Management Practices Questionnaire and the Management Production Function could be developed this might

be beneficial for all parties because considerable research effort has been invested by ONS and ESCoE.

As noted earlier, the surveys focused primarily on Manufacturing and did not include Marketing and Sales or Growth Strategy. The ONS has developed a large database of Management Practices Scores for the UK but what is missing is any linkage between these management practices questions and what actual managers need to do to improve their scores. This is a potential area for research at Neatsmith at a later date.

5.3.14 New Automated Edgebander: October 2023

In mid-2023 Neatsmith set up a direct supply agreement with EGGER UK, who manufacture the MFC board which Neatsmith uses to construct their wardrobes. Moving to direct supply means they will be cutting directly from master sheets and will no longer have to order pre-cut and edged material, which is considerably more expensive. Neatsmith will continue to use their current beam saw to process these master sheets and the optimisation software will minimise waste. A new Edgebander was ordered and went live on the Shop Floor in October 2023. The new Edgebander will edge the newly cut boards that are ready for installation. By moving to direct supply, Neatsmith also expect to save £500k per annum on purchases which will increase GVA; it also aims to remove 11 work activities from the factory, which should lead to a decrease in headcount and further increase in Manufacturing Operations productivity.

5.3.15 Smartphone Update and Reporting

The COO has realised that the Work Activity Update and Reporting functionality must be extended to every department in the firm. At the present time, this functionality is only deployed for Sales and Manufacturing Planning. Marketing, Supply Chain Management, Shop Floor, Customer Installation, and the Support departments will eventually have access to these services. To support those Neatsmith employees that do not have easy access to a Desktop or Laptop PC (roughly half of the workforce!), Opagio has developed the first version of the smartphone user interface that will enable employees to access the work activity update and reporting services from their phones. The existing user interface for both Sales and Manufacturing presents the entire Management Production Function on a single (large) display which would clearly overwhelm a smartphone or tablet. Some further development work is needed to ensure that only the necessary data concerning for that day's work is presented to each employee.

5.3.16 High Performance Saw

A new high-performance saw was commissioned in May 2024. This saw enables the operator to define a series of cutting jobs for different sizes and colours of output. It can automatically load large boards (2800 x 2070 x 22mm) now supplied by Egger which are too large to be handled manually and then follow the cutting instructions. The sawyer's work has been greatly simplified. The new saw will also provide much higher capacity than the previous generation of manually operated saws. Neatsmith's COO expects that the new saw will enable them to double output over the next five years.

5.3.17 Edgebander Return Table

An automated return table was installed in June 2024 on the Edgebander. This enables it to be operated by one man, which reduces costs while increasing productivity

5.3.18 Upskilling Drivers

Early in the project, the COO decided to upskill the work of drivers, who at that time were in extremely short supply, by training them to deliver the furniture to the customer's home and prepare the site for the installation team. This enabled him to pay them a higher hourly wage. This second round of upskilling if for them to learn how to operate the new machinery on the shop floor, specifically the new Edgebander and saw. For each new machine that is mastered an additional bonus will be paid.

5.3.19 Summary of Complementary Investments in Manufacturing

Summary of Complementary Investments in Manufacturing Operations

Reference	Project Description	No.	Type of Complementary Investment
5.2.1	Work Activity Map	2	Work Activity Descriptions
5.4.1	Work Activity Reporting	1	Work Activity Reporting
5.4.2	Customer Installation Manager	7	Human Capital
5.4.3	Apprenticeship Programme	7	Human Capital
5.4.4	Updkilling Factor Employees	7	Human Capital
5.4.5	Upskilling Drivers	7	Human Capital
5.4.6	Updating the Bill of Materials	3	Work Object Database
5.4.7	Updating the Bill of Materials v2	3	Work Object Database
5.4.8	Releasing Customer Orders to Manufacturing	3	Work Object Database
5.4.9	Managing the 13 Week Schedule	3	Work Object Database
5.4.10	Rework Reporting	3	Work Object Database
5.4.11	Implementing the Fair Work Project	4	Fair Growth / Work & Management Practices
5.4.12	Management Practices Questionnaire	4	Fair Growth / Work & Management Practices
5.4.13	New Automated Edgebander	6	Capital Investment (Tangible)
5.4.14	Smartphone Reporting	3	Work Object User Interface
5.4.15	High Performance Saw	7	Capital Investment (Tangible)
5.4.16	Edgebander Return Table	6	Capital Investment (Tangible)
5.4.17	Upskilling Drivers	7	Human Capital

Chart 42: Summary of Complementary Investments

5.3.20 Manufacturing KPIs

	£ Installed	% Completed	Del 1 Go	Del day b4	finals o/s	jobs o/s	finals due	Notes
Week 1	£104,092	84%	92%	62%				4 day week, 20 days holiday
Week 2	£178,710	64%	72%	72%				9 sick days, 6 holidays
Week 3	£185,549	61%	49%	72%	£117,456	57	£50,403	2 sick days, 10 completion days
Week 4	£222,554	67%	73%	84%	£116,877	57	£49,040	17
Week 5	£172,945	56%	86%	79%				there are no £ values in for london architecture
Week 6	£198,796	63%	81%	83%	£115,566	57	£64,109	24
Week 7	£212,708	90%	82%	72%	£113,488		£63,212	7 days holiday
Week 8	£251,313	62%	87%	62%	£111,000		£37,000	
Week 9	£270,736	79%	78%	71%				
Week 10	£243,172	58%	80%	72%	£111,000		£67,000	
Week 11	£268,749	61%	71%	74%	£109,268		£41,812	6 days holiday
Week 12	£280,324	77%	85%	58%	£104,176		£47,141	
Week 13	£186,652	71%	78%	80%	£99,164		£47,711	4 day week, 12 remedials
Week 14	£206,020	81%	80%	88%				4 day week
Week 15	£171,000	83%	80%	86%	£88,822.58		£43,501	
Week 16	£219,469	85%	84%	82%	£68,526		£32,608	
Week 17	£280,008	48%			£59,378		£30,821	
Week 18	£275,825	54%	78%	64%	£50,552		£31,701	32k export STURM
Week 19	£181,143	55%			£49,710		£28,262	
Week 20	£169,638	67%			£44,942		£26,196	
Week 21	£234,910	79%			£44,941		£26,196	
Week 22	£228,171	67%	83%	70%	£44,941		£26,196	
Week 23	£236,748	71%	59%	66%	£44,421		£26,196	
Week 24	£143,547	72%	77%	77%	£41,703		£22,607	
Week 25	£186,205	65%	74%	95%	£260,669		£65,532	
Week 26	£211,501	73%	72%	81%	£185,634		£41,996	
Week 27	£205,994	82%	85%	68%	£174,080		£53,252	
Week 28	£241,885	81%	91%	88%	£172,520		£53,252	
Week 29	£188,456	84%	88%	78%	£169,611		£40,703	
Week 30	£178,305	69%			£169,611		£39,461	
Week 31	£233,000				£119,340		£32,985	
Week 32								
Week 33								
Week 34								
Week 35								
Week 36								
Week 37								
Week 38								
Week 39								
Week 40								
Week 41								
Week 42								
Week 43								
Week 44								
Week 45								
Week 46								
Week 47								
Week 48								
Week 49								
Week 50								
Week 51								
Week 52								
AVG	£211,875	70%	79%	75%				

Chart 43: Neatsmith Manufacturing KPIs

5.4 Sales

Work on providing the Software Platform to support Manufacturing Operations started in July of 2021. In early 2022, having witnessed the productivity and efficiency improvements delivered by the digital growth platform, Neatsmith's Chief Revenue Officer (CRO) decided that his sales department could also benefit from the platform. The CRO had already made investments in the Neatsmith Website, but he agreed that

extending the Platform to include work activity tracking and reporting and a customer database for the sales teams would be beneficial, and also provide better connections between Sales and Manufacturing Operations.

5.4.1 Consolidating the Customer Database: May 2022

Whilst the design consultants in the Marketing and Sales department use PCs and customised CAD application to create room designs for potential customers, at the commencement of the effort to implement the Growth Platform everything else in Marketing and Sales used only a mixture of Excel spreadsheets and email. There was no shared customer database, which led to multiple repositories of customer and project data spread among multiple departments. Overall, the data quality was poor because it had been captured inconsistently with no central governance.

This problem was addressed in May of 2022 by the creation of the shared database implemented to support Manufacturing Operations (discussed in sections 5.3.6 to 5.3.8). This database holds all the information about customers and orders. Because personnel and processes in the Sales and Marketing division could access this database, the multiple data stores that had sprung up to capture customer data became unnecessary and were abandoned. Ease of access ensured that Marketing and Sales personnel could access customer and order information quickly, and the use of a common data store ensured that customer data would be used consistently across all processes at Neatsmith. This would increase team productivity by decreasing the rework arising from the use of poor-quality customer data.

5.4.2 Work Activity Update and Reporting: May 2022

Before moving to a work activity update and reporting system based on the shared database in the digital growth platform, Manufacturing had long tracked its work activities using Excel. However, Sales did not have a standardised sales process that could be modelled in Excel and followed by all employees. Indeed, the Sales process at Neatsmith is based on the Sales Funnel model, and Neatsmith did not have any specific tools or processes designed to increase the productivity of that Funnel.

In May of 2022, Opagio completed a project to implement automated work activity updating and reporting for a pre-defined sales process. All customer journeys are tracked, and each work activity in the defined sales process can be tracked and managed. Each showroom manager can track what each salesperson is doing and help them improve. The goal is to increase sales yields in 2023 and is particularly important to support the opening of new stores and the recruitment and training of new sales personnel in 2024.

5.4.3 Improve Customer Quote Tracking: August 2022

Once a designer had completed a quotation for a prospective customer, the Neatsmith work activity system had them sending the quote to the customer by email. The problem with this approach was that Neatsmith's Sales and Marketing personnel had no

way of knowing whether the customer ever opened or read the email, making follow-up challenging.

Neatsmith worked with Opagio to securely store customer quotations on the Neatsmith website. Starting in August of 2022, instead of sending an email with the quote as an attachment, the designer sends the prospective customer an email with a trackable link that points to the quote on the website. As soon as the prospective customer visits the site and opens the quotation, the website alerts the Neatsmith salesperson. The work activity system then prompts the salesperson to follow up by phone a few days later. This has made it easier for the Sales and Marketing team to stay on top of quotations.

5.4.4 Improving the Quality of Quotations

As noted in section 5.3.6, once Sales and Marketing gained access to the BOM database it was possible to create and accurately price quotes for customers. These quotes would then be passed directly to Manufacturing, dramatically streamlining the process of delivering goods to customers — as long, that is, as the customised articles of furniture could actually be manufactured. Once these customer orders arrived in manufacturing, they were checked for completeness, but around one third of these orders had to be sent back to Sales for some level of rework. This resulted in a number of poor-quality quotations which then had to be reworked with back and forth between Manufacturing, Sales, and sometimes the customer.

In order to deal reduce the size of the rework problem, Marketing and Sales made a growth investment in a new Sales Quotation Application, which was designed check a quote against the BOM using a set of rules that could determine which configurations were valid and which were not. This new application went live at the beginning of Q1 2023 and already appears to be reducing rework levels.

5.4.5 New Sales Showroom

At the present time, Neatsmith's showrooms are all within the M25. A key part of their growth strategy is to expand their showrooms in the Southeast and, later, in Birmingham and Manchester. They have signed contracts to open a new showroom in Guildford and opened it in November 2023. Expected sales from this new showroom will be £1m per year

As Neatsmith expands its sales operations to include new products and new showrooms, there is a growing understanding of the need for performance reporting. Specifically, the CRO wanted to track the state of Enquiries, Quotes and Sales Orders across all Showrooms and all Designers within each Showroom. The CRO believes that this new report will provide information on sales performance that will enable him to implement continuous improvements. Neatsmith already use the services of a sales consultant to help coach the sales teams, but once individual reporting can be provided to each designer and manager this coaching work could be extended to individuals.

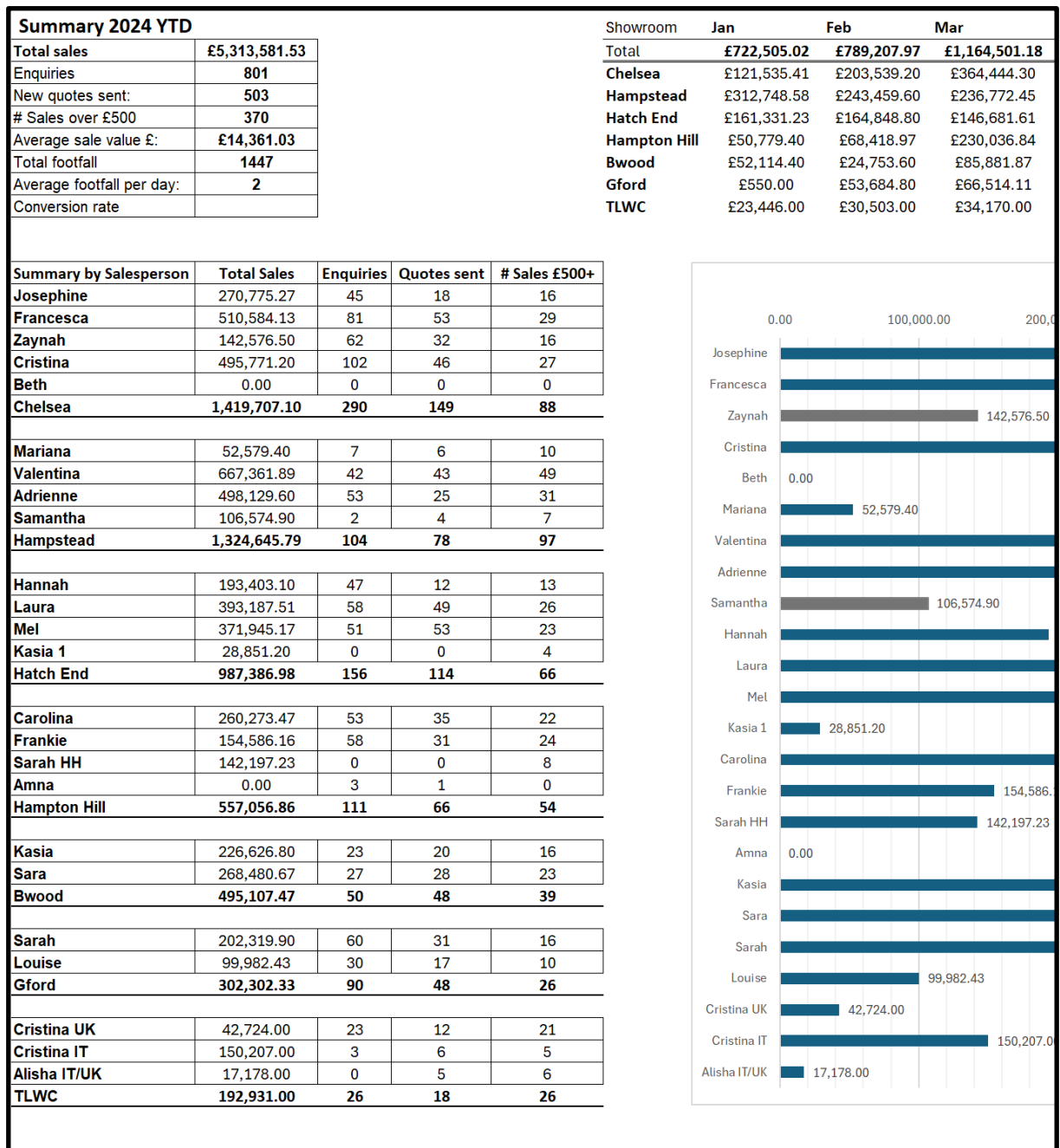


Chart 44: Sales reporting KPIs (Source Neatsmith Ltd)

5.4.6 Summary of Complementary Investments in Sales

Reference	Project Description	No.	Type of Complementary Investment
5.5.1	Work Activity Map	1	Work Activity Descriptions
5.5.2	Consolidating the Customer Database	3	Work Object Database / Technology
5.5.3	Work Activity Reporting	2	Work Activity Reporting
5.5.4	Improve Customer Quote Tracking	3	Work Activity Database / Technology
5.5.5	Improving Quality of Quotations	3	Work Activity Database / Technology
5.5.6	New Sales Showroom	6	Capital Investment
5.5.7	KPI Reporting	2	Work Activity Reporting

Chart 45: Complementary Investments in Sales

5.5 Marketing

5.5.1 Uploading Leads from the Neatsmith Website: August 2022

Neatsmith Marketing unveiled a new website in 2021. While the website could capture data about site visitors and pass this data to Sales, it was passed as a manual report that the Sales Manager then had to break down by showroom and then share with the showroom manager, who would then manually enter the captured data in a lead tracking file maintained at the showroom level. This file, as noted above, thus contained customer and potential order information that was independent of any customer and order information that might be in any other Neatsmith system.

To solve this problem, Neatsmith commissioned the creation of a new application programming interface (API) for the website provider which delivers these enquiries straight into the Sales Process application described in section 5.4.2. From there, they can be allocated to Showrooms and Designer. This change has significantly reduced manual data entry and the errors arising from that process. It has also improved both the flow of information and its quality into Sales. This has enabled the Showrooms to respond more quickly to customer interest and to capture, respond to, and track movement through the Sales Funnel.

5.5.2 Growing Marketing Effectiveness and Productivity: June 2024

One of the challenges identified by both the CRO and COO of Neatsmith is to get a better understanding of Marketing spend and its impact on the Marketing and Sales Funnel. From talking to other SMEs, it is clear that this is not just a Neatsmith problem. It has been also identified by the Productivity Institute (van Ark 2024) as a key driver of productivity growth.

Opagio's growth platform can already identify Marketing spend from the Purchase ledger and Payroll. It also, as part of the Sales application, implements a funnel system which captures data from the Neatsmith website and Sales databases to show activity in each part of the funnel. The missing part of this puzzle is a better understanding of the Marketing Manager's work activities, in particular the work activities associated with

determining which marketing channels to invest in. In the end, the key measure of marketing output is *the quantity and quality of warm leads* which are provided to sales. Each of these warm leads can be tracked all the way through to orders, so insight into which channels yield the most leads is critical. Some leads also lead to higher average sales values, so the quality of the lead is also an important metric.

Neatsmith's COO is now working with the Marketing application and database to better understand the effectiveness of current spending. Once the effectiveness of each of the different marketing channels has been better understood it becomes possible for the Marketing Manager to recommend additional investments with a probabilistic forecast of the additional return, which in turn will drive increased showroom traffic and lead to more quotations and ultimately more orders.

Reference	Project Description	No.	Type of Complementary Investment
5.6.1	Uploading Leads from Website	3	Work Object Database / Technology
5.6.2	Marketing Analysis & Growth Application	3	Work Object Database / Technology

Chart 46: Summary of Complementary Investments in Marketing

5.6 Growth Strategy, Growth Investments and Growth Balance Sheet

Several months into Opagio's engagement with Neatsmith, it became clear that Neatsmith did not have a formal growth strategy. Nor did it have any planning tools which would enable company executives to model the growth of the business by adjusting parameters for timeframe, revenue growth, purchases growth, labour productivity growth, and wages growth. In discussions with the COO, he soon came to understand the need for a formal growth strategy and the value of tools that could facilitate the modelling of such a strategy.

One factor contributing to the COO's increased interest in developing a formal growth strategy was a paper on Intangible Assets that the author had delivered at the ESCoE conference in November of 2021 (Stroll, 2021a). This paper had built on earlier work by the author had done on the subject in the Intangible Gold Project at the Big Innovation Centre in 2016. The 2021 paper outlined how new software applications were needed at firm level to solve the 'unmeasured intangibles' problem. An Innovate UK Smart Grant was used to build a prototype of an application that would classify and allocate data from financial ledgers (payroll and purchasing) to intangible assets (as defined by Corrado, Hulten and Sichel, 2006) and implemented by ONS as part of their TFP reporting. This prototype also included a growth scenario forecasting application which enabled Neatsmith's COO to create a growth forecast for the firm and identify the complementary investments that would be needed to deliver the plan. These investments could then be classified as tangible assets, measured intangible assets, or unmeasured intangible assets and placed on a Growth Balance Sheet.

As part of the Future Research (Chapter 8) a new Growth Strategy application and database is being developed which will enable Neatsmith to export data from its Monthly Management Report prepared by Finance to populate the Growth Database, which in turn would provide the data needed to create monthly TFP Reporting. These are also needed to support the growth scenario modelling as implemented in the prototype.

Chart 47 below, from the Opagio Growth Strategy prototype application, shows a summarised version of Neatsmith's first five-year Growth Strategy.

Growth Scenario April 2022							
Revenue growth	20.00%	20.00%	20.00%	20.00%	15.00%	15.00%	
Productivity growth	10.00%	10.00%	10.00%	10.00%	10%	10.00%	
Purchases growth	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	
Wages growth	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	
	2021	2022	2023	2024	2025	2026	2027
Revenue growth	£8,590,070	£10,737,588	£11,456,710	£13,175,216	£15,151,499	£17,424,223	£20,037,857
Total Purchases	£4,619,599	£5,266,285	£6,331,679	£7,281,431	£8,373,646	£9,629,693	£11,074,146
GVA	£3,970,471	£5,471,302	£5,125,031	£5,893,785	£6,777,853	£7,794,531	£8,963,711
Headcount Sales			24	25	27	28	29
Headcount Operations			54	56	59	62	65
Total Headcount	75	85	78	82	86	90	94
Labour Services Sales			£1,063,749	£1,116,936	£1,172,783	£1,231,422	£1,292,993
Labour Services Ops	£2,536,653	£2,996,421	£2,127,186	£2,233,545	£2,345,222	£2,462,483	£2,585,608
Gross Margin			45%	45%	45%	45%	45%
Gross Operating Surplus	£1,184,342	£2,163,036	£1,934,096	£2,543,303	£3,259,847	£4,100,625	£5,085,109

Chart 47: Neatsmith growth strategy, April 2022 (Source Neatsmith Ltd)

In April of 2022, when this first forecast was produced, Neatsmith's first quarter sales orders were up by 25%, so the CRO forecast that revenue growth would continue at a high rate. The assumption for productivity was that they would make sufficient growth investments to deliver a 10% annual growth rate. Purchases were forecast to grow in line revenues, whilst headcount was expected to grow at half the rate of revenue growth (which illustrates the impact of labour on productivity growth).

During the second and third quarters of 2022, Neatsmith were in discussion with a Private Equity firm who were looking to purchase them to extend their portfolio. These discussions went on for a number of months and it became clear to the COO and CRO that their numerical grasp of the key parameters of their business were on par with their prospective purchasers. This gave the COO great encouragement, and he now runs the Growth Strategy application quite often to test his own thinking and to consider alternative growth scenarios.

Unfortunately, the collapse in UK economic confidence in Q3 due to the short-lived Truss government led to the private equity investors deciding not to continue, but the relationships developed during the acquisition turned out to be very helpful, as will be

seen later. The collapse of the Truss government also had a devastating effect on revenue growth, which dropped dramatically in the second half of the year.

5.6.1 Insights from the 2019 to 2021 Growth Report

The chart below summarises Neatsmith's TFP growth history from 2019 to 2021. This includes the two COVID years which badly affected 2020 and led to a reduction in EBIT during the period and negative TFP Growth.

Neatsmith Productivity History	2019	2020	2021	2 Year Change
Sales Orders	£7,764,368	£7,047,137	£9,652,168	124%
Revenue	£7,783,199	£6,098,724	£8,590,870	110%
Purchases Energy	£88,176	£62,769	£86,677	
Purchases Materials	£2,871,094	£2,155,327	£2,957,223	
Purchases Services	£1,315,715	£1,145,259	£2,058,473	
Total purchases, GBP	£4,274,986	£3,363,356	£5,102,373	119%
GVA - Firm	£3,508,213	£2,735,368	£3,761,940	107%
M&S Headcount	19	20	20	
M&S Labour services	£625,690	£598,868	£798,398	
Operations Headcount	56	56	58	
Operations Labour Services	£2,311,869	£2,108,370	£2,445,441	
Total Labour services, GBP	£2,937,615	£2,707,294	£3,243,839	110%
GVA per Head Labour Productivity	£46,776	£35,992	£48,230	103%
EBITDA, GBP	£570,598	£28,074	£518,101	
Tangible Capital Services	£149,743	£190,629	£247,740	
Intangible Capital Services				
Unmeasured Intangible Capital				
Total capital services, GBP	£149,743	£190,629	£247,740	
Total EBIT Growth / Decline	£420,855	£28,074	£270,361	Cumulative £719,290
Revenue Growth EBIT 10%				10%
TFP Growth EBIT -39%				-39%

Chart 48: Neatsmith TFP Growth 2019 to 2021

5.6.2 Insights from 2022 to 2024 Productivity Growth

To measure the results of the Case Study, Neatsmith have also provided TFP Growth Reporting for the 2022 to 2024 period with the last two months of the final quarter being estimates.

Neatsmith Case Study	Baseline 2021	2022	2023	2024 *	Three Year Change
Sales Orders	£9,652,168	£10,030,221	£9,962,475	£10,663,101	110%
Revenue	£8,590,870	£9,704,874	£9,767,391	£10,709,875	125%
Purchases Energy	£86,677	£152,123	£154,465	£213,499	
Purchases Materials	£2,957,223	£3,576,122	£2,985,536	£2,921,440	
Purchases Services	£2,058,473	£1,615,297	£1,819,789	£2,142,679	
Total Purchases	£5,102,373	£5,343,542	£4,959,790	£5,277,618	100%
GVA - Firm	£3,761,940	£4,361,332	£4,807,601	£5,432,257	144%
M&S Total Employees	20	20	22	22	
M&S Labour services	£798,398	£1,040,136	£1,078,753	£1,031,086	
Operations Total Employees	58	58	56	56	
Operations Labour Services	£2,445,441	£2,924,064	£2,708,915	£2,930,468	
Total Labour services, GBP	£3,243,839	£3,964,200	£3,787,668	£3,961,554	122%
GVA per Head Labour Productivity	£48,230	£55,915	£61,636	£69,644	144%
EBITDA, GBP	£518,101	£397,132	£1,019,934	£1,470,703	284%
Tangible Capital Services	£247,740	£273,140	£206,629	£244,816	
Intangible Capital Services			£20,030	£24,130	
Unmeasured Intangible Capital		£18,010	£30,340	£35,140	
Total capital services, GBP	£247,740	£291,150	£256,999	£304,086	123%
Total EBIT	£270,361	£105,982	£762,934	£1,166,617	£2,035,533
Revenue Growth EBIT: 8.3% annually		£292,801	£317,103	£343,423	£953,327
TFP Growth EBIT Residual		-£186,819	£445,831	£823,194	£1,082,206
Revenue EBIT Growth: Percentage 2024				29%	
TFP EBIT Growth Residual: % 2024				71%	
Valuation EBIT * 6				£6,999,702	

Chart 49: Neatsmith TFP Growth 2022 to 2024

5.6.3 Discussion of 2022 to 2024 Growth

During the previous decade, Neatsmith had never increased labour productivity more than 1–2% per year and TFP had declined during the COVID years. So, the first lesson to be learned before management embark on a productivity journey is that it is very helpful for them to understand their productivity history.

During the case study Neatsmith increased Revenue by 25% and GVA by 44% as shown in the chart above. Total EBIT grew from £270k in 2019 to 2021 to £2.035m in 2022 to 2024, of which Revenue EBIT represented £953k and TFP EBIT £1.082m. In 2024, the year for which the firm valuation is calculated. Revenue EBIT accounted for 29% of EBIT, whilst TFP EBIT accounted for 71% so the firm valuation was very strongly impacted by TFP EBIT growth.

One of Neatsmith's great success stories has been their ability to manage the growth of purchasing costs which have a considerable impact on GVA. During this period there was significant imported inflation which resulted in rising costs, yet Neatsmith managed this very aggressively by pursuing a new wood supply contract with the leading UK supplier which reduced purchase costs by roughly £500,000 a year starting towards the end of 2023.

5.6.4 Labour Productivity Growth

Since Neatsmith began their productivity growth journey they have increased their labour productivity, measured by GVA per employee, 44% over three years as shown below.

2021	£48,230	Baseline
2022	£55,915	
2023	£61,636	
2024	£69,644	Three Year Increase 44%

5.6.5 Why a higher TFP share of EBIT is What Investors Want

As has been seen, firms who invest to deliver GVA and labour productivity growth are rewarded by higher outputs for the same inputs. From the accounting perspective this shows up as margin growth, but the case study firm is interested in a very specific type of EBIT growth which is that which derives from increased productivity. Neatsmith's performance showed not only a high rate of EBIT growth but also that 71% of their EBIT growth came from increasing Total Factor Productivity.

Increasing productivity growth year on year, at a greater rate than revenue, increases margins. But increasing margins through productivity growth is what investors regard as "good" growth, whereas increasing margins by raising prices or reducing wages is regarded as "bad" growth because it is not sustainable. Delivering improved margins through TFP growth will of course require the full range of complementary investments in tangible assets, measured and unmeasured intangible assets, innovation and human capital to be documented on a Growth Balance sheet as outlined below.

5.6.6 Growth Balance Sheet: Classification of Neatsmith's Growth Investments

It has been possible to review Neatsmith's complementary investments since the start of the case study. There are three main areas of investment: new equipment for the shop floor to make better use of the new material supply contract, one new showroom to expand sales capacity, and additional software to implement Productivity Growth Management. These complementary investments can be further classified as shown below:

Operational Investment – this is spending which is consumed within a single financial year which does not create a tangible or intangible Asset and is charged to the Firm's P&L.

Tangible Investment – this is investment which may be classified as a tangible asset, shown on the firm's statutory balance sheet, depreciated and charged to the firm's P&L.

Measured Intangible Investment includes growth investments which may be classified as a measured intangible asset (within the CHS Classification), shown on the firm's statutory balance sheet, depreciated, and charged to the firm's P&L.

Unmeasured Intangible Investments may be classified as unmeasured intangible assets (within the CHS classification) but cannot be shown on the firm's statutory balance sheet or depreciated in the P&L. They can however become part of the firm's growth accounting balance sheet.

Investments in Human Capital Improvement. These may be classified as unmeasured intangible assets (within the CHS classification) but cannot be shown on the firm's statutory balance sheet or depreciated in the P&L. They can however become part of the firm's growth accounting balance sheet.

Investments in Human Capital Stock. These investments require the assessment of level of capability and mode of new and existing employees. Their valuation may be recorded as assets in the firm's growth accounting balance sheet.

5.7 Scaling and Diffusion

In order to support Neatsmith's UK growth plan which is to grow revenues by 30% over the 2025 to 2027 period and their longer-term diffusion plan, which is to expand into the USA, a number of additional complementary investments will be needed.

5.7.1 New Sales Showrooms

At the present time, Neatsmith's showrooms are all within the M25. A key part of their growth strategy is to expand their showrooms further in the Southeast (Tonbridge Wells) and, later, in Birmingham.

5.7.2 Human Capital Development

It is widely agreed that Human Capital is one of the most important assets in any economy, and the ONS have done pioneering work in creating an assessment of the value of UK's human capital which is much larger than both tangible and intangible capital (Dunn, 2022). The contribution of Jaques to the measurement of human capital was documented in the Literature review but since his pioneering work in the 1970s little has been done from a practical managerial point of view. Given that human capital is the greatest asset of the firm then managers need to be able to measure it and value it accordingly. For most firms, specialist support will be needed to conduct the initial assessment but once this is completed the existing Roles and Posts database can be updated provide managerial support for further human capital development.

5.7.3 Growth Platform Investments

The author and Neatsmith COO have identified five more areas where additional research and development is required for the Growth Platform, though this work, outlined below, will take place outside the timeframe of this thesis and is summarised in Chapter 8: Future Research.

5.7.4 Extending Work Activity Reporting to all employees

The COO has realised that the Work Activity Update and Reporting functionality must be extended to every department in the firm. At the present time, this functionality is only deployed for Sales and Manufacturing Planning. Marketing, Supply Chain Management, Shop Floor, Customer Installation, and the Support departments will eventually have access to these services. To support those Neatsmith employees that do not have easy access to a Desktop or Laptop PC (roughly half of the workforce!), Opagio has developed the first version of the smartphone user interface that will enable employees to access the work activity update and reporting services from their phones. Moreover, the COO has decided that that whilst work activity update and reporting is essential it is also insufficient. He has asked Opagio to develop a To-Do lists system for every front-line employee. This will enable employees to use their phones or computers see their daily workload and manage it accordingly. It will also enable weekly and monthly labour productivity reports to be provided for the complete production function which will enable the detailed analysis of the impact of complementary investments on labour productivity to be completed.

5.7.5 Supply Chain Management

As noted earlier significant progress was made in the implementation of the Bill of Materials work object database. However, to manage the supply chain two new databases and associated applications will be needed. The first of these is a new Supply Chain Management work object database which includes a new supplier database and applications which enables purchase orders to be issued to suppliers and tracked through to delivery. The second is a stock control work object database which includes applications update the database as fresh stocks arrive and to update it when these stocks are used by the Shop Floor to manufacture the furniture. These applications will reduce workloads in both Manufacturing Planning and Shop Floor and will also help to better manage working

5.7.6 Managing the Firm's Growth Strategy & Implementation

The third challenge which the COO and I have discussed many times is how to monitor, manage, and value the implementation of the firm's growth strategy. This becomes even more important as the Production Function Systems are implemented. These production functions provide extremely granular productivity reporting at the work-activity, role and post, department and production function. They also make it possible to allocate growth investments to the production system and if needed the department or even work activity level within the system. In addition to managing these growth

investments, they can also be classified using the newly developed template shown below.

Investments excluding Continuous Improvements	Tangible Investment	Measured Intangible Investment	Unmeasured Intangible Investment	Revenue Growth	Productivity Growth	Marketing Sales	Manufacturing
Q4 2021							
Viesturs	£52,000			£52,000			£52,000
Q1 2022							
Q2							
Joanna	£20,000	£20,000		£20,000			£20,000
New Quote System	£59,000	£59,000			£59,000	£59,000	
BOM	£15,000	£15,000			£15,000		£15,000
Contact Form Plug In	£5,460	£5,460			£5,460	£5,460	
Q3							
Q4							
Q1 2023							
Price War	£600			£600			£600
Lukas Forklift	£15,000				£15,000		£15,000
Steliyan Replaces Vlad	£15,000				£15,000		£15,000
Adrian Replaces Ryan	£10,000				£10,000		£10,000
Scheduler	£3,900	£3,900					£3,900
DrillTeq	£58,500	£58,500					£58,500
Q2							
Got rid of Joanna	-£20,000			-£20,000			-£20,000
Old Edgebander	£32,000	£32,000		£32,000			£32,000
Q3							
Homag Edgebander	£122,000	£122,000		£122,000			£122,000
Q4							
Guildford	£200,000	£200,000		£200,000		£200,000	
Bart as Factory Manager	£15,000			£15,000			£15,000
Q1 2024							
Jason Archer	£2,600			£2,600		£1,300	£1,300
Briquetter	£30,990	£30,990					£30,990
Wojtek as Asst Manager	£10,000			£10,000			£10,000
Q2							
New Saw	£170,000	£170,000					£170,000
Q3							
Loopteq	£38,000	£38,000					£38,000
Q4							
Totals 2021 - 2024	£671,490	£83,360	£139,520	£434,200	£119,460	£265,760	£589,290
Questions / Comments July 25th							
Software investment looks too low							
Machinery investments benefit Revenue and Productivity Growth							
I have added the Continuous Improvements to the Unmeasured Intangibles							
I have create a simplified version on a separate tab: This removes the Continuous Investments to a separate spreadsheet							

Chart 50: Neatsmith's Growth Investments 2021 to 2024 (Source Neatsmith)

From this classification the Growth Accounting Balance sheet can be created and updated on a monthly basis in parallel with the Statutory Balance sheet.

5.8 Neatsmith's Next Steps

In the concluding part of the Case Study, Neatsmith's COO provides his view of the next steps in their productivity journey:

"I can see three new areas which will help us increase productivity even further. The first is to bring scheduling, daily to do lists and real-time updating reporting to all the Operations departments, including Manufacturing, Factory, Customer Installations and

Finance & Administration. This will dramatically increase our sharpness and help us engage our front-line employees even more effectively. Because most of these employees do not work in an office environment and do not have access to a laptop or PC, we must make it very easy for them to understand their daily To-Do list and report on their progress. To make this work we will introduce the Neatsmith mobile application which will work on smartphones and tablets.

The second area, which we have talked about and thought about quite a lot, is quality. We pride ourselves as a firm in delivering excellent customer service. We build a high-quality product with the best materials and work hard to install our wardrobes and delight our customers. But we are dealing with many customer orders (heading towards 1,000 per year, each of which may include three rooms, which creates 3,000 cases. As you have seen each case can take 70 work activities from the initial order to the complete customer installation which means we are dealing with over 200,000 discrete work-activities a year in Operations.

Following the introduction of a Rework work activity in Manufacturing in April 2023, Neatsmith can now record and thereby measure the number of sales orders which have to be reworked. At the present time 16% of the sales orders are delivered below standard, and have to be reworked, and rework costs money. What we do not know yet (and need to find out) is the cost of this rework which will rely on the new data from the Neatsmith mobile application. We also need to fully understand every work activity in much more detail, which means extending the Continuous Reporting application with a database that enables us to record all 70 work activities and create and maintain a full description of each one. This is the Complementary Investment application and database which has been discussed earlier. We are discovering that the devil really is in the details when it comes to quality improvement and that poor quality costs serious money.

Let me illustrate this point by looking at the numbers. Our labour costs for Operations in 2022 were £2 million, so that means that every 1% improvement in quality is worth £20,000. Until we put the measurement and reporting application in place, we will not know the true costs of rework in Manufacturing or Sales. But a quick calculation tells me that 5% rework cost us £100,000 a year which is 7% of last year's EBITDA which was £1.4 million. But the truth is, that we do not know what percentage of total work activities have to be reworked. Only by measuring the quality of every work activity will we find out the true costs.

We know that we are nowhere near perfect! We make mistakes, we upset customers, we do not fix things as quickly as we should, and quality isn't really anybody's job. Mostly these problems end up on my desk and I have to fix them, whether that is scrapping the job entirely and starting again, or providing some compensation. I want to see how I can embed quality into every single work activity of the firm and measure it. I then want to figure out the cost of quality and what we have to do to improve it.

The third area really follows the first two. When we are working in real-time with high quality, we will be able to pay our employees and managers much better than other

firms doing the same kind of job as us. What we can then do, is review every single work activity and every employee and ask the following questions, what additional technology could we add to perform this work activity even better, what additional training / knowledge could be added to make this employee perform this work activity even better. Once we have asked these questions and documented them in the Work Activity Descriptions, we can then put Complementary Investments in place to deliver them. What this will get us is the ability to implement Neatsmith anywhere in the world that we choose.

Our 2023 growth strategy included opening a new showroom in Guildford. We expect this investment to support our revenue growth in 2024 and beyond so our focus on quality improvement will have to extend to our Sales and Marketing departments too.

Finally, in order to manage all our investments (including showrooms) we have to put in place a much more robust system for recording, reporting, and managing our investments in Showrooms, Continuous Improvement, Human Capital, and Innovation and tie them back to our strategic objectives of revenue, productivity, and quality growth in our growth strategy. We already capture these ongoing investments, but we have to go much further in relating them to monthly and quarterly performance and to be able to make adjustments based on monthly and quarterly feedback.

In order to expand Neatsmith beyond the UK, we also need to be able to document our investments in intangible assets and innovation in terms that are meaningful to US investors who are much more focused on these 'growth accounting' measurements. This is where the future development work becomes important."

6 Discussion and Results

The three contributions to knowledge resulting from this research are the development a new theoretical framework, which separates a Social Institution (SME in the case study) from its Measurement properties and its Information Systems properties. The second is the identification and specification of the three Production Units which are responsible for implementing the Input → Conversion → Output production function. The third is the software platform to support the implementation of these contributions to knowledge into practice.

6.1.1 How did one Small and Medium SME solve the Productivity Puzzle?

Neatsmith Growth Forecast	2024 Actual	Growth Forecast	2025	Growth Forecast	2026	Growth Forecast	2027	Three Year Change
Sales Orders	£10,663,101							
Revenue	£10,709,875	109%	£11,673,764	109%	£12,724,402	109%	£13,869,599	130%
Purchases Energy	£213,499		£226,309		£246,677		£268,878	
Purchases Materials	£2,921,440		£3,096,726		£3,375,432		£3,679,221	
Purchases Services	£2,142,679		£2,271,240		£2,475,651		£2,698,460	
Total Purchases	£5,277,618	106%	£5,594,275	106%	£5,929,932	106%	£6,285,727	119%
GVA - Firm	£5,432,257		£6,079,489		£6,794,471		£7,583,871	140%
M&S Total Employees	22	25		27		27		
M&S Labour services	£1,031,086							
Operations Total Employees	56	59		62		65		116%
Operations Labour Services	£2,930,468							
Total Labour services	£3,961,554	107%	£4,238,863	107%	£4,535,583	107%	£4,853,074	123%
GVA per Head (Monthly)								
GVA per Head	£69,644		£75,055		£76,342		£82,433	128%
EBITDA	£1,470,703		£1,840,626		£2,258,888		£2,730,797	185%
Tangible Capital Services	£244,816		£331,454		£361,285		£393,800	
Intangible Capital Services	£24,130		£26,302		£28,669		£31,249	
Unmeasured Intangible Capital	£35,140		£38,303		£41,750		£45,507	
Total Capital Services	£304,086		£396,058		£431,703		£470,557	155%
EBIT Growth	£1,166,617		£1,444,568		£1,827,184		£2,260,241	Cumulative
Revenue EBIT Growth: 9% annually			£1,271,613		£1,386,058		£1,510,803	£5,531,993
TFP EBIT: Growth Residual			£172,955		£441,127		£749,438	£4,168,473
Revenue EBIT Growth: Percentage 2027							67%	£1,363,520
TFP EBIT Growth Residual: % 2027							33%	
Valuation EBIT * 7							£15,821,685	

Chart 51: Neatsmith Growth Forecast

The Neatsmith COO and CRO have made a number of decisions for the 2025 to 2027 period. They plan to grow revenue at 30% over the forecast period which compares to the 25% growth in the previous three-year period. They also plan to grow Purchases by 19% and Labour Services by 23% which results in a GVA increase of 40%. If this forecast is achieved, EBIT will nearly double from £1.166m in 2024 to £2.260m in 2027 to provide a cumulative EBIT of £5.311m. Of this EBIT 67% is accounted for by Revenue EBIT growth and 33% by TFP EBIT growth.

To deliver this revenue growth there will be investments in two new showrooms, the first of which is planned to be in Tunbridge Wells and the second in Birmingham. Both showrooms will require £200,000 of capital investment (depreciated over four years) and additional employees to staff them. Sales headcount will rise by five over the period. To deliver the 30% increase in the number of installations, the number of drivers and fitters will rise by three each year for a total of nine over three years. This takes the number of employees from 78 in 2024 to 92 in 2027.

All figures in £000s	2021 EBIT X6	2024 EBIT 6X	2027 EBIT 7X
Total EBIT	£270	£1,166	£2,260
Revenue driven EBIT	£270	£343	£1,510
TFP driven EBIT	0	£823	£753
Revenue EBIT: Percentage of Total EBIT	100%	29%	67%
TFP EBIT: Percentage of Total EBIT	0%	71%	33%
Firm Valuation: Revenue EBIT Only	£1,620	£2,058	£10,570
Firm Valuation: TFP EBIT Only	0	£4,938	£5,250
Firm Valuation: Revenue EBIT Plus TFP EBIT	£1,620	£6,996	£15,820
EBITDA	£518	£1,470	£2,730
Firm Valuation: EBITDA	£3,108	£8,820	£16,380

Chart 52: Neatsmith Valuation Forecast

The chart above shows valuations for Neatsmith in 2021, 2024 and 2027. During the case study years, complementary investments increased TFP EBIT growth from zero to £1.082m which quadrupled the EBIT valuation of the firm at the end of 2024 to £6.996m. The 2027 column shows a forecast valuation of £15.820m due to the next round of complementary investments.

This thesis has focused on the productivity journey of a single SME. Even though the bespoke platform is not yet complete it has supported the Neatsmith in delivering a 44% growth in GVA per head during the case study, which is just under 15% a year.

The chart below extracts the top five deciles from the ONS report (Op Cit) which are shown in the green vertical bar on the right of the chart and plots the case study's progress. This shows Neatsmith's progress in climbing the GVA per head ladder.

ONS All UK Firms			Neatsmith's Productivity Journey			
Mean	£45,000	£50,000	2021	£48,230		Top Five Deciles
1	£50,000	£55,000	2022	£55,915	2026	
2	£55,000	£60,000				
3	£60,000	£65,000				
4	£65,000	£70,000				
5	£70,000	£75,000	2025	£75,055	2026	
6	£75,000	£80,000				
Neatsmith 7	£80,000	£85,000				
8	£85,000	£90,000				
9	£90,000	£95,000	2027	£82,433		
10	£95,000	£100,000				
11	£100,000	£105,000				
12	£105,000	£110,000				
13	£110,000	£115,000	2031	£120,352		
14	£115,000	£120,000				
15	£120,000	£125,000				
16	£125,000	£130,000				
17	£135,000	£140,000				
18	£140,000	£145,000				
19	£145,000	£150,000				
20	Above £150,000					
			Frontier Firms			

Chart 53: Neatsmith's Productivity Journey mapped against ONS GVA Decile

This chart demonstrates provides the context for the productivity growth performance of the case study by comparing its productivity growth measured by GVA per head for three years against the national picture of all UK firms.

In the baseline year of 2021 the case study delivered £48,230 GVA per head. In 2022 this increased to £55,915, in 2023 to £61,636 and finally to £69,644 in 2024. Based on these results the case study's managers decided on a more expansive growth plan which would deliver GVA per head of £82,433 in 2027.

The case study starting position in 2021 was at the top end of the long tail in the Mean band which is £45,000 to £ 50,000 GVA per year. There are five deciles from the mean to the top decile and in three years the case study improved from the Mean to the top of the fifth decile. Their forecast takes them to one band below the top of the fourth decile.

These results are encouraging and whilst not all firms will be as successful as the case study, it does demonstrate that a firm with no prior knowledge or experience of productivity growth could deliver very strong results in a relatively short period of time.

6.2 Implementing Production Units

Unless and until managers can describe, document, implement, and measure the production units for which they are responsible, with all its work activities, its KPIs and its complementary investments they cannot be held accountable for increasing the TFP growth of their unit.

Three types of production units have been identified during the Case Study. These are Marketing; Sales (including Showrooms); and Manufacturing Operations (including Manufacturing Planning, Factory, Customer Installation, Finance and Support Services departments). These production units are important for both firm-level economics and national GDP reporting because they explain how the inputs of labour services, capital services, and purchases are transformed to outputs at market price.

More than one production unit may be needed by the firm, and each production unit can and should be measured separately. The efficiency with which the production unit converts inputs to outputs through work-activities can be directly measured as labour productivity; and, when capital services charges (depreciation) for the use of tangible, measured and unmeasured intangible assets are included, as total factor productivity.

6.2.1 The Marketing Production Unit

Without sales there are no revenues, so all private sector firms must be able to market their products (or services) to paying customers and sell them at a price that enables them to make a profit. That is why this is the first production unit to be considered.

Marketing, sales, and, in some digital-intensive firms, product development, are equally important to drive customer acquisition, retention, and revenue growth. Marketing and sales follow a *funnel system* logic, which is probabilistic in nature. Marketing is used to create awareness of the firm's product or service, but awareness does not, by itself, result in sales. Websites and digital investments in a number of discrete marketing channels are needed to keep potential customers interested and engaged all the way through to the point of purchase. For more complex and expensive products, the firm may also operate a direct sales force, which could be based in a retail showroom or could call on other businesses directly for a business-to-business (B2B) product. Firms can also run a digital sales channel and a showroom-based direct sales operation in parallel.

In a funnel-based production function, there may be many thousands of customer visits to a firm's website ('hits', as they are known), but only a very small number of these hits will result in a sale. What managers need to understand is the whole journey from first website contact all the way to successful fulfilment of a customer order. For this type of production unit, data about the efficiency of the prospect and customer journey — from awareness to placing a first order to a long-term relationship — provides the key measures of success.

The integration between the customer and employee work activities in marketing, sales and product departments becomes a critical success factor, as does the innovation lifecycle for new product and service releases.

A large part of marketing expenditure is now digital. Before the Internet, marketing used television, radio and print as their main channels, and firms deployed their marketing budgets accordingly. The greatest accelerator for digital marketing was not the PC or laptop but the smartphone. Consumers can, and do, make a large percentage of their purchase on their smartphones, even when these purchases are for analogue products or services.

6.2.2 The Sales Production Unit

Sales is much easier than marketing from a technology standpoint. Most SMEs have a reasonable grip on their sales processes, and software providers can offer Customer Relationship Management (CRM) applications and customer databases to support sales work. However, where the firm's products are more complex, general-purpose CRM applications may not be sophisticated enough, and the firm would then need to invest in a more customized (if not entirely bespoke) CRM platform for Sales.

Product Development

In addition to Sales and Marketing, many SMEs will also have one or more Product Development production functions. One of the great advantages of digital products is that they can often be brought to market quite quickly (within 12-18 months) and delivered using the cloud computing infrastructure which is available in most countries of the world. Traditional products may require investments in factories, supply chain logistics, and operating subsidiaries, all of which are too expensive for most SMEs. The challenge for SMEs is not that there are individual departments for marketing, sales, and product but that a single overview of all three production functions will be needed to manage the funnel.

Managing the Funnel

One way of thinking about the problem is to take the metaphor of the funnel and extend it to include Marketing, Sales, and Product Development. By implementing these production functions and providing granular reporting, daily, weekly, monthly and yearly, it becomes possible to integrate the data across all three departments, and provide accurate funnel metrics for leads, conversions, fulfilment, and upgrades, to provide CAC (Customer Acquisition Cost) and LTV (Long Term Value) and retention measures. It also makes it possible to conduct experiments with different marketing channels and campaigns to find out what works best.

KPI Reporting

Managers need to know how well their investments in marketing are raising the market awareness of their brand and driving potential prospects to engage with them and how

many of these prospects book a visit to a store. Once a prospect visits a store and engages with a trained salesperson (a design consultant in a Neatsmith showroom), the result will be a quotation for one or more rooms. Managers will want to know how many customer engagements there have been each week at each store. Prospective customers then have to decide whether to accept the quotation, ask for it to be revised or not proceed with it and this is also an important measure. Lastly management needs to know how many quotations were turned into orders and the value and delivery time for these orders. Once managers have this regular reporting data they can encourage and coach weaker performers.

6.2.3 The Manufacturing Production Unit

In a manufacturing firm, marketing and sales deliver customer orders (of the necessary quality) for the firm's products to manufacturing operations, who then have to make the products and deliver them to customers. Unlike marketing and sales, whose production function systems are funnel-based, the production function systems used in manufacturing operations are usually flow-based. Flow-based systems follow a deterministic logic. Every order or customer must be dealt with within a prescribed time, and the flow of work activities and the expected results of each work activity is well documented and well understood by all the participants. Any missed step in the sequence can lead to disappointment, or in the worst case, disaster.

Flow Systems and Work Activities

Flow Systems track work-activities and individual cases for each of type of work object and are in essence deterministic, because each work activity is prescribed in a sequence, mean that it is always possible to know the preceding work activity and the succeeding one. These types of systems are best served by real-time data capture and reporting. In other words, once a work activity is completed it must be recorded as complete and be visible to all. Flow systems can break down very easily if this simple rule is not observed.

One of the main drivers of the factory system at the beginning of the industrial revolution was to bring all the workers together in the same building so that the flow of work through the division of labour could be supervised and maintained. (Fitton 1989) The second feature of flow systems is that whilst there may be a relatively small number of work-activities to be performed, the complexity of flow systems derives from the number of unique cases into which these activities can be combined. As discussed earlier, Neatsmith's Manufacturing Operations has roughly 50 distinct work activities, yet the company processes some 800 unique customer orders a year, each of which may involve as many as three distinct rooms. This means that Neatsmith's flow system must actually deal with more than 100,000 work-activities each year ($50 \times 800 \times 3$). If any of these work activities is not performed — or is not performed correctly, or is performed later than it should be, or is performed badly — problems will occur down the line. In the worst case, the output at the end of the process may need to be completely reworked. Indeed, before Lean methods were adopted in the highly complex world of automobile manufacturing, where there are many more work activities and work-

objects than in the Neatsmith environment, as many as 25% of the vehicles produced might have to be reworked, at an extraordinary cost.

Implementing the Manufacturing Production Unit

The work activity map for the Manufacturing production unit sets out all the departments and all the work activities in each department which must be completed so that the customer's order is successfully delivered and installed in the customer's home, and signed off by them as being satisfactory.

How are Work Activities Described?

Work activities can be described very simply, as is done on most work activity maps but in order for employees to deliver a work activity there must be a description of the work objects to be produced. As noted earlier there are three very different types of work object: Material, Digital and Human. Manufacturing deals primarily with material work activities.

How are Work Activities Updated?

As noted earlier, every work activity results in an output which contributes to a specific product or service. The growth platform shows the work activities to be performed on the horizontal axis, and the individual customer orders are shown on the vertical axis of what looks like a spreadsheet. When an employee completes a work activity, he or she marks it as complete, and the database is updated. There is also an option for the employee to score the input work activity Red, Amber, or Green, which alerts departmental management to a possible problem. The status of all work activities in the department are updated in real-time and can be viewed by the COO, department manager and selected employees.

How are Work Activities Reported?

Work activity reporting is very specific and includes the date and time the work activity was completed, its quality status and the employee who completed it. If daily to-do lists are implemented and made available through a smartphone user interface, every employee would be able to see their workloads and a real time report of their own performance. From this data, work activity reports can be produced summarizing activity and performance data over any prospective interval (e.g., weekly, monthly, quarterly, and so on). For each work activity, data on the quantity, employee, completion time and quality would be provided. The platform supporting the productivity function would also capture labour hours and labour services costs for each employee, making it possible to calculate average cost and average duration as well.

Department managers may also be interested in knowing:

- Total number of work activities per employee and department per week.

- Average duration of each work activity in hours and minutes.
- Percentage of work activities assessed Green.
- Percentage of work activities assessed Amber.
- Percentage of work activities assessed Red.
- Cost of Rework for Amber and Green Work Activities.
- Number of Work Activities per employee.

All of which can be extracted from the data accrued from real-time updates captured in the system.

How are Work Activities Scheduled?

One of the big challenges in operations is the scheduling of work for different departments. For example, Manufacturing Planning needs to plan on a rolling quarterly basis to ensure that all materials have been ordered to arrive at the right time for shop floor assembly in the factory, and to book customer installation teams to complete the delivery. In addition to this 13-week forward view, each department manager needs four-week and one-week views of the schedule. Lastly, many work activities in the Factory and Customer Installation teams need to be scheduled on a daily basis in the form of To-Do lists.

How are Work Activities Improved?

There is a long list of complementary investments which are described in the next section. These range from continuous improvement, during which the manager may ask the employee how he or she would improve the work activity, to employee suggestions of improvements and / or department or Manufacturing Operations management inputs. Information technology and machinery can also help to improve work activities, as can employee training (often on the job) and / or management coaching.

Discussion of Digital Work Objects

As discussed earlier, the work of marketing managers in the past 20 years has almost been entirely digitised, which requires a different set of skills from those that were required during most decades of the twentieth century. Digitisation has also affected many other work activities and roles in many industry sectors. In these situations, not only is the work activity digitised but the work objects also.

Drucker (1993) pointed out many years ago that one of the impacts of information technology would be a dramatic increase in what he called 'knowledge workers', whose output is in the form of digital work-objects. Firms which offer these knowledge services range from long-established professions like law and accounting to much more recent ones including management consulting, strategy consulting and a wide variety of specialist consulting firms. The production units for this type of work are not, compared to funnel and flow systems, particularly well defined. Indeed, most of the work may be based on tacit knowledge gained through professional apprenticeships. In flow systems, the workflow itself, and every work activity and work object, are rigorously

documented and reported on. In knowledge based professional services, the overall object of the work is well understood by suppliers and customers, but the timetable, discrete work activities and work objects are not. Until now there has been a lot of augmentation of these systems, typically in document management and time and matter recording but very little automation. Some of these services could be treated as 'projects' where the entire scope and sequence is largely pre-determined following the flow logic discussed earlier.

6.2.4 The importance of Work Activities and Work Objects in Labour Productivity reporting

One benefit of ERP systems is that they document the work objects as well as the work activities. The bespoke software for Neatsmith Manufacturing and Sales production units also includes both work activities and work objects. For example, the Bill of Materials in manufacturing sets out not only all the materials needed, but which configurations can actually be built and delivered. Sales has implemented its own Customer database which provides work objects and also the Quotation Application, which screens every customer quotation to ensure that it can actually be built by manufacturing. The combination of work activity reporting for calculating inputs to the production unit and of KPIs for work objects for calculating the outputs from the production unit are both necessary to provide full labour productivity reporting for a production unit.

Initial research suggests that it may be possible to acquire the data required for Work Activity and KPI reporting from existing ERP systems. Two possible approaches will be considered in due course. The first is to write SQL queries to extract the relevant data from the ERP database, where this is possible. The second is to use a specialist data-lake provider who can provide access to a wide range of applications and databases and supply the required data. This would make it much easier to extend the Bespoke Platform into SME's with ERP systems. For those SMEs without ERP systems the Neatsmith bespoke system already provides work activity and KPI reporting of work objects, so there is no technical problem in providing this functionality. There is no reason why this functionality cannot be architected into a generalisable platform. which would be valuable for those firms without IT Departments.

6.2.5 Productivity Deepening

There have been a number of consequences of the ending of work study and the disappearance of work in some, but not all production units. During the 1950s and 1960s employee engagement was primarily through their wage packets. Many manufacturing firms had implemented standard times for each work activity or operation, and paid weekly bonuses on their accomplishment. With the demise of work study this practice disappeared and many occupations paid a flat rate for the work without any bonuses. One of the weaknesses of this approach is that the old style of employee engagement, with all its flaws, has gone but nothing much has replaced it.

Three observations have been developed during the case study which may be relevant for future implementations of Digital Management Practices using the Cube.

1. You can't manage what you can't see
2. You can't manage what you can't measure
3. You can't improve what you can't see

Once the Work Activity Map is created and made socially shareable, every production unit manager can see the work activities for which he or she is responsible. She can also see the flow of cases and case types from the beginning of the map to the end. The decision then becomes, when does one extend the view of Work Activity Map to one's managers, and when do they extend the same view to their front-line employees? These are of course managerial decisions, but they could have a very strong impact on employee and managerial engagement in the work of the production unit. Neatsmith management already engage directly with front-line employees to develop work descriptions, so the work activity map takes this a step or two further.

The second question relates to the measurement and reporting of work activity performance in three dimensions:

- Work activity productivity, measured by the quantity performed, the quality of the performance, the duration and the cost of each activity. As the smart phone application is rolled out to the shop floor and fitters almost all manufacturing employees will be providing real-time updates. This would make it possible to provide work activity reports to all employees as well as aggregated versions for first and second level managers.
- The second dimension is the KPIs for the overall unit and for each manager within the production units. Preliminary versions of these KPIs have been developed for Sales and Manufacturing and will updated in due course.
- The third dimension focuses on the efficiency measurements of labour productivity and capital productivity which together make up TFP. These can only be provided at the production unit level, because this is where the input of labour, capital and purchases are converted through the unit's work activity map to provide the intermediate or final outputs of the firm.

The third question relates to the engagement of all employees in the continuous improvement of the production unit and the complementary investments which can be deployed. There is a strong argument to be made that the people doing the work are the ones who best know how to improve it, purely on the grounds that they spend all their time on a relatively small number of work activities and may have a lot of ideas about improvement.

6.2.6 Lessons Learned at Neatsmith

Based on the Case Study work at Neatsmith so far, some preliminary lessons can be drawn which might encourage other SMEs to consider Digital Management Practices to grow their firm's revenue profitability and productivity-driven profitability in parallel.

The successful achievement of measurable productivity improvements at Neatsmith, if achieved by other SMEs, would help boost overall productivity and profitability in this important sector and thus contribute to solving the UK Productivity Puzzle discussed at the outset of this work. There are six challenges to be overcome.

1. Developing, implementing, and reporting a successful TFP Growth Strategy.
2. Delivering sustainable and cost-effective Revenue Growth.
3. Achieving Operational Excellence and Quality.
4. Getting employees fully engaged in continuous improvement.
5. Investing in innovations that deliver revenue and profitability growth.
6. Hiring, developing, and retaining the right people.

Each of these will be discussed in turn.

6.2.7 Developing, Implementing and Reporting a Successful TFP Growth Strategy

Managing an SME can often feel like a continuous stream of interruptions, all of which are important, but most of which get in the way of delivering the firm's strategy. SMEs are more vulnerable than large firms in this respect, because the number of first level managers compared to the number of front-line employees is quite low, and the number of senior, or second level managers is even lower. Most of the interruptions are just normal day to day business, a big sale is not going through as expected, a new machine has been ordered but delivery has been delayed. Others are caused by external factors outside the control of the business, the COVID outbreak and lockdowns in 2021 and 2022 are still fresh in mind and the April increase in company taxation affects this year. All these day-to-day challenges make it hard to create a growth strategy and even harder to keep it up to date.

6.2.8 Delivering Sustainable and Cost-Effective Revenue Growth

Every SME has at least one senior manager whose job is to deliver new customers and new orders from existing customers. The growth of the Internet has made this sales challenge harder for SMEs, particularly for those serving retail customers. In years past a prospective customer might visit a store to browse, and if they liked what they saw, buy it. Today prospective customers visit the firm's website and decide whether they like the look of what they see. Many prospective customers may not follow up with a visit but who knows how many, or how to influence these prospective customers? One often hears the phrase 'marketing is a bit of a black box: we know where we're spending money, but we don't really know which channels work the best for our products'. Again, there are also factors outside the firm's control. Firms who are selling higher priced products may find that demand weakens when credit tightens. The automobile industry is particularly sensitive to monthly leasing rates which have jumped over the last year. For those SMEs, whose products and services are themselves digital (an increasing part of the economy), the old ways of developing new products and bringing them to market has changed radically as the channel to market and to sales fulfilment also have to change in lockstep with the product.

6.2.9 Achieving Operational Excellence

Many large firms have implemented LEAN practices to drive up quality and drive down the level of rework. Before LEAN was implemented in the automobile industry, European firms with reputations for high quality were reworking 25% of their vehicles. The Japanese firms who had developed LEAN and implemented it first, were achieving less than one per cent rework, and many were striving for the elusive Six Sigma goal, which is one in a million. How do SME's implement these kinds of practices, without a large investment in external consultants and specialists, which they cannot afford. The alternative is to consider investing in software applications, like Enterprise Resource Planning (ERP) which can support Marketing and Sales and Manufacturing Operations. However, ERP software is general purpose and has to be customised to some extent to meet the needs of each firm and larger firms have found that this customisation costs twice as much as the software package itself. The alternative approach to buy individual applications for each part of operations, one application for Bill of Materials, a second application for shop floor planning, a third application for customer services, but who will integrate the data from these applications to avoid duplication or errors?

6.2.10 Getting Employees Fully Engaged in Continuous Improvement

Technological change happens whether desirable or not and there are times when it seems to be accelerating rather than standing still for a while. Unfortunately for SMEs it is a time of exponential technology change driven almost entirely by machine learning. Manufacturers are used to earlier generations of machine learning and robots and have learned to integrate them in the production process to get the most cost-effective mix of human work and machine work. Firms in other industries, professional services, health industries and many other sectors have used computers to augment existing working practices, but the new tidal wave of machine learning software threatens to overwhelm everyone. The old days when managers wrote job descriptions and employees followed them is long-over, now employees, particular the younger and more digitally competent ones will be trying out these applications for themselves. If senior SME managers were not already engaging their employees in continuous improvement, now would be a very good time to start!

6.2.11 Investing in Innovations that Deliver Revenue and Profitability Growth

Managers are exhorted to digitise and innovate to grow their businesses, and both these strategies may indeed be of great value to the firm. But how are senior managers going to be able to judge the effectiveness and return on investment of these strategies. Every supplier claims that investing in his or her product or service will increase your revenue and profitability, but how does your CFO know which investment resulted in revenue growth and which in productivity growth? Or, how long did it take for the investment to start having a measurable effect, or what mix of investments seemed to work well together. All these questions are hard for SMEs to answer. Even more difficult, are questions about the contributions these investments make to the firm's stock of intangible assets or the national definitions of innovation expenditure which are beloved by macro-economists. The truthful answer is that most SMEs do not know and

do not care, but this lack of data may turn out to have a negative impact on the valuation of their business.

6.2.12 Hiring, Developing and Retaining the Right People to Deliver Growth

Finding the right people to do the job, who enjoy their work and do it well and want to stay with the firm and grow their careers is the toughest job for senior managers in most SMEs. The end of free movement of potential employees between the UK and EU has probably had a much greater impact on SMEs than large firms because SMEs have much less capacity to train and grow their own employees than large firms. Free movement provided an easy way for ambitious and often well-trained Europeans to work in the UK. The longer-term impact of this change is that SMEs will have to start recruiting, training, and developing their employees in the same way that larger firms have done for many years. Firms often argue that if they train people to do the job they will leave to work for their competitors, and this will always be the case unless the firms can reward them better based on their performance. Retaining the right people therefore becomes the new challenge for senior managers because if they are successful at training them, they must also figure out how to retain them. There is only one way for SMEs to pay employees better than their competitors, which is to help them to deliver and measure higher productivity than their competitors.

6.3 Applying the new Theoretical Framework to the Research Gaps

The following sections examine how the new Theoretical Framework and Software Platform address each of the findings of the Literature Review.

6.3.1 Division of Labour

Division of Labour	How is this Gap addressed?
<i>Work activities are not documented for all departments and levels of work in the firm.</i>	Work Activity reporting provides the first version of this capability by implementing the Work Activity Map. Future Research will provide a Digital Work Activity Map and the ability to update it with Complementary Investments.
<i>Input → Conversion → Output production units are not captured, tracked, managed, reported or updated.</i>	The production units for Marketing, Sales and Manufacturing have been implemented using Knowledge Grid applications which enables input costs to be allocated to each unit, work-activities and work objects to be defined and outputs to be reported and measured.

Division of Labour	How is this Gap addressed?
<i>For non-office employees real-time To-Do lists and daily updates and reports delivered to frontline employees via smartphones, and tablets, would facilitate the update and tracking of work activities</i>	This software been developed and tested and will be tested at Neatsmith in 2025.
<i>Complementary investments are important drivers of productivity growth but they cannot be measured at the production unit level.</i>	These are an important part of the new theoretical framework and will be implemented as part of a Future Research project outlined in Chapter 8
<i>SME Managers do not fully understand the distinction between revenue-driven profit growth and productivity-driven profit growth this makes it hard for them to justify investment in digital management practices.</i>	The functionality to explain and demonstrate this will be provided by the first version of the platform's Growth History, Forecast and Reporting functionality as part of Future Research discussed in Chapter 8.

6.3.2 Management Practices

Management Practices	How is this Gap addressed?
<i>Fair Work Projects are valued, but, as Lindsay (2022) explained, there is no way of measuring the labour productivity impact these projects.</i>	The platform provides real-time work activity reporting for all production units. This provides the most accurate input to calculate labour productivity on a weekly basis once it is fully implemented.
<i>The original Bloom and Van Reenen management practices surveys focused primarily on manufacturing operations and did not include marketing & sales.</i>	The original Bloom and van Reenen survey questions have been updated by ONS to include additional questions

Management Practices	How is this Gap addressed?
<i>The Management Practices questionnaire can be completed by an SME manager in less than one hour, but the problem is not one of measurement - GVA per head is actually a better measure. What firms need is to learn how to grow productivity year on year</i>	Significant improvements need to be made to Management Practices surveys if they are to be continued. The latest survey questions could be added to Production Unit reporting and added to the platform so they can be updated quarterly.
<i>Management Practices surveys (with the exception of MEPS in the USA) may not be conducted annually so longitudinal growth in scores is hard to measure</i>	This problem could be addressed by providing monthly or quarterly updates for firm level and production units so that longitudinal growth in scores can be measured
<i>If Management Practices surveys could be digitised and reported on a quarterly basis, the Management Practices score could then be correlated with GVA and TFP growth.</i>	If MP were added to the software platform it would enable scores to be compare with GVA and TFP at Firm and Production unit levels. This would greatly increase the value of the reports

6.3.3 GDP and Productivity Reporting

GDP and Productivity Reporting	How is this Gap addressed?
<i>ONS variables for Labour Quality are implemented at aggregate levels but need to be implemented within the firm.</i>	The Growth Reporting and Growth Forecasting application and database (Future Research Chapter 8) would enable ONS variables for Labour Quality to be implemented and updated at firm level. As additional Labour Quality measures are captured following complementary investments the stock of human capital can be updated.

GDP and Productivity Reporting	How is this Gap addressed?
<i>Only one third of Intangible Assets are measured within the firm.</i>	Complementary Investments are first captured in the proposed Growth Reporting and Growth Forecasting application and database and will be used to update the Growth Accounting Balance Sheet (Future Research Chapter 8). These investments can then be summarised in the proposed Complementary Investments application and database (Future Research Chapter 8)
<i>ONS variables for Total Factor Productivity and Capital are only implemented at aggregate level.</i>	This is a well-known problem in GDP Measurement and arises because productivity growth is a residual at industry sector aggregate levels as defined by SIC code and can be explained by both exogenous capital growth and endogenous innovation growth at these levels. In contrast, the Growth Strategy Investment and Reporting application provides monthly Growth reports for both inputs and outputs at the Firm level and production unit. These are updated capital service charges from the Growth Balance Sheet to calculate capital productivity at the Firm level which cannot be done at industry sector level due to lack of sufficiently granular data. The Growth Reporting Platform (Chapter 8) will solve this problem
<i>Revenue driven EBIT and TFP driven EBIT need to be reported at Production Unit and Firm Level</i>	Managers need to be able to measure Revenue Driven EBIT and TFP Driven EBIT on a monthly basis and to be able to assess the impact of Complementary Investments on both types of Growth. The Growth Reporting Platform (Chapter 8) will solve this problem

GDP and Productivity Reporting	How is this Gap addressed?
<i>Innovation activities are only measured every two years using a survey for a representative sample of firms.</i>	Whilst surveys are useful in providing results for a representative sample of firms, they do not provide longitudinal data which could contribute to causal explanations. The same point was made in respect of management practices surveys as discussed earlier. The measurement of innovation activities is however even more difficult than management practices because these are not always fully captured by firms. This functionality could be added to the Growth Reporting Platform discussed in Chapter 8.
<i>ONS QALI variables provide a seriously incomplete record of Human Capital.</i>	In addition to training, skills, and qualifications all of which can be captured for each work activity and added to the Roles and Posts database, levels of work including capability and mode are not currently documented by most firms. Given that labour services represent between 75% and 80% of inputs this lack of interest in better understanding levels of work is surprising. Further research is needed on this issue.

6.3.4 Diffusion

Diffusion	How is this Gap addressed?
<i>The UK's diffusion of the US Productivity Program between 1948 and 1978 was significantly weaker than comparably sized European countries and Japan. This is despite the fact that the UK had a number of what are called 'frontier firms' at the start of the program.</i>	The US Productivity Program provided by the Marshall Plan included: Training within Industry for supervisors (TWI), implementation of work study practices and visits to US firms implementing these, low-cost loans for capital equipment, firm level productivity and best practices reporting by BLS and the implementation of a National Mission to ensure the best possible allocation of labour and capital services to win the war. The complete Digital Management Practices platform when adopted will support SMEs with between 20 and 250 employees to increase their TFP Growth rate
<i>The UK has suffered from much lower growth since the 2008 financial crash than other countries, and this was identified in 2014 as the UK Productivity Puzzle.</i>	This thesis has argued that whilst productivity growth may be associated with investments in intangible assets, increased labour quality through education and investments in information technology these are necessary but insufficient. If a firm really wants to improve productivity, senior management must make a serious and long-term commitment by developing a TFP Growth Strategy and applying Complementary Investments to every work activity in each production unit. Since the demise of work study over fifty years ago, most SMEs have neither the skilled resources or the management commitment to make this happen.
<i>The UK has a much longer tail of poorly performing firms than its European or American competitors.</i>	This creates a large opportunity for the adoption of TFP Growth Management. The Centre for Progressive Policy (Mudie 2023) has highlighted 72 underperforming local economies where they claim that productivity growth in local SMEs could deliver an additional <u>£70.2 billion of GVA</u>.

Diffusion	How is this Gap addressed?
<i>The lack of a Local Growth Reporting system which includes firm level private sector productivity growth makes it harder to drive local productivity growth.</i>	The lack of local data on productivity growth, intangible assets and innovation is a serious constraint on regional growth. outside London and the South-East. If the CPP programme were to be implemented, it could create the foundation for much richer productivity growth data being collected at Regional and Local Authority levels across the UK

6.3.5 Brief History of Information Systems

Information Systems	How is this Gap Addressed?
<i>IT costs are too high for SMEs and productivity growth functionality is non-existent</i>	A bespoke software platform is being development to meet these functionality requirements. Key modules are live at Neatsmith, and additional modules will be part of Future Research (Chapter 8)
<i>The majority of these SMEs do not have an IT department and cannot afford to integrate their office systems and their department-specific software applications.</i>	The Digital Management Practices Platform assumes that SMEs will not have their own IT departments and will rely on external service providers. The platform supports this approach by providing the TFP measurement and improvement functionality that is missing from ERPs. It can however connect to existing accounting applications like Sage or Xero and to firm specific websites to extract important and relevant data.
<i>Very few of these SMEs can afford Marketing Data collection and analytic applications.</i>	Given that almost all marketing is now digital this is a very significant problem. As part of Future Research, the Growth Reporting platform will be extended to include digital marketing analytics.

Information Systems	How is this Gap Addressed?
<i>Very few of these SMEs have access to work activity mapping, real-time to-do lists and work activity reporting.</i>	The Digital Management Practices platform, once complete, will provide a very rich set of cost-effective functionalities, for SMEs with between 20 and 250 employees. There is also a large market of firms with fewer than 20 employees and consideration will be given to the cost-effectiveness of providing a “freemium” version of the platform.

6.4 What contribution does this thesis make to resolving the Research Gaps

6.4.1 Division of Labour

The case study has made substantial progress in resolving the five gaps. Work Activity reporting has been live at the Case Study since 2022 in the Manufacturing and Sales production units and substantial progress has been made in reporting the productivity parameters for inputs and outputs. Work Activity reporting currently supports PC access but smartphone and tablet updating is complete and will be deployed in 2025. Additional functionality for Growth Reporting and Forecasting, Digital Work Activity Maps and Complementary Investments will be part of Future Research and documented in Chapter 8. The case study did document the impact of productivity driven EBIT and its relationship with revenue driven EBIT. There is a gap in management knowledge in this area and many managers find it hard to understand the distinction between the two types of EBIT growth. The case study experience suggests that this has to be demonstrated empirically with the firm’s own data for more than one quarter for it to be fully understood.

6.4.2 Management Practices

ONS and partner researchers have made numerous studies of Management Practices in the UK and the limitations of these surveys are well understood. As the software platform develops it will be perfectly possible to collect data on most of the management practices questions from the Production Units and the Growth Reporting applications. This topic can be followed up in Future Research.

6.4.3 GDP and Productivity Reporting

National income accounting requires the collection of large amounts of aggregated data from firms in every industry sector. Most of this data is collected through surveys although more administrative data is being introduced. However, no data is collected from the production unit level within the firm. Without production unit data it is not possible to measure labour productivity, nor is it possible to measure the effect of

complementary investments which are a mix of labour services and capital services charge. Without this data it is not possible to know the relationships between these investments and productivity growth. The case study showed that the three production units are quite different and will therefore require different complementary investment recipes as well as different quantities of ingredients. Once the Future Research work is complete it will be possible to provide a comprehensive schema for firm level productivity reporting.

6.4.4 Diffusion

The diffusion problem goes back to 1945 and has been documented in the Literature Review. It is a well-known, long-standing, if not well understood, weakness of the UK economy. The long tail of firms with GVA levels below the mean and weak productivity growth is also well understood, the main problem appears to be the assumption that “digitisation” will solve this problem. This thesis argues that once managers understand the difference between Revenue driven EBIT, TFP driven EBIT and their impact on firm valuation they will quite quickly change their behaviour. The Growth Reporting platform will provide a low cost and easily implemented suite of reports which will inform managerial decisions and help them to make complementary investments to drive both Revenue and TFP growth.

6.4.5 Information Systems

The case study has demonstrated robust progress in addressing all the gaps. A bespoke software platform has been constructed which enables senior managers to focus their attention and complementary investments on their production units. This has resulted in 44% growth in GVA per head over three years from two of the three units. Work is underway on the third unit (Marketing) where the management priority is to increase their intermediate output measured by the quantity of leads which resulted in a showroom visit. Future Research outlined in Chapter 8 will complete version 1.0 of the platform with Growth Reporting and Growth Forecasting, Digital Work Activity Maps and the Complementary Investments application and database. This platform can complement existing investments in discrete applications and ERP systems because it is focused on productivity and EBIT growth which the other information systems are not.

6.4.6 Contribution to the Research Question: How can Small and Medium Enterprises solve the UK Productivity Puzzle

The thesis makes three contributions to the Research Question: first is the Theoretical Framework which focusses explicitly on the work of the social institution, rather than financial and performance reporting or information systems, they are properties of the social institution but employees and managers delivering work-activities and work-objects are the priority. The second contribution is the identification of the production units within the firm which implement the conversion of inputs (labour, purchases and capital) into outputs (at market price). The third contribution to practice is the implementation of a bespoke software platform focused on productivity measurement and growth. The case study was limited to a single manufacturing firm, but it did deliver

both labour productivity growth and EBIT growth both of which are going to be needed to solve the productivity puzzle for SMEs with between 20 and 250 employees. The main challenge remains which is the diffusion of productivity platforms of this type more widely. This topic is examined in the next section which considers repeatability.

6.5 How Repeatable is the Digital Management Practices Platform?

The methodology chapter included a preliminary discussion of repeatability. In this section, the four components of the platform are assessed for their repeatability in the large SME market segment.

6.5.1 Growth Strategy and Growth Forecasting

Given that this functionality is implemented using standard application and database technology there seems to be no technical reason why this new application, once completed, cannot be widely deployed in the medium and large SME market sector. Few firms have implemented TFP Growth Strategy and Forecasting, so the available market is the same as the market size.

6.5.2 Work Activity Map and Organisation Structure

Again, most firms will have implemented an organisation structure, but a smaller minority will have implemented work activity or process mapping. The reason for this is that most large SMEs buy discrete applications like websites, customer relationship management (CRM), accounting or CAD tools and a much smaller number by Enterprise Resource Planning (ERP) systems which integrate a number of departmental applications into a single large database with a standardised user interface. In both cases the work activities or business process steps are hidden from view. The Case Study demonstrated that visibility of work activities, work objects, cases and case types and the usernames of roles and posts is actually very important and becomes essential if the firm decides to implement continuous improvements in each production unit. Because these data elements are already widely implemented (if not explicitly) there is no technical reason why the work activity map and organisation structure could not be implemented in all large SMEs. As documented in the literature review, the first work activity map was published in the UK by Adam Smith in 1776 and a fully documented standard was introduced by the Gilbreths in 1921.

6.5.3 Work Activity Reporting – Production Units

In the case of Work Activity reporting, repeatability has already been demonstrated. This was first tested in an earlier research project in local government for a purchasing department as documented in Appendix 2. The same software was then implemented in Manufacturing at the very start of the Neatsmith case study. This demonstrated three dimensions of repeatability: first in a different country, second in a different industry

sector and third in a department. Again, there is no technical reason why Work Activity Reporting cannot be implemented in all large SMEs.

6.5.4 Complementary Investments: the “Cube”

The requirements for this new application and database can be found in Chapter 8, Future Research. When completed, it will provide senior managers (CEO, CRO and COO) and their production unit managers, with a longitudinal record of each complementary investment, in each work activity in the Work Activity Map. These records will include labour services cost, capital service investment and charges (where appropriate), implementation date, and supporting documentation in the form of documents, spreadsheets and presentations. The database will be updated monthly and will report on the status of every work activity.

7 Conclusions

7.1.1 The Problem Statement

The productivity puzzle, first identified in 2014 has now turned into a productivity catastrophe. The UK economy has still not recovered from the 2008 financial crisis and the latest OBR forecasts forecast no improvement in productivity for the next five years.

The research question is: How can Small and Medium Enterprises solve the UK Productivity Puzzle? This thesis has taken an important step towards solving this problem by creating a new Theoretical Framework which puts the work of the social of the social institution at its heart. Whilst measurement and technology are important, work is still done by people for people. Even when work is automated, people will still have to design, manage and maintain the robots.

The Literature Review showed that this rigorous focus on work had started in the late 1880s in the USA led by Frederick Taylor and called Scientific Management and come to fruition in the first two decades of the twentieth century. The Marshall Plan introduced the latest set of US Management Practices based on Work Study to Europe and Japan. But in the late 1960s work study was replaced by systems analysis and over the past sixty years the focus on work has all but disappeared.

The first contribution to knowledge is the creation of a theoretical framework which shifts the focus to the work and its organisation and on driving productivity growth through complementary investments. The second contribution is the identification of the “production units” which convert inputs of labour, purchases and capital into outputs. These production units are where complementary investments drive productivity growth. The development and implementation of a software platform to support productivity measurement and growth also makes a contribution to practice.

7.1.2 To What Extent was the Research Question Answered?

The Literature Review identified some 25 gaps in knowledge covering five broad topics. These included the Division of Labour, Management Practices, GDP and Productivity Measurement, Diffusion and Information Systems. The gaps in knowledge for two of these topics: the Division of Labour and Information Systems were almost entirely answered. Possible solutions to Management Practices and GDP Measurement were identified, but Diffusion requires considerable additional research.

The case study demonstrated that it was possible for a medium sized SME with no previous experience or knowledge of productivity measurement or growth to make complementary investments in two out of their three production units. These led a 44% increase in labour productivity. One by-product was the increasing confidence of the case study management in creating a three-year growth plan which would further increase Revenue and Productivity EBIT.

7.1.3 What new questions did this research raise?

Software Platform completion

This topic is covered in some detail in Chapter 8 Future Research

Software Platform integration with departmental applications

SMEs use a wide variety of applications some of which are department specific like CAD or Bill of Materials and others of which are used by all firms, like websites and accounting applications. There is generally little integration between these applications which make it difficult to have a single view of the firm's productivity growth. Because the software platform provides digital work activity maps for all production units together with productivity growth reporting at firm level and production unit level there may be an opportunity to extend the software platform to leverage existing customer investment in these off the shelf applications

Software Platform integration with ERP systems

A similar question arises with ERP systems. By virtue of their design, they already provide applications for all departments of the firm, a single database view of the firm and rich financial and KPI reporting. They are not optimising for productivity reporting or more importantly driving productivity growth through complementary investments.

Software Platform integration with A.I. applications

The Literature Review described the rapid growth in A.I applications many of which will be of interest to SMEs. Some of these applications will be used by everyone in the firm as addition to their existing application portfolio, others will be department or even role specific. It may be possible to enhance work activity update and reporting by adding A.I. applications to each work activity where the A.I. can add value.

Software Platform packaging to addressing micro enterprises (less than 20 employees)

Micro enterprises have almost as many employees as small and medium enterprises, and they may have similar complexity to these SMEs. Once the software platform has been completed consideration should be given to this sector by providing some freemium services which can be upgraded to monthly subscriptions to avoid capital costs. The economics of the software industry and SaaS applications are well known so there is clearly a market opportunity for the right functionality the right monthly subscription.

Can the Software Platform be used by Directorates within Large Firms

Appendix 2 describes some earlier research in a local authority which is there the first KnowledgeGrid application was developed. There seems to be no reason why the software platform could not be applied to a Directorate in a local authority to provide production measurement and the management of complementary investments to drive productivity growth.

Enterprise Management Training

During the 1950s the British Productivity Council invested heavily in promoting the use of work study techniques to increase productivity. The newly founded Technical

Colleges developed rich curricula to teach Work Study to employees and managers and were able to offer educational qualifications. Now that Digital Management Practices are being designed and developed there is a need for management training for Enterprise managers.

Production Unit Management Training

The production unit might seem to be familiar only to manufacturing firms but the same input→conversion→output logic is universal to all social institutions which are established to provide products and services to customers. These managers would also benefit from management training.

First Level Management Training

In the case study as discussed there are two main production units, Sales and Manufacturing both of which have first level management. In Sales these are Showroom Managers and in Manufacturing they include CAD, Supply Chain, Shop Floor and Installation Managers. These managers would also benefit from management training.

Front-Line Employee Training

The most important audience for training are the front-line employees who deliver the great majority of work activities within each production unit. Their active engagement is required for any productivity growth initiative to succeed. Their knowledge of their own work activities usually greatly exceeds that of many first level managers and most second level managers too. When they have a full understanding of the whole production unit, they will be able to contribute to its continuous improvement.

8 Future Research

This chapter reviews four topics for future research. The first topic is TFP Growth Reporting and Forecasting which has been discussed extensively in the Theoretical Framework and Case Study. Without an understanding of the firm's own productivity history and the development of a TFP growth forecast it is difficult for managers to fully understand what TFP really means and why it is so important. The second topic is the implementation of Complementary Investments to grow TFP which requires the construction of a Work Activity Map which includes the firm's organisation structure, Growth Reporting and Forecasting, Production Units and the means of managing and reporting on Complementary Investments. The third topic is the scaling up of an SME to include significant investments in new products, processes, markets and organisations which will, when complete, enhance or replace existing production units.

8.1 TFP Growth Platform

This section sets out the requirements for the TFP Growth Platform which is a suite of applications and databases which will enable a COO / CEO to review the firm's TFP historic growth, create growth scenarios, select a single growth scenario, make relevant complementary investments and report monthly variances between this chosen scenario and results.

8.1.1 Growth Reporting Inputs

The Neatsmith finance officer prepares a monthly management report using data provided by their accounting package Xero. This data should be mapped into the Growth Reporting template and imported on a monthly basis. This data once mapped should be stored in the growth reporting database. It is desirable to import both monthly data and annual data.

8.1.2 Growth Reporting Database

This database should have sufficient capacity to hold up to five years of history and five years of forecast.

8.1.3 Growth Forecasting Application

Based on experience of the forecasting prototype, in order to create alternative growth scenarios for up to five years, four variables are needed. These are revenue, purchases, labour productivity (which is linked to headcount) and wages each of which can be adjusted independently. Implementation should follow the existing Google spreadsheet implementation in the Growth Platform which is still used by Neatsmith. Once each scenario has been completed it can be exported to Excel. The chosen scenario can then be uploaded into the platform as the default forecast.

8.1.4 Comparisons between Forecasts and Actuals

It has been suggested that this approach will only work when a single forecast has been selected. In order to be able to review multiple forecasts, the application should provide an “export feature” which exports the Forecast as an Excel file in the same format as the monthly TFP report. It would be helpful to have a long-term view, similar to the one shown in the chart below, a three-year forecast, and a one year view which will show monthly variances between forecast and actuals.

TFP Reporting - Firm Level	History			Case Study			Forecast		
	2019	2020	2021	2022	2023	2024	2025	2026	2027
Sales									
Revenue									
Purchases									
GVA									
GVA per head									
Revenue EBITDA									
Productivity EBITDA									
Capital Service charges									
Total Factor Productivity									
TFP/Revenue Ratio									
Distribution									
Valuation									

Chart 54: TFP Growth Reporting (Firm Level)

8.1.5 TFP Growth Metrics

Orders - Inputs

This shows sales orders which have been booked and a deposit paid.

Revenue -Inputs

This is the firm’s revenue as reported in its annual accounts and quarterly VAT returns. It can be based on the Production Unit’s Installation weekly report.

Purchases - Inputs

These are broken down into

- Energy
- Materials
- Services

GVA - Calculation

This takes the firm's revenue and removes all purchases of energy, materials and services from it. All national productivity statistics rely on GVA at the firm level.

GVA per Head - Calculation

This is a simple calculation which divides GVA by total headcount and provides a single number for the firm. It is a useful metric because national productivity statistics provide it for each industry sector so it enables a firm to compare itself with others in the same sector.

Labour Services – Inputs

These data are provided as inputs from the firm's payroll. In addition, headcount numbers are provided as inputs and labour hours can also be provided if needed.

EBITDA - Calculation

This is calculated by taking Labour Service charges from GVA.

Capital Services Charges – Inputs

There are three types of capital service charges, the first two of which are captured in the firm's statutory accounts:

1. Tangible Assets
2. Measured Intangible Assets
3. Unmeasured Intangible Assets

A note on Capital Service Charges

A key part of any TFP growth strategy is the ability to capture the capital services charges for all types of investments. The requirements for capturing intangible assets, particularly those which were considered to be "unmeasured" were documented in a presentation to the ESCoE Intangibles conference in November 2021 (Stroll, 2021). The first implementation of this functionality was completed in April 2002 as part of the Innovate UK Grant. The Growth Reporting application included the classification of the purchasing ledger to separate operating expenses from investments, and the ability to create a preliminary intangible asset register and lastly to provide monthly productivity reports. This learning will be included in the TFP Growth application and database

EBIT (Total) Calculation

EBIT measures earnings before Interest and Taxation but most importantly it includes Capital Services Charges which are based on the depreciation of assets held on the firm's balance sheet. The calculation starts with EBITDA and removes Capital Services charges from it.

Calculating Total Factor Productivity (TFP)

TFP is a residual which arises when the inputs of purchases, labour and capital (measured as labour services and capital services charges) increase at a lower rate than outputs at market price (measured by GVA). The corollary is that when inputs grow at the same rate, year on year as outputs. there is no productivity growth. Firms can use a

number of levers to drive TFP growth – raising prices; growing revenues with new products and services; growing revenues with new distribution (e.g. more showrooms) reducing purchases costs relative to revenue growth; increasing labour costs at a lower rate than revenue, increasing capital services charges at a lower rate than revenue. To calculate TFP we need to determine the proportion of EBIT growth which results from revenue growth and the proportion which results from productivity (i.e. growing inputs of purchases, labour services and capital services at a lower rate than revenue.)

Total Factor Productivity

Total Factor Efficiency will provide the Gold Standard for firm level productivity reporting. It goes beyond EBITDA by including the cost of capital as measured by capital services charges to produce EBIT. TFP then measures the change in the ratio between the growth in inputs and the growth in outputs, year on year. For example, if purchases and labour services charges are growing at a slower rate than GVA the difference will show up in the TFP ratio which is the growth rate in revenue less the growth rate inputs of purchases, labour services and capital services.

The Difference between Firm Level TFP and National TFP

TFP growth is measured by National Statistical Offices using data aggregated data for all sectors of the economy and netting out the value -added using input – output tables. It is usually expressed as percentage growth over the previous year. Both inputs and outputs in these tables are adjusted for deflation for both input prices and output prices. This is known as double deflation. At national level a TFP growth rate of 2.5% TFP is highly desirable but as this is “real TFP” it has to be adjusted by inflation at the firm level. Given that the Bank of England mandate is to keep inflation to 2% per annum, this suggests a minimum firm level TFP target at firm level of 4.5% a year.

Mapping Firm Level TFP to ONS TFP

Once the Digital Management Practices platform has been completed, it would be valuable to discuss the mapping of firm level TFP data to national level TFP data with the Office for National Statistics.

Distribution Alternatives

It was argued earlier that one of the biggest barriers to increasing labour productivity is the lack of reward for employees. When a firm is growing productivity faster than its revenue, it can share some of this productivity surplus between employees, customers, investors and capital formation. Many US firms reward their employees with share options and discounted share purchases. This works because US firms deliver higher levels of TFP growth than UK firms and US managers are measured on earnings per share and therefore wish to grow their share prices by increasing profit per share. In the UK this alternative is less common because the stock market is much smaller and valuations are much lower.

Valuation

Every firm has a value, whether it is quoted on the stock market or not. For smaller SMEs there is an active Venture Capital marketplace in the UK which brings investors

together with SMEs at different stages of growth. These investors have good estimates of enterprise value for SMEs and will share them to ensure that the firms' managers are properly aligned with their investors. Initial evidence from the case study showed that complementary investments during the case study years increased firm valuation from £1.620m in 2021 to £6.996m in 2024 which demonstrates an exponential increase in value. Neatsmith's senior managers are forecasting a further growth in value to £15.820m in 2027 which, if accomplished will reinforce the exponential growth trend.

8.2 Managing Complementary Investments for TFP Growth

Economists have known since 1990 (Milgrom and Roberts) that a number of what they called "complementary investments" were needed to drive productivity growth. More recently Professor Diane Coyle (2020), Director of the UK Productivity Institute and author of *GDP: A Brief but Affectionate History*, summed up the productivity puzzle succinctly in a letter to the Financial Times on April 9th 2020:

"Productivity – the output the economy gains for the resources and effort it expends – matters because it is what drives improvement in living standards: better health, longer lives; greater comfort. Investment, innovation and skills are the key ingredients, ***though the recipe is still a mystery*** (author's italics and bolding)."

The case study showed that a wide range of complementary investments are needed to deliver TFP growth and that these must be recorded and valued when they are applied to the specific production units in the firm (marketing, sales and manufacturing) and within these production units, to the specific work activities, roles, posts and the first, second and third level managers who perform the work. TFP growth requires the active and continuous engagement of the COO and the production unit managers and these efforts must be tracked and reported.

8.2.1 The Need for "the CUBE"

Neatsmith now have three years of experience in managing the implementation of the eight complementary investments in three production units. Three important lessons have been learned so far. The first, is that keeping track of these investments going forward will require a specialised application and database. The second is that, over time, the production unit managers themselves have to take a more active role in driving the improvements and coaching their departmental managers. The third lesson is that first level managers also have to take responsibility for driven improvements with their front-line staff.

There are three dimensions which must be managed, hence the term "the Cube". The first dimension is the Work Activity Map which includes the Organisation Structure, the COO's own work activities, the Production units and the support work-activities. The second is the implementation and documentation of complementary assets for each work activity and production unit. The third is monthly reporting for the firm and each

production unit to include Work Activities, KPIs, GVA, Capital Productivity and Innovation Productivity (TFP).

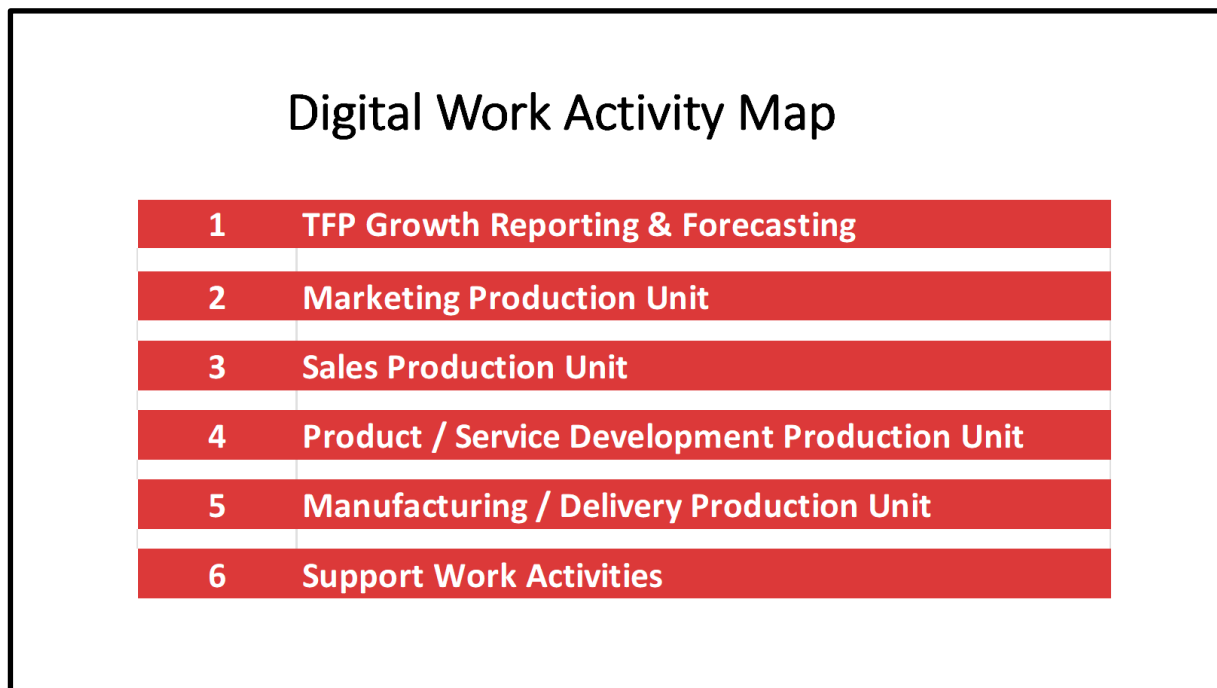


Chart 55: Digital Work Activity Map - The Front Face of the Cube

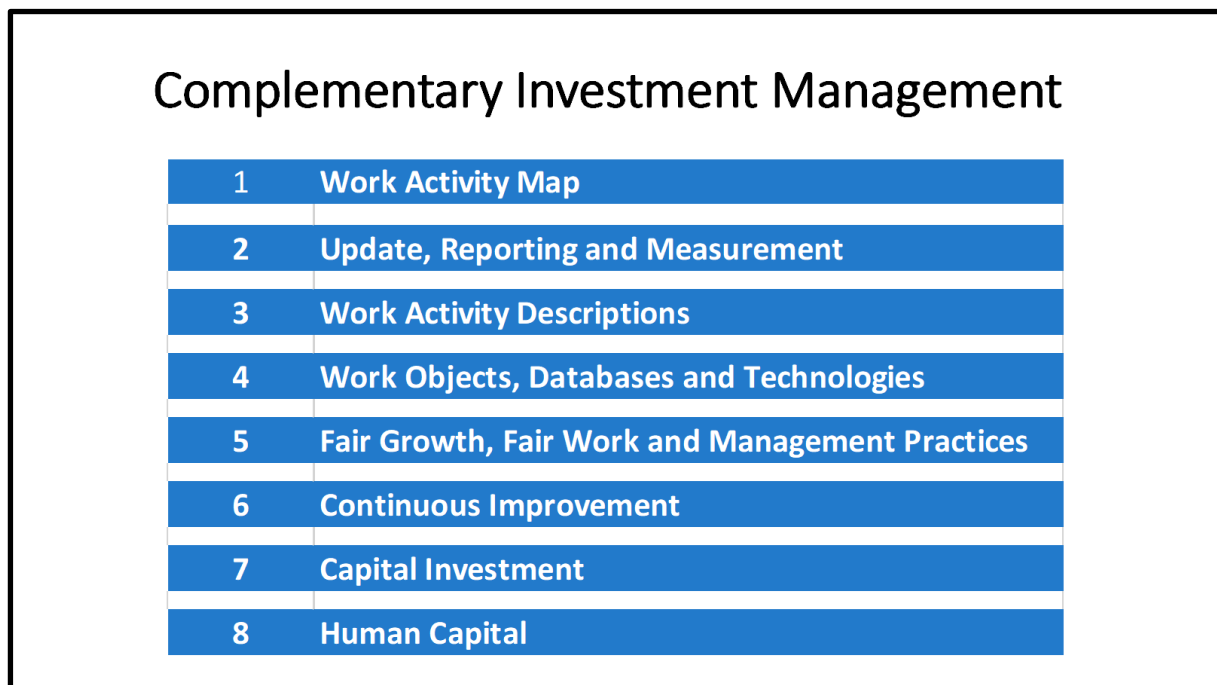


Chart 56: Complementary Investments - The Top Face of the Cube

Total Factor Productivity Reporting

Sales, Revenues
Purchases: Energy Materials Services
GVA: Firm Level, GVA per head , Labour Productivity
EBITDA Total: Revenue Driven, Productivity Driven
Innovation Activities: OECD / BIS / ISO standards
Capital Service Charges: Tangibles, Intangibles, Unmeasured Intangibles
Growth Accounting Balance Sheet
Total Factor Productivity Growth: Efficiency Ratio

Chart 57: Growth Reporting - The Side Face of the Cube

8.2.2 Create the Complementary Investments Database

Neatsmith have kept track of all the growth investments made from 2021 to date as well as their continuous improvement. Going forward, to understand the impact of these investments and picture the different “recipes” there is a need for a complementary investments database which ties each investment to the work activities, departments and production units and records the date on which these investments were activated. It is the combination of complementary investment, individual work activity, and deployment date, which is needed to assess the impact of this investment on Total Factor Productivity. Clearly, some investments will impact more than one work activity, more than one role and more than one department, so the firm’s organisational structure is required as part of the design.

8.2.3 Integrate the Work Activity Map with the Complementary Investments Database

In order for the COO to drive TFP growth with each production unit manager he needs to be able to discuss which investments should be made in which work activity and budget accordingly. As investments are made the work activity must be fully updated.

8.2.4 Update the Complementary Investment Database with Case Study data

The Neatsmith Case Study and Continuous Improvement logs have tracked all complementary investments since mid-2021. The Neatsmith finance manager will need to construct (or copy from his predecessor) the costs for each one of these investments and classify each one as Continuous Improvement, Tangible Investments, Measured Intangible Investments and Unmeasured Intangible Investments. Secondly each

investment will have to be allocated to Growth Reporting and Forecasting, Complementary Investment Management and / or marketing, sales and manufacturing production units. Each investment should be assigned to the specific month that it goes into production (i.e. starts being used by employees)

8.2.5 Update Growth Balance Sheet for each Production Unit

Once all these investments have been fully documented and allocated it becomes possible to create the Growth Balance sheet for the Case Study and update it monthly thereafter. Once all entries have been made capital services charges can be calculated and updated monthly.

8.2.6 Create GVA and TFP Reports for each Production Unit

Every senior manager (Level IV) and production unit managers (Level III) will have access to the suite of GVA and TFP Reports at firm level. Once these are well established and have bedded down (it always takes time to make sure all the employees are connected, all the data sources are completed, and all the data is kept up to date) it may be thought sensible to extend the reporting to first level managers and employees. This is particularly important if Fair Growth is to be implemented because this could have quite a large impact on some employees.

The collection of accurate data for the Intangible economy is widely regarded as essential given that two thirds of intangible assets are not captured under current accounting standards. A reliable method for doing this data collection has not been available up to this point but was called for by the Big Innovation Centre's Intangible Gold report (Stroll and Anderson, 2017) and backed by Andy Haldane (then Chief Economist at the Bank of England) and Jonathan Haskel (Member of the Bank of England Monetary Policy Committee) who has written extensively on intangible assets for more than a decade (Goodridge, Haskel, & Wallis, 2016b). In my presentation to the ESCoE Intangibles conference (Stroll, 2021a) I outlined the approach to be taken to collect more complete intangible asset data and delivery of these requirements will go a long way to providing a more complete set of what are called Growth Accounts at the Firm level.

Once Capital Services Charges are complete, it will be possible to create the monthly TFP Growth Report together for all production units. This report includes the following:

Monthly Labour Productivity made up of monthly quantity of all work-activities delivered in the Production Function including, monthly quantity of work activities reworked (Amber) and monthly quantity of work activities reworked (Red)

Monthly Average Quantity of work activities per person in the production unit. This makes it possible to compare the empirical report with the calculated GVA per head number

Monthly Labour Productivity calculated as GVA per Head in each Production Function – this will be allocated based on headcount.

Monthly KPIs – these will be different for each production unit

Monthly Complementary Investments deployed. This report includes all complimentary investments implemented each month.

Monthly Complementary Investments Completion report. This enables the production unit manager and the COO to assess the completeness of their productivity journey. This report provides the status of each work activity and its potential complementary investments.

8.2.7 Cause and Effect Analysis

Once the complete data set for all historical complementary investments in all production unit for all work activities is available it may be possible to run more advanced analyses to rank investments by their TFP impact.

8.2.8 Measuring Management Practices Scores

Once the work activity map and complementary investment database are operational it becomes possible to extend the firm level Management Practices questionnaire to each production unit, perhaps to be updated quarterly. This would enable these scores to be directly correlated with TFP growth on a longitudinal basis. This topic was documented in the Theoretical Framework.

8.2.9 Creation of a full Productivity Schema

Once version 1.0 of the platform functionality is completed it will become possible to produce a complete schema for productivity reporting at the production unit and firm level. This schema would include richer labour services data, specifically in the areas of skills, experience, capability and career path growth. A future extension could include the PIAAC categories of learning. It would also include the unmeasured intangible assets and a growth balance sheet on which these assets were capitalised. It would also include the Complementary Investments of both labour services and capital services at firm level and production unit level. Lastly it could also include Innovation Activities and Expenditure using the OECD categories.

8.3 Scaling and Innovation

The Theoretical Framework in Chapter 4 documented the eight levels of work complexity. The Neatsmith Case Study has been implemented in an SME with four levels of work complexity. When a firm implements geographic scale up and / or structural innovation it needs to grow from a four-level to a five-level organisation structure.

8.3.1 Geographic Scale Up

This is the most common method of growing customer-facing firms like retail, wholesale, leisure and restaurants. A firm can start with a single restaurant and then expand within a city or region. Because the work can be fully specified, it is possible grow such businesses to become national chains. Brand names like Pizza Express, Nando's, Costa, Marks and Spencer and David Lloyd are nationwide and have built strong customer relationships.

8.3.2 Four types of Innovation

The second way of growing a firm is through innovation. The Level IV firm includes production units for Marketing, Sales, Product / Service Development and Product Service / Delivery; TFP Growth Reporting and Forecasting; and Complementary Investment Management. In order grow market share this Level IV firm needs to add Research Directorates to implement one or more of the OECD innovations which include product, market, process and organisation.

8.3.3 Environmental Monitoring

As firms strive to scale-up and innovate the need to fully understand their environment becomes far more critical. Michael Porter (1988) set out a comprehensive set of work activities that need to be performed to ensure that the firm's investments in both scale-up and innovation are soundly based on market needs. This environmental monitoring also needs to take account of current and potential competitors. Whilst the CEO may choose to delegate this monitoring, he or she will have to have an excellent working knowledge of market conditions, major competitors and key trends in their industry.

8.3.4 Corporate Governance

It is quite likely that Level 5 firms will need to access additional capital for both scale-up and innovation investments. Sources of external funding include bank loans and venture capital investors. External funding places an additional set of reporting requirements on the business and form an important part of the CEO's work activities.

8.3.5 Research Projects

A number of new roles will be needed, and these are summarised below.

- CEO (Level V)
- Innovation Director: Products (Level IV)
- Innovation Director: Markets (Level IV)
- Innovation Director: Processes (Level IV)
- Innovation Director: Organisation (Level IV)
- Environmental Scanning Director (Level IV)

- Corporate Governance Director (Level IV)
- Information Systems Director (Level IV)
- Compliance Director (Level IV)

Further research is needed to document the work activities, work objects and working relationships of as many of these new roles as possible to enable the firm's work activity map and organisation structure to be updated. This research becomes of greater importance given the growth in AI technologies and solutions many of which will apply to individual work activities within each role. The BEIS Innovation Survey should be used to capture innovation activities on a monthly basis and as these investments are implemented in production units, they can be added to the Growth Balance sheet and their capital services charges can be updated and become part of the monthly TFP reports

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10 Appendices

10.1 Appendix 1: A Brief History of the Division of Labour

The Division of Labour stands as one of the founding theories of economics, and, over the last two and a half centuries since it was first published, has been built upon and extended, so it is as relevant today as to when it was first written. This chapter looks at the evolution and development of the Division of Labour from Adam Smith to the present day. Smith focused on what is now called a single set of work activities or department, but the unit of analysis changes through history – expanded to whole nations by Babbage, Marx, and Durkheim, and then contracted to the manufacturing ‘shop’ by Taylor, Gantt and the Gilbreths starting in the 1880s before being extended to the whole firm by Ford at the Highland Park plant in Detroit beginning 1908.

10.1.1 The Founding Father: Adam Smith

Adam Smith’s *Wealth of Nations*, first published in 1776, is often claimed to be the founding work of economics. The work is divided into three books, the sub-title of the first of which is:

“Of the causes of improvement of the productive powers of Labour, and of the Order in which its Produce is naturally distributed amongst the different Ranks of the People. The title of first chapter is ‘the Division of Labour’.”

Smith illustrated the Division of Labour with examples from a pin factory, shown in Chart 58. For many centuries prior to the development of the factory system, craftsmen had produced a wide range of metal goods, usually after following a seven-year apprenticeship with a master. The craftsman was expected to understand and to be able to perform all the operations required to make such goods.

1	2	3	4	5	6	7	8	9	10
Draw out the wire	Straight the wire	Cut the wire	Grind the top for receiving the head	Make the head	Make the head	Make the head	Put on the head	White the pins	Put them into the paper

Chart 58: Division of Labour in the Pin Factory 1776

Smith pointed out the revolutionary consequences of dividing the work into ten discrete steps, each performed by a different worker. He claimed that a single worker would find it difficult to make twenty pins a day, but ten workers, with appropriate machinery, could make 48,000 pins a day. His explanation for this dramatic increase in production is succinct.

“This great increase of the quantity of work which, in consequence of the division of labour, the same number of people are capable of performing,

is owing to three different circumstances; first to the increase in dexterity of every single workman; secondly to the saving of time which is commonly lost passing between one species of work to another; and lastly, to the invention of a great number of machines which facilitate and abridge labour and enable one man to do the work of many.” (Smith, 1776)

10.1.2 The First Cotton Factory: Richard Arkwright

In the same year that Smith published *Wealth of Nations*, Richard Arkwright opened his first cotton mill in Derbyshire. According to Fitton (1989), Arkwright not only created the first cotton mill, but diffused the entire factory system across the UK — to the extent that his son was the wealthiest man in England by the turn of the century and in the following century the British textile industry became the biggest in the world. Fitton also includes a description from 1812 of a typical cotton mill, from which it would be possible to construct a work activity map.

“A large cotton mill is generally a building of five or six stories high: the two lowest are usually for spinning frames, if they are for water twist, because of the great weight and vibration caused by these machines. The third and fourth floor contain the carding, drawing, and roving machines. The fifth story is appropriated to reeling, doubling, twisting, and other operations performed on the finished thread. The sixth, which is usually in the roof, is for the batting machine, or opening machine and for the cotton pickers, who for a large mill are very numerous. ”

Note how much more complex this is compared to Smith’s pin factory.

10.1.3 Fifty Years Later: Charles Babbage

Writing fifty years after Smith, Charles Babbage (Babbage, 1832) completed an economic survey of the UK economy which reported on the extraordinary growth of British Industry caused by the expansion of the factory system to many other industries. As he explained, this groundwork for this survey arose from his work on the ‘calculating engine’ which had led him to visit a considerable number of factories and workshops over the previous ten years. His snapshot of economic activity in a number of different countries and their comparison with the non-farming industries of the UK shows the extraordinary impact of the division of labour since Smith’s days. He compares the ratio of employment between agriculture (100) and other industries in four countries:

Bengal	Agriculture	100	Non Farming Industries	25
Italy	Agriculture	100	Non Farming Industries	31
France	Agriculture	100	Non Farming Industries	50
England	Agriculture	100	Non Farming Industries	200

Chart 59: Declining share of Agriculture in high productivity growth countries

Babbage then looks at the growth of population in Great Britain from 1801 to 1831 and finds that whilst population had increased by 52% over those 30 years, the population of the top five manufacturing cities (Manchester, Glasgow, Liverpool, Nottingham, and Birmingham) had grown by 132%. This is probably the first recorded evidence which ties productivity growth to economic growth and population growth.

In Chapter 19 of *On the Economy of Machinery and Manufactures*, Babbage then extends Smith's description by providing additional information about the division of labour, which included the labour employed (breaking it down into men, boys, women, and girls), together with their labour costs, labour times, machinery used and material costs for each step. Thus, Babbage provides a complete description of the division of labour, including the steps, the roles, the machinery, the materials and, crucially, the measurements which apply to the description of the work. He also summarises the key advantages of the Division of Labour which had underpinned the economic growth of manufacturing employment:

"The time required for learning – traditionally five to seven years for an apprenticeship which is driven by the difficulty of execution of each process and the variety of distinct processes (work-activities) to be learned. Reduction in variety of work-activities learned leads to a reduction in learning time.

Waste of materials in learning - Reduction in variety of work-activities leads to a reduction in waste.

Saving the time lost in changing from one occupation to another – 'when the human hand or the human head, has been for some time occupied in any kind of work, it cannot instantly change its employment'.

Change of tools – the more complex the tools the bigger the time and effort needed to switch from one work-activity to another.

Skill acquired by frequent repetition of the same processes – 'The constant repetition of the same process necessarily produces in the workman a degree of excellence and rapidity in his particular department, which is never possessed by a person who is obliged to execute many different processes'.

The division of labour suggests the contrivance of tools and machinery to execute its processes – Babbage argues that the focus on a single process is more likely to result in improvement to the tool than if the worker were distracted by a greater variety of processes."

10.1.4 The Appropriation of Labour: Karl Marx

Harry Braverman (1974) writing a hundred years after Karl Marx, presents a detailed historical analysis of the use of the division of labour which builds on the work of Smith,

Babbage, Marx, and Taylor. He complements this historical analysis with his own work experience on the shop floor, first as an apprenticed coppersmith in a naval dockyard, and then in pipefitting, sheet metal work and layout in different engineering firms, and latterly as an editor and publisher of socialist magazines and books.

It was Karl Marx, looking back at the economic history of Great Britain from the 1860s, who first took the Division of Labour, which under Smith and Babbage had been applied to shopfloor work in factories and extended it into a macro-economic construct, whose unit of analysis was no longer the shopfloor, but the whole nation. As Braverman summarised:

“The central place in the first volume of Marx’s *Capital* is occupied by the labour process as it takes place und the control of capital, and the subtitle describes it accurately as a ‘critical analysis of capitalist production’.”
(Braverman, p. 6.)

Braverman claimed that the American Capitalist system was based on four pillars: control; deskilling; appropriation and marketization. Taking each one in turn. Control was introduced in the factory system, first implemented in Great Britain in the 18th century. This replaced the traditional contracting out system which was primarily home based. The factory system enabled the owners (who at that time were also the managers) to control the working hours and conditions of their workforce. Once factories were established, mostly in the textile trade, it became possible to implement the Division of Labour as described by Smith. The primary benefit of the Division of Labour was to reduce the complexity of each step and thereby reduce the labour cost of each step by using child and female labour, as illustrated in Babbage’s example.

Once the division of labour for textile production was implemented in factories, machines could be developed which further reduced labour costs. The complete system (factory, division of labour and machines) was first deployed in the textile industry and dramatically reduced the costs of spinning cotton and weaving it into fabrics, which could then be finished and made up into garments. This new cotton-based clothing was much cheaper than traditional woollen wear.

Appropriation describes the method by which surplus value created by labour was appropriated by the owners and managers as payment for their capital investment and managerial work. The fourth component of the industrial system was marketization which substituted home based products and services for manufactured products and services.

Marx’s analysis reframed the Division of Labour from an economic phenomenon to a political one, which focused on the power relationships between the different social classes and the ability the capitalists to control the *distribution of the economic benefits* which resulted from the Division of Labour.

10.1.5 The Pennsylvania Railroad

As Alfred Chandler (1977) the American economic historian wrote:

“The Pennsylvania railroad’s system, once complete, was a huge business enterprise. In a period when very few industrials had assets of over \$1 million, the Pennsylvania’s were valued at \$400 million. In the five years from 1869 to 1873, the Pennsylvania sold, or otherwise disposed of, \$87 million worth of securities. Through this fundraising the Pennsylvania helped to create the financial institutions on Wall Street and the legal innovations necessary to fund large enterprises. The innovatory impacts of the Pennsylvania Railroad extended well beyond organisation, accounting and operational management. They laid the foundation for the great industrial enterprises which followed one and two generations later.”

The organisation of the Pennsylvania railroad (see Chart 60 below) is of interest and relevance for three distinct reasons: It was the first seven level organisation in the modern world; it was one of the first large-scale organisations to use information technology for front-line reporting; and it was one of the first organisations to document and implement a set of management principles which are summarised below in full. These were initially developed by McCallum at the Erie Railroad and later adopted by J. Edgar Thomson at Pennsylvania.

1. A proper division of responsibilities.
2. Sufficient power conferred to enable the same to be fully carried out, that such responsibilities may be real in their character [that is, authority to be commensurate with responsibility].
3. The means of knowing whether such responsibilities are faithfully executed.
4. Great promptness in the report of all derelictions of duty, that evils may at once be corrected.
5. Such information to be obtained through a system of daily reports and checks, that will not embarrass principal officers nor lessen their influence with their subordinates.
6. The adoption of a system, as a whole, which will not only enable the General Superintendent to detect errors immediately but will also point out the delinquent.

By implementing the telegraph and using their rights of way enabled US railroads to create the first real-time communications network which was distance independent. These railroads “perfected the flow of internal information so essential for top and middle management to coordinate complex widespread activities and to monitor and evaluate the performance of the large number of managers handling them.” (Chandler, 1977).

SYNOPSIS OF THE ORGANIZATION OF THE PENNSYLVANIA RAILROAD COMPANY.

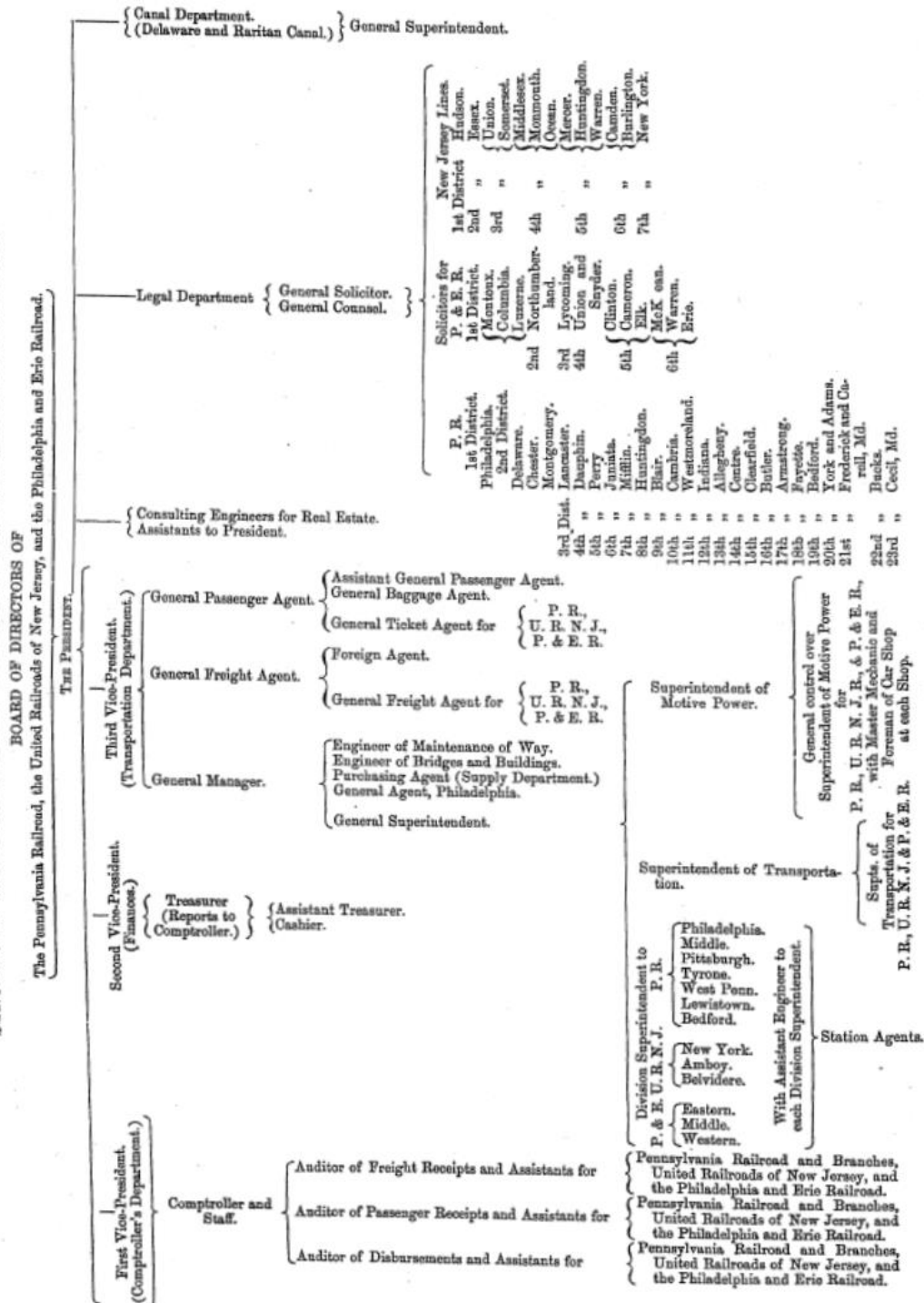


Chart 60: The organization of the Pennsylvania railroad (Dredge)

It is assumed that digital communications are a very recent invention and indeed only became public knowledge in 1995 with the arrival of the Internet and widespread with the development of the smartphone in 2007. However, as Tom Standage (1998) points out, the first telegraph connections were demonstrated in both England and the USA in running along railway lines by the late 1840s and growth had exploded after that. The first attempt to connect the New world and the Old across the Atlantic was completed in

1858. As is often the case with new technology, the first transatlantic cable failed within a month, but two further attempts were made, which resulted in success at the third attempt in 1866. Not only were the railroads connected using the telegraph by the 1860s but the world's financial capitals too.

Contemporaries were fascinated by the Pennsylvania Railroad, and thanks to James Dredge, writing in London (1879), there is an organisation chart and a detailed description of the organisation's work. This was followed three years later by an article in December 1882 in the *Railroad Gazette*,¹ then the leading railway journal in the United States. According to Jenks (1961) the *Gazette* planned to publish an anonymous series of articles for the information of "young men training for position" describing historically the rise of "the division of authority and between the various offices" of the Pennsylvania Railroad Company. Jenks includes the entire article in his paper which complements the descriptions made by Dredge. The key organisational breakthrough was the creation of what are now called 'multi-functional divisions' centred on the firm's major routes. These divisions included daily operations, accounting, track and equipment maintenance and all necessary departments to run a railroad. Each Division manager reported to the Third Vice President (Transportation Department) who reported to the President. These sources provide us with a seven-level organisational structure which was later reimplemented by DuPont in the 1920s and the US Army in peace time.

10.1.6 The Social Division of Labour: Emile Durkheim

Writing his doctoral dissertation in the 1890s, Durkheim (1902) was well aware of Marx's extension of the Division of Labour to include power relationships traditionally dealt with by political sciences. He followed Marx by continuing with the same unit of analysis (the nation state) and further extending the Division of Labour to include sociological constructs. As Lewis Coser explains in his 1984 introduction to Durkheim's *Division of Labor in Society*:

"Writing over a century after Adam Smith, Durkheim was no longer concerned with the productive gains made by the new division of labour, nor was he much concerned with what Marx had called alienation, although he was indeed perturbed by what he called pathological consequences and the 'abnormal' conditions of the contemporary division of labour. What concerned Durkheim above everything else were questions that had hardly been raised by his predecessor, though there are anticipations of his thought amongst such thinkers as Auguste Comte or Saint-Simon. What were the consequences of a complex and advanced system of the division of labour on the cohesion and solidarity of societies? And more important still, how could the autonomy of the individual, to which Durkheim was passionately attached, be reconciled with the necessary regulation and discipline that was required to maintain social order in modern differentiated types of societies. How in other words could social bonds be maintained and reinforced without

submitting individuals to the distasteful guidance of tutelary institutions that would repress human autonomy and individuality? "(Durkheim, 1902, p. xiv)

Durkheim believed that the Division of Labour would increase social solidarity and that this could be measured by the growth of law governing contracts compared to those governing behaviour, which he saw as belonging to an earlier age of feudal society. But he also understood that his version of the Division of Labour might not always result in increasing social solidarity and identified three pathologies. The first of these was the Academic Division of Labour which he had learned from the works of Comte which would require a national effort to remedy. The second one was the Forced Division of Labour as described below.

"We are certainly not predestined from birth to any particular form of employment, but we nevertheless possess tastes and aptitudes that limit our choice. If no account is taken of them, if they are constantly frustrated in our daily occupation, we suffer, and seek the means of bringing that suffering to an end. There is no solution other than to change the established order and create a new one. For the division of labour to engender solidarity, it is thus not sufficient for everyone to have his task: it must also be agreeable to him." (Durkheim, 1902, p. 294)

And the third was the misuse of labour:

"It often happens in a commercial, industrial or any other kind of enterprise that functions are distributed in a way that they fail to afford sufficient scope for individual activity. It is plain that there is a regrettable waste of effort, although we need not deal with the economic aspect of the phenomenon here. What should be of interest to us is another fact that always accompanies this wastage, that is, a more or less lack of co-ordination of these functions. We know that in a business where every employee has insufficient work to occupy him activities are badly co-ordinated, and operations are conducted in an ill-concerted manner; in short solidarity relaxes its hold and incoherency and disorder appear." (Durkheim, 1902, p. 304)

10.1.7 The Division of Labour and Bureaucracy: Max Weber

For a modern-day reader, Weber's unit of analysis in *Theory of Social and Economic Organization* (1947) first published in 1920, is extraordinarily wide. It spans modern day societies without geographic restriction; it spans a historical perspective which goes back to the world of the Greeks and Romans, and it includes at least five separate disciplines: history; culture and religion; sociology; political science; and economics. Weber's goal was to provide a descriptive language and a set of 'ideal types' which would enable historical records to be analysed and compared across disciplines over long time periods. Not only does Weber state this point explicitly, but he is also clear that this descriptive language is not meant to deal with the dynamic.

“What follows is not intended in any sense to be ‘economic theory’. Rather it consists only in an attempt to define certain concepts which are frequently used and to analyse certain of the simplest sociological relationships in the economic sphere.... For the present all questions of dynamic process will be left out of account.” (Weber 1947, Page 158)

The Importance of Bureaucracy

One of Weber’s most important contributions was his concept of bureaucracy. This followed his analysis of sociology and economics and was a separate section of his work concerned with the basis of legitimacy. The construct he used to explain this was ‘imperative co-ordination’, which he defined as ‘the probability that certain specific commands (or all commands) from a given source will be obeyed by a given group of persons’. In order to anchor this construct in historical evidence he outlined what he called ‘the three pure types of legitimate authority’ which included ‘rational grounds, traditional grounds, and charismatic grounds’ (Weber, 1947).

Of these three, the ideal type for rationally grounded authority was an organisation established with legal authority with a specified field of competence. This organisation was free to hire employees to work in a clearly defined hierarchy of ‘offices’ (later called *roles* by Parsons). Appointments to these offices would be based on free selection and educational and technical competence. Weber argued that the ‘purely bureaucratic in type of administrative organisation is, from a purely technical point of view, capable of attaining the highest level of efficiency and is in this sense formally the most rational known means of carrying out imperative control over human beings’ (Weber, 1947).

Avoidance of Historicism

As Parsons points out in his lengthy and explanatory introduction, Weber was well aware of the German historical approach which had been used by Marx and Spengler. This is what Karl Popper (1957), writing after the second world war, called *historicism*. Weber wished to avoid historicism precisely through the use of a neutral non-dynamic descriptive language, which is as powerful today as it was when it was first written 100 years ago. One example will suffice: Section 24A (Weber, 1947) is entitled, *The Principal Forms of Appropriation and Market Relationship*. Any reader of Marx will know that appropriation by capitalists of the ‘surplus value’ produced by labour is a key tenet of what Braverman called ‘labour process theory’. Based on his own historical analysis of British industrial capitalism in the third quarter of the nineteenth century, Marx had argued that this was a deterministic feature of all capitalism.

What Weber was providing was not a deterministic view but a descriptive one. It enables an observer to document the types of appropriation to be found in market relationships. The benefit of this language is that it enables different historical periods in different societies to be observed and classified using the same descriptive typology. Weber was also aware of the enormous changes in industry which had taken place in the forty years since Marx’s death, many of which had been driven by the creative destruction, caused by technological innovation, so well described by Schumpeter

(1911) his *Theory of Economic Development*. Weber understood the division of labour very well. In section 25, *Conditions Underlying the Calculability of the Productivity of Labour*, he states the following:

“There are three primary conditions affecting the maximization of calculable performance by labour in carrying out the specifications: (a) The optimum of aptitude for the function; (b) the optimum of skill acquired through practice; (c) the optimum of incentive for the work.”
(Weber, 1947, p. 261)

Weber specifically refers to the Taylor system as providing rational methods for accomplishing these three conditions. He also understands that a successful market economy must appeal to the workers’ self-interest. In order for such an economy to operate, the following conditions must apply:

“It presupposes the expropriation of the workers from the means of production and their dependence on competition for paid employment. This in turn presupposes that the appropriation of the means of production by the owners is protected by force. As compared with direct compulsion to work, the system of free labour involves responsibility for reproduction, in the family, and part of the responsibility for selection based on aptitude is turned over to the workers themselves. Further, both the need for capital and the risks to which it is subjected are, as compared with the use of unfree labour, lessened and made more calculable. Finally, through the payment of money wages on a large scale, the market for goods which are objects of mass consumption is broadened.” (Weber, 1947, p. 262)

In contrast to Marx’s determinism, that capitalists would always appropriate labour surpluses and drive wages down to subsistence levels, Weber left the possibility open that it might not be in the interests of capitalists in general to drive wages down to subsistence levels, since that would reduce the markets for their goods and services.

10.1.8 Scientific Management: Frederick Taylor

Scientific Management was well understood by Weber and Alfred Chandler, the great American economic historian, who summarised its pivotal importance:

“In 1895, Frederick W. Taylor delivered his first paper on what he soon termed ‘scientific management’. He explicitly addressed himself to improving the gain-sharing plans of Towne and Halsey. First, he pointed out that the costs and the resulting savings to be shared should not be based, as they were in those plans, on past experience, but rather determined ‘scientifically’ through detailed job analyses and time and motion studies of the work involved. In addition, Taylor would apply the stick as well as the carrot. He would do this by returning to the piece rate and by paying a ‘differential piece rate’. The workers who failed to meet

this standard time and output receive a lower rate per piece, while those who excelled received a much higher rate per piece". (Chandler, 1997, p. 275)

The study and measurement of efficiency in manufacturing industry and the roles and responsibilities of managers for improving efficiency at the shopfloor level, was invented, developed, and diffused by Frederick Taylor between 1881 and his death in 1915. He did this with his close colleagues, Gantt, Frank and Lilian Gilbreth, and others, together with intermittent support from the American Society of Mechanical Engineers (ASME).

Taylor started as a shop floor worker at the Midvale manufacturing works in Philadelphia in 1883, and based on his experience, developed what would now be called a 'work description language' to describe work on the shop floor. This language enabled him, and later his colleagues, to describe roles, managerial relationships, working relationships, material work-objects, information work-objects, work-descriptions and to then document these in the form of work process blueprints for every shop.

Taylor also recommended a new type of organisation which he called 'functional foremanship' for which eight roles were needed. These included route clerks, instruction card clerks, cost and time clerks who plan and give directions from the planning room and gang bosses who provide coordination and control. Three other functional foremen, the speed boss, the repair boss, and the inspector were concerned with the performance and result of the work. An eighth, the shop disciplinarian reviewed the workers' 'virtues and defects' and aided them in more effectively carrying out their tasks (Taylor, 1905). Note how far the simple division of labour in the pin factory has grown.

In addition to describing the work, he also created a method for measuring work-activities, of all kinds, using a stopwatch to time them. This enabled him, and later his colleagues, after sufficiently numerous observations, to define a 'standard time' for each work-activity. This was the time during which the work-activity could be performed by a 'first-class man'. These individual measurements were then bundled to create standard costs for each unit of output.

Thirdly, he created a method for implementing these descriptions and measurements on the shop floor and for training workers and management on their use. This included the need for specialised roles to ensure that each production worker was supported by the necessary equipment, knowledge, work-descriptions, and machine maintenance to achieve these standard times and associated quality measurements.

10.1.9 Any Colour You Like: Henry Ford

Ford's new Highland Park plant opened in 1908 to build the Model T, famously offered 'in any colour you like, as long as it's black', and Taylor's division of labour was adopted. A number of other innovations were implemented which included electric motors, which freed factory layout from the constraints of overhead belts, and interchangeable

parts which reduced the amount of work in progress stock. This was documented by Arnold and Faurote in *Ford Methods, Ford Shops* published in 1919. The introduction of the moving production line, perfected by 1914, also had a dramatic impact on productivity, as Womack (1990) shows in Chart 61:

	Minutes of Effort to Assemble		Reduction in effort
	Late Craft production 1913	Mass production Spring 1914	
Engine	594	223	62%
Magneto	20	5	75%
Axle	150	26.5	83%
Vehicle	750	93	88%

Chart 61: Production line efficiencies achieved (Womack, 1997)

Ford's fourth innovation, one which both Taylor and Gantt (1911) had foreseen, was the introduction of the five dollar a day wage which was double that which a 'high priced man' could earn. Drucker (1993) points out that the implementation of Taylorism by Henry Ford resulted not only in the highest manual worker wages in the US but the productivity gains from the moving production line pioneered by Ford resulted in a Model T being available for \$250 in 1926. This represented less than three months' wages for a Ford production line worker, a figure which compares very favourably with the UK in 2023, where it takes ten months' wages for full time worker on the average salary £38,270 (indeed.com website, 2023) to buy a medium sized car: Volkswagen Golf – Style £31,050 (carwow.com, 2023).

10.1.10 The Division of Labour in Motion: Frank and Lilian Gilbreth

Industrial engineers led by Taylor created their own language to describe work and working. This language later became standardised by the American Society of Mechanical Engineers (ASME) after Taylor's death and was extended to include the Gilbreths' notation of movement. In 1921, Frank and Lilian Gilbreth published the first edition of *Process Charts* (an example of which appears in Chart 62 below).

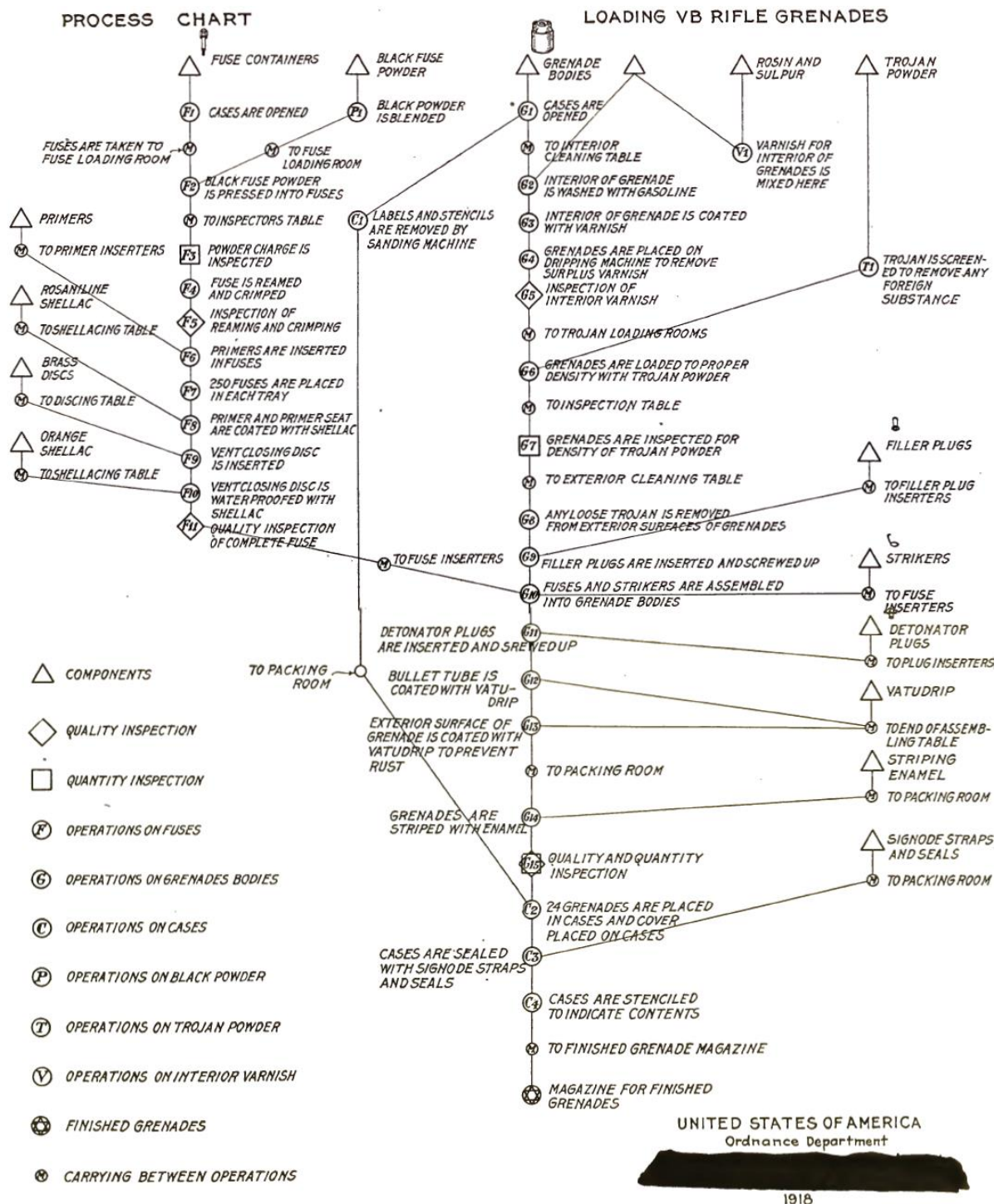


Chart 62: A Gilbreth Process Chart

Their introduction to *Process Charts* (Gilbreth, 1921 page 3) clearly sets out the purpose of these charts:

"The process chart is a device for visualizing a process as a means of improving it. Every detail of a process is more or less affected by every other detail; therefore, the entire process must be presented in such form that it can be visualized all at once before any changes are made in any of its subdivisions.

In any subdivision of the process under examination, any changes made without due consideration of all the decisions and all the motions the precede and follow that subdivision will often be found unsuited to the ultimate plan of operation. In the present paper the authors point out the place of the process chart in management and present established working data used successfully in numerous working installations for many years. They also point out its simplicity, field of application, its relation to standardization, etc. While the process chart method will be helpful in any kind of work and under all forms of management, the best results can come, the authors state, only where there is a mechanism of management that will enforce and make repetitive the conditions of the standards. "

The Gilbreths' notation enabled much richer descriptions of work activities to be created which were still in use during WW II. Anne Shaw (1944) wrote a short book with the title, *An Introduction to the Theory and Application of Motion Study*, first published in 1944, with a foreword by Stafford Cripps, who was the minister for aircraft production during the war. She pointed out that time study and motion study were complimentary.

10.1.11 Reducing the cost of Production: Wright's Law

Taylor's scientific management as extended by the Gilbreths and others and Ford's practices were embodied in the new professional discipline of Industrial Engineering, which was applied to both existing and new industries. Experience shows that the more times an activity has been performed, the less time is required for each subsequent iteration. This relationship was quantified by T.P. Wright, who calculated that every time total aircraft production doubled, the required labour time decreased by 20% (Wright, 1936). Subsequent empirical studies from other industries have yielded different values ranging from only a couple of percent up to 30%, but in most cases, it is a constant percentage. Far from being obsolete, Wright's Law, as it came to be known, is still used today to predict the cost of batteries for electric vehicles.

Writing in the 1990s, Peter Drucker (1993) summed up the extraordinary contribution of Taylorism and Industrial Engineering:

"What, then, overcame the 'inevitable contradictions of capitalism, the "alienation" and "immiseration" of the labouring class, and with it the whole notion of the proletariat?' The answer is the Productivity Revolution. When knowledge changed its meaning two hundred and fifty years ago, it began to be applied to tools, processes, and products. This is what 'technology' means to most people and what is taught in engineering schools. But two years before Marx's death, the Productivity Revolution had already begun. In 1881, an American, Frederick Winslow Taylor (1856-1915), first applied knowledge to the study of *work*, the analysis of work, and the engineering of work." (Drucker, 1993, p. 33)

As Gottwald (1991 page 110) explained:

“The Bureau of Labor Statistics, the American organization whose primary purpose was to enable government and private officials to assess US economic performance relative to other countries and to evaluate the competitive position of the United States in international trade. The BLS started making productivity studies in 1894 and by the mid-1940s it had become a 200-man organization pioneering in studying the impact of technological change on productivity.”

From the turn of the twentieth century, shortly after BLS started measuring the productivity of US firms, Drucker observed:

“Within a few years after Taylor began to apply knowledge to work, productivity began to rise at rate of 3.5% to 4.0% compound a year – which means doubling every eighteen years or so. Since Taylor began, productivity has increased some fifty-fold in all advanced countries.” (Drucker, 1993, p. 38)

He goes on to assess the significance of Taylor, Ford, and Industrial Engineering’s contribution to the Allied victory in WW II:

“Taylor’s axiom that all manual work, skilled and unskilled, could be analysed and organized by the application of knowledge seemed preposterous to his contemporaries. And the fact that there was a mystique to craft skill was universally accepted for many years. It was this belief that encouraged Hitler, as late as 1941, to declare war on the United States. For the United States to field an effective force in Europe would require a large fleet to transport troops. America at that time had almost no merchant marine and no destroyers to protect it. Modern warfare, Hitler further argued, required precision optics in large quantities; and there were no skilled optical workers in the United States.

“Hitler was absolutely right. The United States did not have much of a merchant marine, and its destroyers were few and ludicrously obsolete. It also had no optical industry. But by applying Taylor’s Scientific Management, US industry trained totally unskilled workers, many of them former sharecroppers raised in a pre-industrial environment and converted them in sixty to ninety days into first rate welders and shipbuilders. Equally, the United States trained the same kind of people within a few months to turn out precision optics of better quality than the Germans ever did – and on an assembly line to boot.” (Drucker 1993 page 38)

10.1.12 The Hawthorne Studies and Human Relations School

The extraordinary success of Taylorism did not go unnoticed by Harvard. Elton Mayo captured this in his book, *The Human Problems of an Industrial Civilization* (1929). Mayo's thesis was that Taylor's Scientific Management was overly prescriptive, setting out as it did not only 'what' was to be done, but 'how' it was to be done in equal detail. It also spelled out the time and costs of the 'what' and the 'how' in equally fine detail. Craft unions objected strongly to Taylorism and found an unlikely ally in Mayo. The major research project conducted before the war to explore Mayo's thinking was the 'Hawthorne Project' at Western Electric reported on by Roethlisberger and Dickson (1939). This created the Human Relations School with its focus on individual and group psychology, and the importance of the interaction between the 'human system' and the 'tool system'. The other main strand of thinking at Harvard was the work of Talcott Parsons, who brought the work of Max Weber to the US and greatly expanded his thinking on organisational hierarchies and role theory.

Urwick and Brech (1948) wrote a short introduction to the Hawthorne project aimed at British managers as part of their three-part series 'The Making of Scientific Management, which included Volume I 'Thirteen Pioneers', Volume II 'Management and British Industry' and Volume III 'The Hawthorne Investigations'. The importance of the Hawthorne Investigations was the extraordinary scope, size and staffing of the project. Over 20,000 employees of Western Electric were interviewed, including 500 supervisors. The interviews were consistently done and carefully summarised. Staff from Western Electric and Harvard University worked together through the life of the project.

For British management they summarised the main findings of the project (pp 202 to 208) in the nine main points below:

1. Management is primarily a social skill
2. Good front-line supervision is essential
3. Personnel management must maintain effective two-way communication throughout the organisation
4. Employee consultation is essential and must include all employees
5. Economic incentives are not the most important driver of worker behaviour
6. The Informal organisation of employees must be taken into account
7. Employees are motivated (or not) by the leadership and motivation of their senior managers
8. Employee behaviour must be understood as an expression of underlying discontent or malaise with the working situation
9. Training for management and supervision has been extremely well documented by the Western Electric company and could be used in the UK

After WW2 the Human Relations approach was taken up enthusiastically by the Tavistock Institute of Human Relations, led by Trist and Rice and expanded to

encompass psycho-analytical thinking alongside the psychological. In his historical overview Trist states that:

Great stress was placed on “working through” difficulties and conflicts by analogy with the psychoanalytic method. Not that the interpretations of a psychoanalytic kind were directly made. Jaques called the process “social analysis”. No standardized procedures, however, were established’. Page 14

In the end, these explorations of individual and group psychology, and individual and group psychoanalysis, whilst providing many interesting hypotheses, did not advance organisational thinking beyond the industrial engineering methods as developed by Taylor, his colleagues and successors, and the two main forms of organisation as outlined by Chandler. Jaques explained this in his lecture delivered at the 50th anniversary of the founding of the Tavistock Institute (Jaques 1998 page 2).

“Thus it was, that I found myself attending the regular business meeting composed of the Managing Director and his nine immediate subordinates, called Divisional Manager, in what was termed the Divisional Managers Meeting or DMM. They had been having trouble because they had decided to work by group decisions but had found that procedure difficult to carry out in practice. The main difficulty, they thought, came from what they openly referred to as Wilfred Brown’s autocratic personality. Brown was seen as dominating the meetings in an autocratic way, seemingly unwilling, for example, to allow consensus decisions if he did not agree with them, or seek to impose his own decisions even when most of the group opposed them. These situations when they arose led to vitriolic discussion, with charges of bad will, mistrust, and lack of understanding, filling the air.

Because of my experience with Bion’s group dynamics theory and group therapy methods, they asked me if I would take them through a series of Bion groups, to see if they could sort out their problems. So, we began a series of special weekly one and a half hour meetings in the course of which I soon learned a stunning lesson. Their problems lay not in group dynamics and personality differences, but the unreality of group decision making in a managerial hierarchy organization.”

10.1.13 Pre-War Comparative Productivity

In 1937, Lazlo Rostas (1943), an economist at the UK Board of Trade, conducted a comprehensive analysis of UK productivity, using data from 1935 and 1936 comparing it to the levels achieved in the US and Germany. The number of employees in manufacturing was given as 5 million in the UK, 6 million in Germany and 10 million in the US. These figures represent one-fourth of British employment compared to one-fifth in Germany and US. The exact figures of average productivity figures per head are:

Britain	1935	100
Germany	1936	100
US	1935	199
US	1937	227

Chart 63: Pre-War Comparative Productivity per Head

Rostas noted:

“The greatest superiority of the United States is in the radio and motor car industry, and in iron and steel products where output per head is four times as great as in Britain, and in pig-iron production and machinery, where it is threefold. It is interesting to note that the United States has a superiority in each single industry covered by our sample.” (Rostas, 1943, p. 48)

These productivity figures are somewhat surprising taking into account that a number of leading British firms had invested in the Bedaux system.

The Model T versus the Austin 7

Whilst the data presented by Rostas appears to come as a surprise, it cannot have been unknown by consumers in the 1920s and 1930s. This is illustrated by a short comparison of two automobiles, Ford’s Model T and the British made Austin 7. The first Austin 7 went on sale in the UK in 1922 for £225 and was regarded as the first affordable car for many who had never owned a motor before. With its small frame, large thin wheels, and lightweight body, the Austin 7 quickly took control of the market, becoming Britain's answer to Ford’s Model T. Total sales 1922-1939 totalled 290,000.

In comparison, Ford’s output of Model T totalled 1,911,705 by 1925 and it sold for \$260. The dollar / sterling exchange rate in 1925 was \$4.83 to £1 sterling, the rate which remained until the 1949 devaluation to £2.80. If Ford could have imported the Model T directly from Detroit without import taxes, the UK price before shipping and domestic purchase taxes would have been £53.80, less than a quarter of the price of the Austin 7!

10.2 Appendix 2: Research History

This chapter sets out the author’s personal research history and the main developments which led to the development and to the author’s own PhD research.

10.2.1 Brief History of research and development

The initial phase of research and development began at Donegal County Council in 1997 with the appointment of Stephen Cang as the Organisation Specialist to the County Manager (Michael McLoone). The author’s participation started in 2003 at the invitation of the County Manager and the Organisation Specialist and continued to 2012. From

2021 the research and development work continued as part of this PhD Case Study with Neatsmith Ltd, a UK Manufacturing SME.

Phase 1: Early Days

1. 1997-2003 Donegal Project (Better Local Government)
2. 2003 Stephen Cang's Interim Report
3. 2003 Structure, Process and IT
4. 2004 The HR Recruitment Project

Phase 2: The New Ontology, Epistemology and Method

5. The Unexpected Creation of the Work Description Language: 2005
6. Entities, Properties and Quantification: 2006
7. Work Activity Reporting: 2008
8. Enterprise Transformation: 2010
9. Implementing Work Activity Reporting for Donegal Purchasing: 2012

Phase 3: PhD Research

10. Measuring Productivity within the Firm: ONS Policy: 2008
11. Purchasing Case Study: 2010

10.2.2 Phase 1: Social Analysis and the Donegal Project

Section 1: 1997-2003 Social Analysis in the Donegal Project

The appointment of Michael McLoone as County Manager for Donegal County Council was made in 1996. At that time the Council's performance was not considered satisfactory by its citizens or the Department, and McLoone, at that time the Chief Executive of the Beaumont Hospital in Dublin, was invited to take up the vacant post. As a Donegal man himself McLoone was keen to take up the post. At Beaumont, McLoone had worked with Cang from the Brunel Institute of Social Sciences (BIOSS) in the 1970s and 1980s and was impressed with the work of Elliott Jaques, Ralph Rowbottom and other colleagues on health projects in the NHS. Kinston and Rowbottom (1989) provide an excellent summary of their NHS work in their book.

Jaques had developed a method called 'Social Analysis' to guide researchers in this practical work with clients, much of which had been developed as part of the Glacier Metal Project. Rowbottom, at that time working with Jaques at Brunel, documented the method in his book *Social Analysis* (Rowbottom, 1976) and summarised it succinctly:

"Social Analysis is an activity devoted to (1) gaining scientific understanding of, and, thereby (2) facilitating enacted change in (3) social institutions, through (4) collaborative exploration by those actors immediately concerned in their working, and an independent analyst."
(Rowbottom, 1976, p. 21)

Jaques had also summarised his latest thinking based on his own research at Glacier Metal and the large number of projects in health and social services conducted by BLOSS in the 1960 and 1970s in his *General Theory of Bureaucracy* (Jaques, 1976). This was an important new contribution to sociological writing since Weber's publication in 1920 based as it was on number of empirical social analytic research projects starting with Glacier Metal in 1947. This thinking was reinforced by further studies in health services. (Kinston & Rowbottom, 1989)

McLoone hired Stephen Cang as his Organisation Analyst for the Donegal Project in 1996 and created a project team which included representatives of the major departments in the Council. For most of the project he worked with Sean Sheridan, who later became Director of Corporate Services at Donegal until his retirement in 2010. Cang and Sheridan interviewed about 300 of the then 1,400 Donegal employees to gain a better understanding of their issues and concerns and advise McLoone on their findings. One of the outcomes of this Social Analysis project (Rowbottom, 1976) was the design of a new five level organisation modelled on the Brunel findings. One of the main outputs of the project team were the descriptions of the work to be done at all five levels and preliminary job specifications which were both used in setting up and making appointments to the new organisation.

This new organisation was to be implemented in five newly-built Area offices to bring the Council's services much closer to their customers. Donegal is a large rural county with a widely dispersed population so each of these new Area Offices was designed to serve small town. The County HQ remained in Lifford, located next to the border with Northern Ireland across the river to Strabane in Northern Ireland and quite a long way. They also had provision for the accommodation of other Public Services to make it easier to facilitate inter-agency working.

Section 2: Cang's Interim Report 2002-2003

As the new council buildings were commissioned and built the new organisation also took shape. There were numerous problems to be solved, many of which were long-standing. Easy problems to solve included the lack of telephones and computers which were in short supply and could be easily added to the new Area Offices as they were deployed. Much harder problems included the dual-structure, the distinctions between 'indoor staff' and 'outdoor staff' who had different terms and conditions, the absence of a clear organisation structure, or as Cang would put it, any organisation at all, in which managers were in any way concerned or involved in the work of their subordinates.

During 2001 Cang started to have serious reservations about the success of the new organisation despite the new buildings, new telephones and computer systems and new organisation. At this time Cang and the author met quite regularly in London, and he was sharing his experiences and concerns. The author's experience was in the marketing, sales, development and implementation of IT systems for ICL and DEC and at that time he was working for a US company who were bringing the first B2B internet payment systems to market. The author was therefore quite knowledgeable about the latest technologies and developments in the US market and the practical challenges of

bringing them to market. Cang and the author had discussed Jaques's levels of work and the potential role of Information Systems many times, but without the benefit of a real-world project.

Cang's underlying view, which he was struggling to express, was that despite the new organisation and considerable investments in new offices, meeting rooms, telephones and computers, nothing had really changed. He summarised these concerns in his 'Interim Report' various version of which were discussed with Sheridan and McLoone and finally presented formally in July 2003. (Cang, 2003)

Section 3: Structure, Process and IT 2003

During 2001 and 2002 Cang and the author had numerous discussions about the Donegal Project and his increasing worry that nothing had really changed, but neither of us had any convincing explanation as to why this might be the case. As an IT systems designer, the author's operating assumption was that IT systems did solve real customer problems, and did enable firms to provide new and valuable services to their customers. Having worked in Boston between 1999 and 2002, the author had an eye-witness view of what was happening in the USA at that time. The Internet boom had been triggered by the Netscape IPO in August 1995 and a veritable wall of money, much of it from Wall St. was finding its way into literally thousands of start-ups, many of whom had no business plan.

Schumpeter's process of 'creative destruction' was in full swing and out of this chaos came a whole raft of new products and services which included Amazon, Internet Banking (most famously PayPal), E-Bay, Alta Vista (the internet search pioneer) and Google (the search winner) Facebook, Microsoft and many more household names. Even though 99% of the start-ups failed, the ones that prospered are now amongst the highest value firms in the world.

Corporate investments in technology started in the early 1990s, more than five years before the internet boom, under the banner of Business Process Management. Michael Porter in 1985 in his second book 'Competitive Advantage' (Porter, 1995) set out a view of the enterprise as a series of interconnected 'value chains' or processes, rather than the conventional view of organisation hierarchies. The rapid development in computer networking, personal computers and servers in the 1980s reduced the cost of computing dramatically.

This new 'process view' of organisations was extended by Michael Hammer and James Champy (1990) starting with Hammer's article 'Re-engineering Work: Don't Automate, Obliterate', published in the Harvard Business Review in July / August 1990. This was followed by 'Re-engineering the Corporation,' first published in 1993. Thomas Davenport (1993) in his book titled 'Process Innovation, Re-engineering work through Information Technology extended the thinking.

With much less publicity at the time, Oracle and SAP created complex Enterprise Resource Planning software applications for the Fortune 500, which drove US

productivity to hitherto unimagined heights. At that time there was a widespread view that the supply side of the US economy would deliver enormous and sustained growth in productivity which would make it much easier to manage the demand side of the economy in which rising real wages would reduce the Federal deficit and at the same time reduce inflationary pressures. Despite the market correction at the end of the dot.com boom in April 2000, this happy combination of macro-economic circumstances was known at the time as the 'Goldilocks' economy, neither too hot, nor too cold with relatively high productivity growth and low inflation, and it spread from the USA to Europe. After the 2008 financial crisis it was understood that much of the growth was driven by increased leverage by US and European Banks which created a classic bubble, which burst when Lehman Brothers were forced into bankruptcy.

When the author returned to London from Boston in 2022, he and Cang met quite frequently, and discussed his view that nothing had really changed on the ground as a result of the Donegal Project and what might have caused this.

In late 2001 the author met up with an old Boston neighbour, who happened to be in London. He introduced me to the CEO of a small software company who specialised in Business Process Reporting, thinking that it might be of interest. He had worked with this CEO many years before and had a good opinion of him. Given that the author and Cang were looking for something that would capture the dynamic rather than the static nature of work, the author explored this further. During 2002 the author and Cang met with the firm and viewed their Business Process Reporting (BPR) software. It seemed to offer a lot of promise and the author and Cang introduced the technology to both McLoone and Sheridan and discussed it with them for some months. Sheridan made the breakthrough at a meeting in Stansted airport with the author and Cang. He suggested that whilst the management structure had changed, and some Directorates and services had deployed IT applications, the way that the work was being done had not changed at all. The implication of this was that if we could better understand how the work was done in a small number of services, we might be able to better understand how to make changes more widely, which would improve performance.

These discussions led to a proposal written by Stephen (Cang, 2003b) to the County Manager and Director of Corporate Services (Sean Sheridan) to test out this new Business Process Reporting approach as the next phase of the Donegal Project. There followed another three months of discussion between the four of us which led to the author's proposal (Stroll, 2003a) which more fully explained the new approach to bring together Structure, Process, Statics and Dynamics into a Method for customer implementation. Cang and the author called this new approach the Whole System of Work (WSW). The two new components were Process which described the work to be done using the software firm's mapping technology and the Dynamic Reporting which reported on the work that was actually being done, using the software firm's business process monitoring software. After some discussion with Donegal, the proposal was accepted, and the author joined Cang to provide additional knowledge and skills to implement this next phase of the project starting in the summer of 2003. The four charts below illustrate the key points from the proposal. Little did we know at the time that it

would take another five years to implement what we later called Work-Activity Reporting.

Statics – what does this mean

- Most business and IT thinking takes a static view of organisation
- For example - Visio is the most popular tool for process mapping but results are static
- Data modelling is the basis for IT applications but this is also static
- Static documentation is quickly out of date and only provides a 'snapshot' view of the organisation
- Analogy is with photography – invented in the 1840s

Chart 64: Statics defined.

Mapping

- Mapping provides a way of documenting business processes
- A business process documents a series of activities
- Many business processes are documented today
- Business process mapping generally uses static tools like Visio
- BPM provides support for business process mapping with maps saved as XML documents
- Process maps can be viewed and printed

Chart 65: Mapping defined

Dynamics – what does this mean

- Transition from static to dynamic was the first great revolution in physics (Galileo c 1500)
- Second great revolution was Newtonian dynamics and the invention of calculus which provided the mathematical language to describe dynamic systems
- Organisations are dynamic so static views are always incomplete
- Analogy is with 24 hour television to capture what is actually going on hour by hour
- Capturing this dynamic behaviour is difficult but essential if we are to really understand what's happening
- Human behaviour is also dynamic ('goal seeking work with the use of judgement and the making of judgements and choices' – Jaques 2002)

Chart 66: Dynamics defined

Tracking

- Tracking takes a static process map and makes it dynamic
- It does this by connecting to the underlying systems (IT, manual, communication) which support the activities
- Connecting to systems is passive and uses adaptors
- Most business processes (even simple ones) use two or more systems
- Tracking is performed in real time and accumulates data which can be analysed
- BPM software include high performance real-time state engines and links to Mapping

Chart 67: Tracking defined

Section 4: The HR Recruitment Project 2004-2005

The author's first two years on the project proved, beyond reasonable doubt, that 'whatever could go wrong, will go wrong.' Under Sheridan's guidance we were introduced to the other Directors, but Sheridan decided that the focus would be on the most serious and pressing problem at that time, which was recruitment. Ireland was experiencing dramatic economic growth and there was a shortage of workers to deliver

the plans for Better Local Government. As a former member of the original project team, Sheridan had been appointed as Director of Corporate Services in the new organisation working directly for the County Manager (Michael McLoone). In this role he was responsible for HR, IT and other Corporate Services and therefore ideally placed to supervise the next phase of the project with its focus on recruitment.

Cang and the author tackled the HR Recruitment Project from four perspectives. The first of these was to be the definition of the HR recruitment process, with Sheridan himself as the Director responsible. This definition was subsequently reviewed by the recruitment manager who was responsible for this work. To everyone's embarrassment, the Director's view and the manager's view of the work were not the same.

The second perspective was the "mapping" of the HR recruitment process using software from the software company, which was delayed. This perspective required engagement from Donegal's IT department, several of whose members were seconded onto the project. The IT team were not convinced that the software company's process mapping software was the best approach, and both they, and the Local Government Computer Services Board (LGCSB) who developed applications for all Irish Local Government, were more familiar with Visio which was a widely used tool at that time.

The third perspective was Cang's work to define the new organisational requirements following on his and Sheridan's original work on the Project Team, which had created the new five-level organisation structure together with the job specifications for all 55 managers to be appointed within the new structure.

The final perspective was the implementation of the process monitoring software (real-time tracking) which was to deliver the dynamic reporting for the HR Recruitment Process. To the complete embarrassment of all parties, this software did not work with the newly created process map, and with the benefit of hindsight it is likely that what the author and Cang had seen in 2002 was a very early prototype.

10.2.3 Phase 2: Work Description Language and Work Activity Reporting

Between the end of the HR Recruitment Project at the end of 2005 and the Global Financial crash in November 2008 considerable progress was made in three areas: the development of the Work Description Language (WDL). The development of a new Ontology and Epistemology based on Jaques's thinking and the implementation of Work Activity Reporting.

The abrupt end of the HR Recruitment Project was completely unexpected and had a big impact on the direction of the research and development project and the belated recognition that a fuller understanding of Ontology and Epistemology would play a central role in the future development of the project. This played out in five ways which are outlined below and discussed more fully in the sections that follow.

With the benefit of hindsight, even though the HR Recruitment Project had used the Social Analysis method and the Levels of Work developed by Jaques, Rowbottom and the BLOSS project, and the IT team had used the latest process mapping technology it was discovered that the ontology and epistemology were implicit rather than explicit. It turned out that this implicit ontology and epistemology was deficient in a number of ways, and that this had led to many of the difficulties experienced by all members of the HR Recruitment Project Team.

The Unexpected Creation of Work Description Language

One of the great frustrations of clarifying the requirements for the failed HR Recruiting Project was the mis-match between the IT language of systems analysis, applications and databases and the lack of a similarly comprehensive language with which to discuss the work. This section discusses the Ontological breakthrough made by Cang which led to his creation of the Work Description Language (WDL) in late 2005. Cang had attended many of the HR Recruitment Project meetings both in London and Ireland and had become increasingly frustrated with what he thought was the complete lack of clarity of any of the descriptions of work provided by either the software company or Donegal's IT specialists. They did not, to him, seem to be talking the same language. In addition to his education and training as a psychologist and a participant in psychoanalysis (which was part of the Tavistock tradition). Cang was also an accomplished linguist whose first language was Polish.

His father was a Polish journalist who wrote for the News Chronicle in London. The newspaper article, 'The Last Train Out of Warsaw' (Cang, 1939), describes their escape from Warsaw on the last train in September 1939 which was heavily bombed by the Germans. After four days it stopped, and the remaining passengers had to walk with their belongings to the Romanian border and finally end up in London as refugees. As a result, English was Cang's second language and French, German and Italian his third, fourth and fifth.

At the time, the Work Description Language seemed to appear like a bolt out of the blue, but looking back nearly 20 years later it was clearly the outcome of working on many different social analytical projects and facing the same problems, but, as at Donegal, not being able to solve them with the language available. One of the most important practical consequences of this new language was that it gave us a way of making progress from what had appeared an insurmountable obstacle which was the alternative descriptions of work were all in technical language which was needed for the specification of information systems. At that time a specialist language called BPMN (Business Process Management Notation) was being developed and was being used by IT enterprise architects. There was also, but the author was not aware of it at the time, a language that had been developed by the work study pioneers led by Taylor, Gantt and Gilbreth which was in use until the late 1960s.

The Work Description Language enabled the author to use the Work Narratives, which had been developed by Donegal's Organisation Development staff, as a way of providing additional knowledge about a given work process following staff interviews. The author

then developed a technique to mark up these work narratives using coloured pens to highlight the different components of WDL in the text (see Chart 68 below).

5. Machinery Yard Payroll Procedures

This is a new section not featured in the previous version of this document. With minor amendments, the text is taken from a report prepared for the Machinery Yard in November 2004, titled "THE MACHINERY YARD & PLANT HIRE".

5.1. Wages Processing

- Each driver submits a Daily Record Sheet (see note below) for week just passed on Thursday morning to CO assigned to payroll.
- Non-drivers (spray bar operators, helpers, etc.) submit timesheets
- CO sends all sheets to Technical Services Officer for checking and signing (and coding where necessary).

TS 6 When checked and signed, the sheets are returned to payroll CO, usually by lunchtime Thursday.

- CO transfers data from the daily record sheets and timesheets to payroll timesheets, adding in allowances and service record.
- The driver's (and helper's) wages in full are usually charged to his machine's fleet number. However, there are some exceptions:
 - When a lorry is on salting duty, the driver is charged to the fleet number but the Areas provide a code for the helper.
 - If both are working in the yard, they are charged to a maintenance code or stores bitumen code, depending on what they are doing.
- From this point, payroll is processed in the normal manner (see Section 3.4 above).
- After payroll upload (on Friday before 2.00pm), all daily record sheets, timesheets and batch reports are sent to Senior Executive Engineer for checking. *By which Role?*
- These are all returned to the CO with any required changes noted, usually within a day or two but no later than the following Thursday, so that adjustments can be made in the following weeks payroll run. *By which Role?*
- Upon return, the daily record sheets and timesheets are transferred to the CO assigned to machinery transfers (with no copy being kept in payroll)

By which Role?

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Chart 68: Marking Up a Work Narrative

Later on, this feature was added to the software, which enabled the mark-up to be applied electronically to a stored Work Narrative.

Some years later when studying for an MSc, the author learned about Grounded Theory (Glaser & Strauss, 1967) and their use of specialised mark-up software, which enabled a researcher to capture similarities and patterns from which theoretical statements could be created. The main difference between the two epistemological approaches was their respective purposes. Work Narratives were based on interviews with employees and managers by an Organisation Development specialist (of which there were two in

Donegal) and signed off by the employee or manager. They were then 'marked-up' by a WDL specialist to better understand how these potential needs could be met by the process maps and real-time reporting which were to be implemented. They were in this sense instrumental. The purpose was not to develop new theory but to clarify the work activities and work objects for both the employee and his or her managers. In his introduction to WDL, Cang (2007-23 page 5) explained as follows:

"There is one feature of implementation worth noting in advance. An early consequence of the discovery of a complete language in which to describe work was the realisation that it would be possible to state, for each role in the organization, everything relevant to working in that role. It will become the responsibility of each manager to create and maintain, for each employee, such a statement, agreed between manager and employee, and called a Work-Description (W-D).

The full meaning of having such Work-Descriptions for all can emerge only in the course of using WDL to examine existing working-arrangements and gradually improve them. In doing so, it can be seen that the contents of each role involved will inevitably start to accumulate. For every employee taking part in the performance improvement of the department, therefore, there will be the added experience of seeing the gradual clarification of his or her own work in all its detail, clearing up "what you always wondered about your job and never had a chance to get clear".

Brief Summary of WDL

Full definitions of each of these terms are available in the WDL Glossary but the list below summarises the entities which together comprise a full description of work.

1. Work-activity ID
2. Work-activity description
3. Narrative Page reference
4. Work-Object
5. Work-Object Type
6. Work-Activity set
7. Work-Activity group
8. Work-Process
9. Role/Position
10. Managerial relationship
11. Working-relationship
12. Counterparty role/position
13. Working-relationship properties
14. Customer
15. Governance Issues

Entities, Properties and Quantification: The New Ontological Foundations

Jaques had been engaged in social analytic studies, starting with the Glacier Metal Project in the late 1940s. On appointment to Brunel in 1964 he continued these social analytic studies mainly in the Health Services through BIOSS (Brunel Institute of Social Sciences) mostly funded by the Department of Health. After he retired from Brunel he moved to the USA and continued work with a number of private firms and the US Army Research Institute, then managed by Owen Jacobs. In his book 'the Form of Time,' (Jaques, 1982) he explained the difference between entities, properties preferences and quantification. The author has quoted the relevant paragraphs in full in Chapter 3 Methodology because they provide the clearest ontological foundation for the work of social analysis.

Many of the social analytic projects delivered by BIOSS in the UK had focused on the need for a clear organisation structure founded on the levels of work. What they did not do was explore the measurement of the projects either in financial or productivity terms. They did also not take into account the future importance of information systems which were not widely used in UK Public Services in the 1970s beyond accounting departments.

As part of the Donegal project there was a need to deal with modern information systems for specific Departments or Work Processes which were developed by the local authorities as a group through the Local Government Computing System Board (LGCSB). At Donegal, in the early 2000s the first enterprise-wide commercial accounting systems, which included payroll, purchasing, chart of accounts and cost centres were being implemented. This application was considered to be too complex to be implemented by the LGCSB and a commercially available application (Agresso) was purchased instead.

Three Types of Observation

In the social sciences, unlike the natural sciences, it is possible to ask the person being observed to describe the work they are being asked to do. 'Direct Observation' as, implemented by the Work Narrative described above, provides the only real material on which all subsequent descriptions are based. Without direct observation it is not possible to tie the work back to specific people and this opens the observer to the risk of ungrounded abstraction.

- **Direct observation** is the closest possible to the reality where the employee reports what he/she actually does as fully as possible and this is either:
 - a. Recorded by the employee
 - b. Recorded by an observer whose written narrative is agreed by the employee to be an accurate version

It should be noted firstly that the more experienced the observer, the better the narrative in terms of it being detailed and complete and secondly that an

observer trained in using the Work-Description-Language (WDL) will construct the most complete narrative possible. It is this Work Narrative which provides the foundation for all descriptions of work.

- **Indirect Observation** is performed by an observer who views the work being performed, often with a particular interest in mind (e.g. to observe the number of operations, the elapsed time, the use of machines, the layout of the shop or office) and then documents the results of these observations. This may result in one or more facets of the work being described, quality being just one example. The narrative is not checked with the employee and is therefore at one remove from the work hence the term 'indirect observation'. This describes the primary method used by the work study practitioners beginning with Taylor.
- **Dynamic Direct Observation** is the observation of 'working' and can only be performed where the observer (or authorised manager) has created complete descriptions of the work using WDL. These complete descriptions can then be tracked using Work-Activity Reporting to provide reporting of the work actually being performed.

The Properties of Work Activity Reporting

The 'founding fathers' of work study, writing before the First World War, were deeply concerned with observation and documentation of the properties of work focusing on what is now called labour productivity. Frederick Taylor (Taylor, 1903) used indirect observation of what would now be called the individual work-activity level for factory workers. But the Gilbreths, (Gilbreth & Gilbreth, 1921) building on Taylor's work, introduced process descriptions which could be derived from direct observation and also developed a rich language for describing physical movement, which is still in use today.

Henry Gantt (Gantt, 1918), who worked with Taylor, was particularly interested in the quantification and measurement of time and resources, and the chart which bears his name is still the foundation of project and programme management today. Bedaux who packaged and popularised work study in the USA and UK in the 1920s and 1930s was particularly concerned with the financial properties, developing the concept of standard times for particular levels of effort. (Weatherburn 2014)

Quality was introduced after the Second World War by Joseph Duran and W. Edwards Deming but was famously ignored by American industry at that time. It was in post-war Japan, where both Deming and Duran's thinking and methodology were widely adopted in the 1950s and these contributed in no small measure to the Japanese industrial miracle, during which Japan grew to become the world's second largest economy. Thirty years later, popularised by MIT's studies of the Toyota Production System (Ohno, 1996), the US then imported many these ideas and Six Sigma became of major importance in the 1980s and 1990s.

1. Quantification: Productivity – pre WW1
2. Quantification: Financial – pre WW1
3. Quantification: Time – pre WW1

4. Quantification: Capital – pre WW1
5. Quantification: Quality – 1946 in Japan
6. Quantification: Intangible Capital – Corrado, Hulten & Sichel 2006

Reporting, Measurement and Quantification

It should be noted that whilst the descriptions of work are static, all work is actually dynamic; there is no such thing as static work. In order to capture the dynamic nature of work activities one needs first to describe these and then capture the relevant measurements of these entities. Once a full description of the work has been recorded, the methods and tools for capturing and reporting on the dynamics of the work need to be developed. Reporting therefore, cannot be fully developed without:

1. A complete description of the entities and properties (of each work activity)
2. A complete set of tools for capturing the start and finish of each work-activity
3. A full set of quantifications for each work activity

Only once work-descriptions, work-activity reporting and work-activity quantification have been implemented can it truly be stated that there is a complete description of the static and dynamic nature of work and working.

Entities, Properties, Measurements and Quantification

This section explains how WDL enabled the extension of Jaques' thinking about social entities, properties, measurements and quantification, published in *The Form of Time* (Jaques, 1982). The author had worked with Jaques on a research project for what was known at the time as "Executive Information Systems" for his then employer, Digital Equipment Corporation (DEC) (Stroll, Miller & Mitchell, 1983). The author presented the results of this project at the first Conference on Computer Supported Co-Operative Work (CSCW) conference held at MIT in Boston. The 'Executive Research Project', as it was known, interviewed 40 senior US executives on their needs for 'Executive Information Systems'. The results were inconclusive partly because there was no detailed understanding of the work activities which these managers were asked to perform. A DEC colleague, Paul Cashman and the author did further research on the same topic with the aim of building an application for use by a 'New Business Marketing Group' which the author was also managing which was a Level 4 role. These papers were also presented at subsequent CSCW conferences in 1986 (Cashman & Stroll, 1986) and 1987. (Cashman & Stroll, 1987)

Section 9: Testing Six Services

This section explores the testing of six services agreed by the Council in June 2010. Having reached the mandatory retirement age for public sector employees in July 2010, McLoone retired. His successor as County Manager took over the responsibility for testing six services, the most complex of which was Purchasing. The section describes

the difficulties of this project which included the large number of potential users (over 200 people were engaged in the purchasing process, the number of different locations at which these people were deployed and the high volume of purchases (some 60,000 in a full year). The testing project was signed off in January 2012 by McLoone's successor as being successfully completed (Stroll, 2012) but no further implementation work on transforming the remaining 115 services was requested or authorised.

Work Activity Reporting: 2008

Cang wrote a very thorough report at the end of 2007 (Cang, 2007 page 6) looking back to his Interim Report (Cang, 2003) and documenting the many important learnings which are directly relevant to the ontology and epistemology of the project. The quotation below summarises his despair at the result of the first six years of work on the project.

"It was therefore something of a surprise to find in the context of applications for the newly named roles (Director of Service; Divisional Manager; Area Manager) that little attention was paid by staff to the new role descriptions. More surprising still was that once appointments began to be made, there was no evidence that the new responsibilities were of concern to the newly-appointed officers. In short, nothing happened.

This outcome caused some dismay to Cang for several reasons. First, the concepts he had used for some years, to the development of which he had himself contributed, and of whose value he was deeply persuaded, now appeared to have (so to speak) fallen at the first practical fence. Secondly, it removed the logic of writing an 'Interim Report,' when it was hard to see that any further reports would be called for. Lastly, it began to seem that an outstanding opportunity to show what improvements in organisation could do for performance was about to disappear, without some new thinking."

However, the work conducted between 2003 and 2007 did appear to solve the key ontological and epistemological problems to the extent that it was possible to look ahead with some confidence as shown in the chart below.

Transformation Step	Organisation	Budget	Work-Objects	Work-Activities 1	Reporting	Properties	Work-Activities 2	Working-Relationships	Governance	Working Arrangements	Work-Descriptions	Work-Process Specifications
	A1	A2	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6
Organisation												
Work-Objects												
Work-Activities												
Working-Arrangements Reporting												
Working-Relationships												
Governance												
Service Indicators												
Productivity												
Responses Comments & Issues												
Work-Descriptions												
Work-Process Specifications												

Chart 69: Managing a Transformation Project

The biggest ontological challenge was the creation of the Work Description Language and the newfound ability to Mark Up of Work Narratives and the distinction between the work itself and the properties of the work as formulated by Jaques (1982). This opened the way for two major epistemological advances. The first was the development of the Method to be used by an accountable manager to implement a Transformation Project. The second was the construction of the first KnowledgeGrid called KG1. (Stroll, 2007a) to support the manager who was tasked with implementing the transformation. The first version of the KnowledgeGrid had been developed and demonstrated in 2007 in response to the need to manage the quantity of documentation that was being generated by each project. The idea was to give each manager their own KG to manage their own project.

Work-Activity Reporting

Work Activity Reporting provides the missing technology for real time monitoring and reporting of the state of each work activity and case in a work process. This was what was originally promised by the software company back in 2003 but never delivered. The clarifications provided by the new ontology and epistemology made the development of this new work-activity reporting software possible. The third major development was the implementation of the first Working Arrangements Reporting application known as KG2 (Stroll, 2008a). The user guide is for Version 4, but the first version was issued in late 2008. This was an important milestone for two reasons. It finally implemented what had been called in the 2003 presentation, 'Modelling and Tracking'. However, the context was now completely different – there were an agreed set of Work Processes defined, documented and agreed by the Director of Corporate

Services (Sean Sheridan) and agreed with the County Manager and all the Directors. There was an agreed Transformation Method, supported by KG1. There was now a means of capturing the performance of working arrangements for a specific work-process and reporting on it for the first time. The application focused entirely on entering and updating the status of a new recruit to Donegal County Council. Cases can be assigned to different officers in the HR Department and are then updated by that officer. Reports are produced for the HR manager showing the status of each recruitment, and lastly historical performance data for all cases maintained in the database.



Chart 70: HR Reporting at Donegal

In parallel with the Working Arrangements Reporting, a Working Arrangements Editor known as KG3 was also developed. (Stroll, 2008b) This editor enabled the user to take the results of the mark-up of a work narrative and capture the details in the application's database. When taken together KG1 supported the transformation project for a specific work-process; KG2 provided working arrangements reporting and KG3 provided a detailed description of the current working arrangements which could be tied back to the original work narrative, which was itself signed off by the employee / manager who was interviewed, and the OD consultant who did the interviews and wrote the narrative. This sequence of work narrative, mark-up, working arrangements

reporting and working arrangements editing completed the project objectives set out in the original 2003 presentation which itself was a response to Cang's Interim Report from 2002.

10.2.4 Phase 3 The National Crisis in Ireland

The Irish Government was already concerned by the relatively poor performance of the public sector had asked the OECD to prepare a report on its public services (OECD 2008) with a view to recommending possible improvements. McLoone was asked to participate in this study on behalf of the local government sector and provided a substantive summary of its findings and the potential impact on local government management. (McLoone 2008) One of the important recommendations reported by McLoone focused on performance management:

“There is a need to improve the system of performance management in the public service according to the OECD. The focus should be on outputs and outcomes, on setting appropriate benchmarks (for cost, quality, timeliness) and on taking action to improve services/standards or on reallocating resources or on reprioritisation of need. The focus currently is on inputs.”

In other words, the national context was already beginning to shift from budgeting inputs, which were not necessarily aligned with outputs, which were not themselves measured, to the more systematic of Input → Process → Output approach documented by Sheridan for the Councils 121 services.

The 2010 Donegal County Council Budget

In response to the OECD report and the Financial Crisis the County Manager asked Sheridan to construct the Council's 2010 Budget by applying the Input → Process → Output logic to Donegal's 121 services. The new budget implemented recommendations from the OECD Report (2008) into Irish Public Services which had reported that most reporting dealt only with the inputs and there was much less complete measurement of the outputs and almost no specifications of the process by which inputs were converted into outputs. The important breakthrough here was having clarified the list of Services, each one was provided with its own budget which determined what staffing levels and other resources (now called Energy, Materials and Services) as well as Capital Services would be required for each one. That Work Activity Reporting could be applied to each of the services had already demonstrated, and, in principle, the outputs of each service could be measured in terms of number of cases, kilometres of road, number of houses built and so forth.

The Irish Financial Crisis: 2008 onwards

As reported by the Irish Independent (Bielenberg, 2018), the financial crisis hit Ireland's bank more than six months before the global financial crisis and resulted in Ireland

having to seek a bail-out from the European Union. The article highlighted two key events in 2008:

“November 21: Brian Lenihan (Irish Finance Minister) flies to Brussels to apply for a €67.5bn international bailout for the State.

November 28: 'Hell at the gates': The Irish bailout is agreed and includes punitively high interest rates, Troika oversight of public finances and a commitment to austerity. Repaying the vast bulk of bank debt - much now owed to the Central Bank - is a condition of the deal.”

The global financial crisis began with the bankruptcy of Lehman Bros, a New York investment bank on September 15th 2008. That hit Ireland very hard. Almost all commercial banks and investment banks had invested in packages of securitised assets, whose credit ratings turned out not to match their mark to market value. At its peak Lehman's had assets were nearly fifty times its capital. As the packages of securities assets fell in value, Lehman's could no longer sell these assets and was forced to liquidate.

The Financial Crisis which hit Ireland the USA in late 2008 led to a crisis budget in November that year which demanded cuts local government spending. The preparatory work by Sheridan and McLoone in 2009 in budgeting by service became the foundation for McLoone's presentations (2010a, b and c) to the Elected Members and Trades Unions in June 2010, setting out a complete transformation programme for Donegal County Council in response to the financial crisis. This programme built on the 2010 Council budget and planned the transformation of each of the 121 services over the following five years (2011-2016). This presentation was also made available by McLoone to the senior civil servants in the Local Government Department in Dublin (DoEHLG).

The impact on Irish Public Services was dramatic and the County Manager was required to take a number of trips to Dublin to work on what became known as the Transformation Programme but was in effect a reduction in headcount and benefits for all public sector employees. These measures were hotly disputed by the Irish Trades Unions and intense discussions between all parties took place between September 2008 and June 2010 which resulted in the Public Services Agreement (Irish Government, 2010), known to all as the Croke Park Agreement, after the Irish national rugby stadium where the negotiations took place. In addition to further reductions in public sector headcount and spending there were the first statements on the need to increase productivity:

“In order to maximise productivity gains, both from how work is organised and from streamlining procedures, processes and systems to allow for shared services and e-government developments, a substantial commitment to the redesign of work processes will be necessary.”

The impact on Irish government finances was documented the Government's National Recovery Plan published in the summer of 2011 (Treasury Department, 2011 page 5):

"Over the last two and a half years, we have responded promptly to the deterioration in the public finances. In five separate adjustment packages, savings and revenue-raising of around €14.6 billion on a full year basis have already been achieved. As a result, our public finances have stabilised with an underlying deficit of 11.7% of GDP in 2010 compared with an implied uncorrected deficit of 20% of GDP.

To demonstrate the seriousness of its intent, the Government has decided that 40% or €6 billion of the €15 billion adjustment will be made in 2011. This commitment to the early delivery of the Plan will engender confidence at home and abroad that we can restore order to our public finances. The adjustment will be made up of €10 billion in spending reductions and €5 billion in tax and revenue raising measures. These are demanding but realistic targets. With a concerted national effort, they can be achieved."

In order to support the County Manager's responses to the Irish Financial Crisis, requirements for a number of new KGs were developed and some of them were built.

KG5 Requirements: Master Organisation Editor and Database. (Stroll, 2010a) Whilst it makes sense to capture the organisation for each work-process in the existing working-arrangements editor, there is a need to ensure that there is a single KG based organisation database which can be updated from the DCC HR system on a weekly basis. This master database could then be linked into each of the work-processes so that they could also be updated and ensure that there was no duplication of roles.

KG6 Budgeting User Guide: The design of this application mirrors the work done by Sean Sheridan to construct the Council's 2010 Budget by Work Process with the input costs and output measures. (Stroll, 2010b) Much of the work of creating this budget was aligning all budget, headcount and non-payroll costs, which had been done before at the work-process level.

The screenshot shows a software window titled 'Add / EDIT Work-Process'. It contains a table with the following columns: W.P. ID, Sub-Service Code, Work-Process Name, W.P. Contact, Budget 2009, Budget 2010, Head Count 2009, Head Count 2010, Non Payroll Costs 2009, Non Payroll Costs 2010, and Output Measures. The table lists various work processes, with row 81 (Local elections) highlighted. A small dialog box with the text 'Add/Edit Work-Process Saved' and an 'OK' button is overlaid on the table. Below the table are 'Save' and 'Exit' buttons.

W.P. ID	Sub-Service Code	Work-Process Name	W.P. Contact	Budget 2009	Budget 2010	Head Count 2009	Head Count 2010	Non Payroll Costs 2009	Non Payroll Costs 2010	Output Measures
77	H0101	Plant and machinery ser...								
78	H0201	Procurement and stores								
79	H0301	Rate collection								
80	H0401	Register of electors		£400	£400					
81	H0402	Local elections								
82	H0501	Coroners and inquests								
83	H0601	Weighbridges								
84	H0701	Casual trading								
85	H0901	Elected members' allowa...								
86	H0999	Council meetings support								
87	H0999	Council Committees supp...								
88	H1001	Motor taxation								
89	H1001	Driver licensing								
90	J0101	Office accommodation								
91	J0201	Public relations								

Chart 71: Budget for 121 Donegal Services (Work Processes)

Budgets were of course produced at Directorate level and cost centres allocated but as discussed there is a need to correctly identify all input costs at the work-process level.

KG7 Requirements: This set of requirements provides a high-level Dashboard for the CM to review progress and reports on a monthly basis with all stakeholders and all Directors (Stroll, 2010c)

KG8 Requirements: In order for the County Manager and Directors to transform and manage the services for which they are responsible, there is a need for an enterprise-wide reporting system, which provides the following views of DCC: The Directorates and their Work-Processes; The state of transformation of each Work-Process; the relevant property information for each Work-Process. This would enable the CM and Directors to drill down into the 121 services to review implementation progress. (Stroll, 2010d)

During June 2010 the County Manager (McLoone) made presentations to Elected Members, Directors and Stakeholders, including the Corporate Policy Group on June 21st, the Public Service Unions on June 23rd and a Special Council Meeting on June 28th (McLoone, 2010c). He made three key points to all these meetings and to the National Efficiency Review Group:

1. "Government, Unions and Management now need to work together to implement TPS and deliver the productivity gains required to maintain staffing, pay and pension levels
2. Donegal County Council has invested in developing and testing the transformation method needed for each of the 121 services
3. Donegal County Council has invested in developing and testing a suite of custom-built software to implement and report on the productivity transformation and improvement of each service"

Following the retirement of McLoone, the new County Manager decided to partially test the transformation method and software on six services of which Purchasing was by far the most complex. This testing project was completed to the Council's satisfaction in January 2012 and the findings fully documented. (Stroll, 2012)

Implementing Work Activity Reporting for Purchasing: 2012

As noted earlier, of the six services to be tested, by far the most complex was Purchasing. From the epistemological viewpoint this implementation broke new and important ground which is discussed below. At that time most of the 121 services delivered by the Council did not have occupation / department specific applications implemented. In this respect they are rather comparable to medium sized SMEs who will have a finance application (often Xero or Sage), a website (usually custom built on WordPress technology and some marketing applications (Google Analytics). The rest of the firm runs on spreadsheets and email. The first implementation of work activity reporting software assumed that data entry would be required, but Donegal had installed a commercial application called Agresso for their Finance Directorate and the Purchasing Work Process used this software. What's more, because Purchasing was done by every Directorate and from every Council location the number of users was much larger than in other Directorate-specific work processes.

The work activity map for Purchasing was created by their OD Department and included 21 work activities of which 18 were included in Agresso. The author and his software engineer had to obtain the data from Agresso and map both the individual cases and the individual users which included some 200 roles and posts. All the necessary usernames from Agresso were provided and these were mapped into an organisation database which was also constructed. Lastly Donegal supplied six months of purchasing data, which totalled some 30,000 records which enabled the Work Activity Reporting application to be demonstrated successfully. This was all completed and signed off by the Council in the Final Project Report in January 2012.

Retrospective

Writing fifteen years later, the author observes that the UK has still not grasped the simple point that public services can only be improved one production unit by following Sheridan's Input → Process → Output logic for all 121 Donegal services. Subsequent research in the Neatsmith case study has also demonstrated the need for a Level IV Director who can drive the implementation of the necessary complementary

investments in each production unit supported by the Digital Management Practices software platform.

10.3 Appendix 3: PhD Research

Measuring Productivity within the Firm: ONS Policy: 2018

The author had met the ONS team during the Intangible Gold project (sponsored by the Big Innovation Centre) and decided to arrange a follow up meeting with Philip Wales, who was at that time ‘Head of Productivity’ for ONS based in Newport. The author prepared a short presentation (Stroll, 2018) to set out the topics of interest. The presentation covered the research question, an early version of the units of analysis and the data model to be used within the firm. To the author’s surprise, Wales informed him that ONS did not collect data from within the firm for productivity purposes but, in conjunction with BEIS they did collect survey data from firms every two years about the firm’s innovation practices based on the requirements in the Oslo Manual (OECD, 2005). Wales also explained that ONS also conducted surveys of Management Practices (Awano, Heffernan, & Robinson, 2018) using the methodology developed by Van Reenen and colleagues at LSE and he introduced the author to his colleague, Greg Awano, who had conducted one the early surveys.

Labour and Total Factor Productivity

The ONS actually provides *two* productivity measures as part of their quarterly GDP reports: *labour* productivity and *multi-factor* productivity (MFP). It is worth noting that many other organisations and authors call MFP *total factor productivity* (TFP). These different names all refer to the same concept, so this thesis will refer to the two measures of productivity as *labour productivity* and *total factor productivity* (TFP) for consistency’s sake throughout.

Labour productivity reviews the total hours spent by the firm’s employees on delivering outputs of products and services at market price. Data is collected from surveys and administrative data, and is reported quarterly (Taylor, 2018).

TFP is more complicated. It involves *three* sets of inputs: labour (for which the preferred measure is hours worked), capital (which is measured as a service charge based on an imputed rental cost), and purchases (energy, materials, and services) (Franklin, 2018). There are also potentially different output measures. These are usually measured by market prices, but in Franklin’s example (a small bakery) TFP output is measured in units (i.e., the quantity of loaves sold). As Franklin says, ‘Productivity is simply the rate of conversion of inputs to outputs. The tricky part is measuring the inputs and outputs properly’ (Franklin, 2018).

Labour Quality and Capital Deepening

There are two further concepts which are used by ONS, these are *labour quality* and *capital deepening*. Labour quality refers to the fact that not all labour is equal. There are

important differences in the level of education, the level of experience, and wages. ONS weights labour inputs by labour quality, assuming that more experienced, better education, and higher paid workers are higher quality than others. In order to increase their labour quality, firms might ask for additional educational qualification or more years of experience. In return, they offer higher wages.

In order to understand capital deepening, it is necessary to start with a clear definition of capital, such as the one provided by Franklin (2018 page 6):

“Capital input includes anything that provides an ongoing use to output without being used up in the production process. In our bakery, capital inputs would include things such as the oven and the building of the bakery; as they can be used in the production process more than once, they are not simply ‘used up’ in each production cycle.”

In order to simplify data collection for TFP calculations, ONS use an imputed rental input cost rather than accounting depreciation, which is used in financial accounts. Capital deepening is measured by an increase in imputed rental payments to pay for rental of more tangible and intangible assets.

To calculate TFP, statisticians need to remove purchases from outputs (measured in market prices) to provide what economists call *gross value added* (GVA). This is necessary because there are many intermediate inputs which need to be reflected in the final output prices of all goods of services provided to consumers and which are computed for all economies using the input-output tables reviewed earlier.

The next step is to calculate the ‘weights’ of quality-adjusted labour services and capital services of GVA. This is done by calculating labour costs and deducting them from GVA. The result is expressed as a percentage and, by definition, the remaining percentage (which includes gross operating surplus) is allocated to capital services. It is important to note that this is a statistical convention used to simplify calculations.

At a later user-group meeting with ONS, the author learned about the work programme to improve measurement of Labour Productivity Reporting and Total Factor Productivity Reporting. (Franklin, 2018 page 9) Franklin defines TFP as follows:

For any given change in output, [total] factor productivity [TFP] measures the amount that cannot be accounted for by changes in inputs of quality-adjusted labour and capital’. It represents **a change in efficiency over time** between transformations of capital and labour inputs to outputs.’
(author’s bolding)

Epistemological Discussion

Since 2016 the author has held many discussions with ONS on their measurement of labour productivity, total factor productivity, intangible assets, innovation and management practices. These discussions can be summarised in two main points. The

first is the unit of analysis on which ONS is focused. In order to produce their quarterly GDP reports, ONS uses mostly survey data from firms within different industry sectors and processes this data through the Input / Output Tables to calculate GVA for each sector of economy. Their purpose is to report the UK's macro-economic performance. Their Management Practices surveys used quite large sample sizes in each sector and the ONS suggests that more robust implementation of these practices within a firm are associated with higher productivity.

The second is the method of data collection, which in most cases is by survey. Over the past few years these surveys have moved from being paper-based to web-based online.

Measuring TFP within an SME

In order to answer the research question (How can SMEs solve the UK Productivity Puzzle) it is necessary at firm level to use different methods of data collection and different units of analysis. Administrative data from existing applications and databases (primarily the firm's accounting systems) and real-time direct data for work activity updating, tracking and reporting is required. For a large SME (20-250) there are two units of analysis based on levels of work complexity, these are at Firm Level (COO or CEO) and at Production Unit Level (e.g., Sales, Marketing and Manufacturing) and are shown in bold below:

Level IV	Growth Strategy, Growth Forecasting and Complementary Investments (COO / CEO)
Level III	Production Units (e.g., Sales, Marketing and Manufacturing)
Level II	Department Managers (e.g., Showrooms, Manufacturing Planning, CAD, Factory and Installation)
Level I	Front-Line (e.g. Sales personnel producing quotations and pricing for potential customers, CAD personnel producing site drawings; Manufacturing Planning personnel updating the bill of materials, creating supplier orders and weekly schedules, Factory personnel cutting large boards into pre-defined parts for assembly and installation personnel installing the factory produced units into customer premises).

Purchasing Case Study: 2020

This case study was developed and implemented as part of the three-part PhD thesis which was actively discussed during the spring and summer of 2010 at a time when no suitable case study candidate had been found. The Case Study took the original implementation from the Donegal Project documented earlier and used it to demonstrate how productivity could be improved.

Epistemology

The Work Activity Map is an important epistemological construct because it enables the work to be done in any production unit to be documented and made visible to all relevant employees and managers.

Purchasing Process																			
	Agresso Group 1.		Agresso Group 2.			Agresso Group 3.			Agresso Group 4.							Agresso Group 5.			
Process Steps	Raise PO.		Approve PO & Send			Receive Goods & GRN			Register Supplier Invoice and resolve any queries which arise							Pay Supplier.			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Description	Decide to make a purchase	Raise Purchase Order (PO)	Approve PO and send to supplier	Print PO and send to Supplier	Supplier provides goods / services to Purchaser	Purchaser receives Goods / Services. Receiving officer signs goods received note (GRN).	Enter GRN details into Agresso	Supplier sends invoice	Purchaser receives invoice	Register Invoice in Agresso ("Speedy Reg").	Post Invoice for Payment	If there is a problem with the three-way match, refer the matter to the appropriate person for resolution	If required, amend PO	If amended re-approve PO.	Complete and send requisite documentation to Finance	Check for tax compliance	Process payment run	Send cheque & remittance advice to the Supplier	Supplier receives cheque and remittance and posts
Additional Comments	Be mindful of Procurement Guideline depending on the value of the purchase.		A PO can't be printed until approved. However, PO No. is available once PO is raised, and can be issued verbally without Approval. Sending hard copy Order to Supplier rarely happens in practice.			A GRN is not always received - e.g. telephone bill. (Also, they can get mis-layed). Agresso only has one small text field for recording all GRN ref. no. details - a potential problem where there are multiple deliveries for a single PO.	Generate a GRN No.	Currently to Area Office where PO came from, but a Central Invoice Matching Unit (CIMU) is proposed	Currently, if no PO No. is quoted, the User searches in PO Details section of Agresso for a match. If none is found, a PO is raised at this stage and sent for approval (i.e. Steps 2 & 3). (Note: this constitutes a breach of purchasing procedure rules)	Prerequisite: PO raised and date stamp on Invoice. Includes checking tax status of Supplier. Generate a "703" Transaction No. when completed	Incorporates doing the 'three-way-match' - ensuring that PO, GRN & Invoice all reconcile exactly - without which posting cannot be completed. Generate a "304" Transaction No. when completed	This is most likely to be whoever requested the PO.			This step, in most cases, will not be required if / when Central Invoice Matching is implemented	Check for Tax Clearance status. Ensure payments card is held for Contractors. Ensure payments to contractor's do not exceed payment card limit. Check for correct Reverse VAT procedure.	Euro payments can go ahead without waiting for arrival of document from Area/Service offices. However, for Sterling and Withholding Tax payments, document is required before payment issues.	Cheques post one week after printing. (Special requests are accommodated for early posting)	Suppliers will call Purchasing AP section if there are problems

Chart 72: Purchasing Work Activity Map

Work Activity Maps are Socially Shareable

One of the most important epistemological features of the Work-Activity Map is that it is socially shareable with all the members of the production unit. This need for this was made quite strongly by Haeckel and Nolan in their 1993 Harvard Business Review article (page 132):

"An enterprise model should be expressed in business language, not IT terminology. Management should select and use one business design language and insist on its use throughout the organization. In many companies, a variety of first, and second-generation modeling tools have already been used to capture key processes in different functions or operating units. But in order to create a unified understanding of "how we do things around here" (and if it makes strategic sense, to facilitate future integration of presently autonomous organizational units), a common language is required."

In addition to explaining the importance of real-time (or as near as possible) feedback to employees, to enable them to take remedial action) they also highlighted the need for a common business language not IT terminology.

By making the Work Activity Map socially shareable to all relevant employees, (and Directors and colleagues in supporting departments) shared understanding is increased. This socially shareable documentation becomes even more important in the post-Covid world, when traditional methods of supervision and control, based on co-location, have been uprooted by working from home practices.

Work Activity Maps Support Managerial Agency

The second important epistemological feature of the Work Activity Map is that it supports a particular type of managerial agency called Digital Management Practices. In the purchasing case study, five types of improvement have been identified, corresponding to different work activity groups. Each of these could be considered as a possible complementary investment.

- Change the mix between Standard and Purchasing Card cases
- Implement electronic purchase orders
- Implement electronic payments
- Implement electronic invoicing
- Outsource the payments back end to a national shared service centre

Work Activity Reporting Delivers Labour Productivity Measurement

Labour productivity reporting is usually done at the firm level in the form of GVA per head. This is a very powerful measurement and is used to compare the productivity of firms in each sector of the economy and to compare between different sectors. However, as the author discovered at Neatsmith, the Sales, Marketing and Manufacturing production units all have their own productivity metrics which need to be measured. Work-Activity reporting shows the status of every case irrespective of the type of case; the example above is a purchase order, in the Neatsmith Sales Department it is a sales quotation, in Neatsmith Manufacturing each quotation turns into an individual room which is then tracked to completion. Visual tracking with Red, Amber and Green status shows the state of every case in the production function and enables managers to deal with Amber and Red exceptions before they cost money. In addition to Work Activity Reporting it is necessary to measure key performance indicators for the outputs of the work (the work-objects) for the work activities themselves, the employees who occupy the roles and posts which do the work, their departmental managers and the production unit manager.