Abstract

Purpose – The purpose of this paper is to propose a “Fit” manufacturing paradigm for industry so that manufacturing companies can become economically sustainable and can operate effectively in a global competitive market. The proposed Fit paradigm is aimed at providing a new manufacturing management perspective to both academics and industrialists.

Design/methodology/approach – The Fit paradigm is developed and proposed as a new manufacturing management strategy towards creating economically sustainable manufacturing organisations. Fit is a theoretical development using the principles of existing manufacturing paradigms along with new and innovative management concepts to create a sustainable approach to manufacturing.

Findings – Manufacturing strategies such as lean and agility allow companies to deliver bottom-line savings in production terms although their effectiveness depends upon the volume and demand profile of their products. The trend towards mass customisation requires companies to provide personalised products and services at mass production prices. This now places a further burden on companies and therefore a holistic manufacturing framework must be developed in order to ensure that the factory of the future is able to meet this new demand. This paper proposes a fit manufacturing paradigm which integrates the manufacturing efficiencies achieved through lean and agility with the need to break into new markets through effective marketing and product innovation strategies to achieve long term economic sustainability. The small scale application of the approach in a case company shows that the initial results to be positive when measured against a fit index which is developed within this paper.

Originality/value – The development of a fit paradigm aimed at tackling directly the issues of economic sustainability is proposed and is considered by the authors as one of a kind. Fit will also provide a framework for the implementation of sustainable manufacturing operations within organisations.

Keywords Manufacturing industries, Lean production, Agile production, Manufacturing systems

Paper type Research paper
1. Introduction

For various social, economic, technical and political reasons, manufacturing has become globalised, with supply chains that regularly extend beyond national boundaries. The marketplace has also seen greater internationalisation as a result of developments in modern information and communication technologies. The demands of global customers have grown more varied and unpredictable, compressing the lifecycle of products and creating major planning difficulties. At the same time, world resources are diminishing and environmental problems are rising. To achieve competitiveness in this complex turbulent situation, new manufacturing strategies such as lean and agile manufacturing have been devised the former promoting efficiencies through the elimination of waste and the latter enhancing a manufacturing system's ability to deal with change and uncertainty by building in measures that increase flexibility and responsiveness.

This paper makes the case for fit manufacturing (Pham and Thomas, 2005). This is a manufacturing paradigm linking the manufacturing efficiencies achieved through Lean and agile manufacturing (Womack et al., 1990) and (Kidd, 1994) with the ability to break into new markets through integrated marketing and product innovation strategies to achieve long term economic sustainability. As fit manufacturing is based on the theme of integration, the paper starts with a brief review of the general aims of integration, the different levels and types of integration, and the potential benefits and drawbacks of integration. A detailed discussion of fit manufacturing ensues. The paper concludes with a description of an index to assess the level of fitness of a system and a case study demonstrating an application of the proposed fitness index.

2. Integrated production machines and systems

The dictionary definition of “integrating” is “combining two or more things so that they work in concert to achieve greater effectiveness”. Integration can be vertical, horizontal or conglomerate (HMRC, 2007) and can take place at different levels. Vertical integration, which can be backward or forward, involves assembling together elements that form a chain (such as a supply chain) and share a task or function sequentially, each element being unable to complete the task or fulfil the function on its own. Horizontal integration joins elements carrying out approximately the same type of work, perhaps with a view to increasing throughput. Conglomerate integration occurs when elements with entirely unrelated functions are linked up usually for the purpose of diversification and risk spreading.

At the component level, different components can be integrated into a module. A familiar example of a module is a VLSI chip which contains millions of transistors, capacitors and resistors in one package, giving unquestionable increases in performance by comparison with an assembly of the same components but in discrete form. Other familiar modules include computer programs that integrate lines of code to perform a defined computational function and mechanical hardware units that assemble together parts, such as gears, shafts and bearings, to carry out a common task, for example, power transmission or motion conversion.

At the module level, individual programs can be integrated to yield a package, for example, a CAD package, an accountancy package, a database or a HR package. Hardware, software and/or firmware modules can be brought together to create an
integrated production machine, for instance, a CNC machining centre or a materials handling unit.

Software packages for a variety of applications can be further integrated into larger, more comprehensive and more streamlined systems, such as those used for enterprise resource planning (ERP) (Times 100, 2007). Different machines, including lathes, grinders, machining centres, inspection machines, conveyors and manipulators, can also be linked into a production cell. Such a cell could be treated as a mini integrated production system if it has a unitary structure, organisation or behaviour.

Finally, cellular and higher-level integration involving the tight coordination, usually by a computer system installed with a wide-ranging ERP system, of different production units as well as other company functions leads to integrated production systems. In former times, these were known as computer-integrated manufacturing (CIM) systems (Monk and Wagner, 2005), but preference is given in this paper to the term “integrated production systems” which is generic and non-restrictive.

Designing an integrated unit or system requires adopting a holistic view to ensure that the constituent elements can work well together to produce the desired effect. The relationships between all elements, including communication channels, communication protocols, interfaces and other connections between them, have to be correctly engineered. How the unit or system will interact with other units and systems in its environment needs to be carefully considered, so do the different conditions that it will operate under – normal steady state and transient - and the disturbances that it might be subjected to. This holistic view ideally should extend over the life cycle of the unit or system, from its conception, through its development, implementation and operation to its maturity and eventual disposal. Where appropriate, in addition to technical issues, social, economic and environmental factors should also be taken into account. True integration design is a total systems engineering activity.

At the system level, true integration reduces, and could minimise or even eliminate, waste, fragmentation, disjointedness, duplication, inconsistencies and incompatibilities. It also promotes higher system effectiveness and robustness and, therefore, sustainability, through economies of scale, improved control and co-ordination, increased standardisation and greater cohesion. A well-integrated system exploits symbiotic and synergetic relationships between its component parts. This can lead to the system exhibiting emergent properties not possessed by the individual components.

Integration is not without potential disadvantages. It could be costly to implement, particularly with the need for high initial investments. Very tight integration could result in inflexibility in operation and maintenance. Failure in one part of a system could cause the entire system to malfunction. Unless a totally modular approach is adopted, integration could magnify system complexity as the numbers of components and interrelationships increase.

Despite these drawbacks, it is argued that, when judiciously applied, integration holds the key to competitive manufacturing in a globalised market. The remainder of the paper discusses manufacturing systems designed and managed with the appropriate degree of integration between production functions, business and marketing strategies and technological resources. Such systems are “Fit” manufacturing systems, combining the lean and agile manufacturing philosophies with measures to enhance sustainability (Pham and Thomas, 2005).
3. Fit manufacturing: a total manufacturing perspective

Over the years many manufacturing strategies and paradigms have been developed purportedly to provide a “total” answer to the manufacturing problem. In many cases, a solution to the efficient manufacture of products is achieved. However, rarely do the paradigms connect all the elements of a manufacturing organisation in order for that organisation to grow and prosper well into the future. It is the “integration” of a company’s manufacturing operations with its business strategy, its marketing strategy and its technological capabilities that is required to enable it to achieve sustainable economic growth.

Fit manufacturing (or simply “Fit”) adopts an integrated approach to the use of Lean, agility and sustainability to achieve a level of fitness that is unique to each company. “Fit” does not only develop a company’s latent potential to meet new market requirements. It actively encourages companies to seek new market areas and to operate in unfamiliar areas knowing that the technological, human and financial aspects of the company are robust enough to enable the company to achieve market breakthrough. Figure 1 shows the structure of “Fit” manufacture. Table I lists the elements which make up the “Fit” model. The first elemental stage comprises the foundation elements of the model. It is here that the company’s infrastructure is defined and subsequently developed in order to support the “Fit” initiative. These elements are: marketing and sales integration, strategy integration, financial integration, and worker knowledge and skills integration.

3.1 Marketing and sales integration

The provision of an advanced warning mechanism (AWM) that allows companies to identify new markets and to align its manufacturing operations to high-value-added customers is one of the main issues of “Fit”. Integrating marketing and sales with the company’s manufacturing system is critical. Instead of only aiming to achieve sales targets, the sales and marketing departments should build into their strategy the need to identify markets that suit a company’s manufacturing and technological capabilities, using a company’s technological platform rather than their product portfolios as their sales capability. This requires marketing and sales people to become technologically aware of a company’s capabilities and act as a “product gatekeeper” when out in the field. Integrating market intelligence to provide for an effective AWM for the company will achieve a closed-loop manufacturing system and allow reconfigurability to occur in a timely manner.

3.2 Strategy integration

An area frequently overlooked is the need continually to align a company’s business strategy with its manufacturing, marketing and operational strategies. In many companies, the alignment of the four strategic areas is undertaken early in the company’s development but efforts made to continually align the strategies die away often leaving fragmented strategic outlooks.

3.2.1 Business strategy. This is the overall company strategy. It provides the direction and vision to drive the company forward and to achieve sustainability. It is here that plans are made to tackle new markets, achieve new levels of customer satisfaction and improve “bottom line” results (Pham and Thomas, 2005). At this level, Kaplan and Norton’s four main sustainability perspectives (financial, customer,
Figure 1. The fit manufacturing structure

- Lean
  - Continuous Improvement
  - Zero Defects
  - Pull on Raw Materials
  - JIT Delivery
  - Multi-Functional Teams
  - Deconglomeration
  - Integration of Functions
  - Vertical Information Systems
  - Value Adding Operations
  - Elimination of Waste

- Agility
  - Scheduling Flexibility
  - Supply Chain Flexibility
  - Workforce Flexibility
  - Routing Flexibility
  - Distribution Channels
  - Physical Infrastructure
  - Flexible Technologies
  - Product Mix
  - Market Timing
  - Information Infrastructure

- Sustainability
  - Organisational Structure
  - Value Measurement
  - Competitive Position
  - Performance and Growth
  - Political Factors
  - Economic Factors
  - Environmental Factors
  - Social Factors
  - NPI
  - NPD

- Technology Systems
  - ERP
  - AMT
  - CAD/CAM/CAE
  - E-Manufacture
  - E-Commerce

- Operational Elements
  - Systems Reconfigurability
  - Systems Complexity
  - Machine Responsiveness
  - Hardware Systems
  - Software Systems
  - Systems Scalability
  - Part Family Algorithm
  - Life Cost Modeling
  - Set Up Efficiencies
  - Supply Reconfiguration
  - Machine Monitoring

- Foundation Elements
  - Organisational Strategy
  - Marketing & Sales Integration
  - Customer Monitoring
  - Trend Analysis
  - Product Life Cycle
  - Competitor Analysis
  - Sales/Marketing Integration
  - Customer Monitoring
  - Trend Analysis
  - Financial Integration
  - Turnover
  - Profit Analysis
  - Financial Capability
  - R&D Investment
  - ROI/ROCE Analysis
  - Knowledge and Skills Integration
  - Knowledge Management
  - Workforce Capacity
  - Management Vision
  - Teamworking Leadership

- Enabling Elements
  - Strategy and Integration
  - Business Strategy
  - Manufacturing Strategy
  - Operational Strategy
  - Manufacturing Strategy

- INTEGRATION
  - Performance
    - Flexibility
    - Efficiency
    - Efficacy
    - High productivity
    - Mass customisability
    - Economic sustainability
    - Downtime
    - Quality
    - Product Cost
    - Delivery Targets
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Table 1.
internal business and learning) (Rehg and Kraebber, 2005) are housed and it is from here that the manufacturing strategy is formulated.

3.2.2 Manufacturing strategy. At this level the company plans its strategic manufacturing direction. Here the company attempts to align its manufacturing strategy to meet its current customer base applying a balance between lean and agility in order to meet its quality, cost and delivery (QCD) requirements. This is a difficult area requiring significant analysis and planning of each customer’s specific needs. The QCD priorities for each customer vary with cost being the major issue for one customer whereas delivery may be a major concern for another. It is here that the operational strategies are formulated and a working plan is developed.

3.2.3 Marketing strategy. At this stage, the company’s overall marketing direction must be established. “Fit” stipulates that Sales and Marketing departments include within their strategy the requirement to monitor closely product performance in the market place and also to gain market intelligence from high value manufacturing sectors within which the company can work. An approach based upon “what can be produced” rather than “what is being produced” is needed. This calls for closer integration between manufacturing and marketing strategies and signals a move away from purely product focused manufacture towards a combination of product and process focused manufacture.

3.2.4 Operational strategies. It is here that the real integration takes place with each operational strategy contributing to ensuring the company can respond to customer demands in a quick and cost effective manner. On one side lie the TPM and Six Sigma methodologies. The implementation of such strategies allows a company to build its internal business structure through reducing waste and improving manufacturing efficiency and performance.

On the other side lie the agility strategies aimed at improving system responsiveness through reconfiguration and the development of flexible and reactive supply chains. This area can be considered to build primarily the “external business structure” and the interfaces between the internal and external business areas that supply the manufacturing system.

It can be seen that each operational strategy employed provides the essential inputs to enhance a company’s operations. This is achieved by developing reliable and productive machinery and equipment through the adoption of Total Productive Maintenance, by improving product quality via the application of Six Sigma, by improving responsiveness to customer demands through reconfigurable manufacturing systems and by increasing product diversity and by providing greater customer choice through the development of a highly responsive supply chain system. These operational strategies are integrated by simultaneously working on the development of both the internal and external business structures with the aim of meeting the overall vision of achieving a “Fit” manufacturing company.

Integration is critical to “Fit” manufacture. Traditionally, companies have incrementally and systematically implemented various manufacturing paradigms (TQM, lean, agility etc) in a sequential manner as they become available or fashionable. This leads to an operational environment that is often left fragmented as individual systems are bolted onto existing infrastructures, usually causing internal conflicts within the company as the demands of one paradigm pull against those of another. These conflicts result in a significant increase in system and operational complexity as
well as increased project costs and extended project timescales which, in turn, delay the benefits that can be gained from the application of a joint strategic approach (Kaplan and Norton, 1996).

“Fit” will integrate key business process strategies together with a company’s existing and future technology platforms and operational strategies (National Research Council, 1998; Katz and Kahn, 1978). This integration provides not just a single new business approach but leads to an integrated manufacturing system that combines the systemics of a range of business process concepts into one model that has low operational and systems complexity (Small, 1999; Gonzalez-Benito, 2005).

Alongside this, fit identifies the need for effective integration of the technologies in order to implement and sustain change. This technology platform includes more than just the machinery and associated systems that convert the raw material into a finished product. It also covers E-commerce at the front end through to the electronic transfer of customer order requests and the complete E-manufacturing facility that takes essential customer data, design data and manufacturing data and drives them forward in a simultaneous manner so that a product can be manufactured quickly and cost effectively. It is the tight integration of these various electronic platforms along with the strategic and business systems that will provide the cost effectiveness and rapid response required to meet customer demands.

3.3 Financial integration

Over the years many companies have traditionally looked at relatively simple cost accounting approaches to monitor the health of their company. “Fit” adopts an approach that also requires a company actively to build into their financial procedures two major aspects namely:

(1) The need to link technological development and innovation into its cost accounting system.

(2) The need to tackle and amortise fixed costs through product/customer diversification.

On the first of these issues, “Fit” requires companies actively to plan for continual upgrading of its technological platform by analysing how much of a company’s profit is reinvested in new and advanced technologies. Through the continual upgrading of such technologies, new market areas can be defined and the confidence to operate effectively increases due to the knowledge that the company has the technical power to do so.

Secondly, it is important that a company links and closely monitors its product’s life cycle in accordance with the financial performance of the company. Closely monitoring the sales of a product will enable a company to identify early that a product is losing market share. This will enable a company to take corrective action by possibly introducing a new product to their range or enhancing the existing product. Product diversification can provide a company with an opportunity of “splitting” its overhead and fixed costs into a range of different product lines or customers. Single product manufacturers have the problem that all fixed costs are channelled into one product and thus the weight of the complete company’s costs are centred on one product line or customer. Having a wider product portfolio and/or customer base can alleviate this
3.4 Knowledge and skills integration

Worker skills and knowledge are important to the performance of any company. For companies that continually enhance their technological capacity as can be expected under the “Fit” paradigm, this issue is seen as being even more critical. A study undertaken by Thomas and Webb (2003) into technology implementation in companies identified that one of the main reasons that companies failed to adopt new and advanced technologies was that the managing directors felt that their workforce did not have the technical and intellectual capacity to take on such technologies with the fear that the technology would be under-utilised and thus will not return a cost effective yield on investment.

“Fit” actively promotes knowledge and skills alignment. Through the continual enhancement of a company’s technology will come the need to ensure that a company’s workforce are suitably trained. However, this does not extend simply into the manufacturing aspects of the company. Since “Fit” promotes the continual development of new and innovative products in order to attract new markets, a company’s design and engineering team must also be continually trained to meet market needs.

The “Operational Elements” in the “Fit” model provide the means by which a company can convert the foundation elements to enabling elements (Figure 1). However, they do not act as one-way gates in the system but also as a feedback mechanism to ensure that the foundation elements are aligned with the feedback received from the operational elements. This two-way approach allows a company to balance its effort undertaken in developing its infrastructure with the results obtained from the operational aspects of the model.

The “Enabler Elements” provide the company with the working interface between themselves and their customer which allow the company to respond to customer requirements through connecting advanced market intelligence systems with the internal production and design system’s capability to balance demand with supply and to reconfigure itself to meet those demands.

As previously discussed, being “Fit” as opposed to being purely lean or agile allows a company to respond quickly to changes in future customer demands and provides the capacity for a company to seek new customers and markets. This is because a “Fit” company has at its heart an integrated manufacturing and business infrastructure capable of “reconfiguring” quickly to meet new customer and hence manufacturing requirements.

“Reconfigurability” is a key enabler in the “Fit” paradigm and is not simply limited to readily adaptable machine systems but includes the need to reconfigure the complete company, its manufacturing system including its design system, technology, logistics, and supply chain (Wainwright, 1995) so that optimum responsiveness to customer demand is achieved. Therefore, the ability of a company to balance its demand requirements with its supply capabilities is critical to “Fit”. However, regardless of how effective a company’s ability to reconfigure, the process still takes time to achieve. It is therefore essential that a company is sensitive to customer trends and movements
so that advanced warning is given to a company for it to be able to take appropriate action at an early stage.

3.4.1 Demand – supply balancing. With any organisation that captures new markets, the customer demands and requirements extend not only to the supply company but to its supply chain. Traditionally a company may have only dealt with one type of customer and so has been able over a number of years to transform its supply chain to meet the demands of this customer. However, through the “Fit” approach, new markets and customer/product diversification is seen as critical for survival. This means that a company’s supply chain must also respond to the new demands. Central to this approach is the need to reconfigure a company’s supply chain so that its technological and operational characteristics are aligned with a company’s demand profile. It is incumbent on the company to ensure that its supply chain becomes responsive to the needs and that “Fit” is driven into these supply companies.

3.4.2 Technology and product innovation. This is considered to be the cornerstone of “Fit”. Here it is critical that a company has the required technological platform that is able to respond to the increasingly complex customer requirements. Also, the development of new and innovative products allows a company to break into new markets and also to stay ahead of its competition in mature market environments. It is through the effective integration of technologies that have the capacity to support the product innovation process that real market penetration can be made. The exploitation of new and advanced technologies is critical in today’s manufacturing environment. Companies need to reduce product lead times, introduce new products more frequently into the market place and rapidly reconfigure their manufacturing systems as well as ensuring high product quality and low manufacturing costs (Wainwright, 1995; Bessant and Haywood, 1988). Technology therefore is a key facilitator in this “time compression” process (Boer and During, 1987).

In the light of the model developed, “Fitness” can therefore be considered:

[... ] a company’s ability to prosper in a sustainable manner through the manufacture of high quality products facilitated by an integrated, robust, highly responsive and reconfigurable lean manufacturing system that returns high product quality and reduced internal and external manufacturing costs.

It is clear that, by enabling a company to become “Fit”, manufacturing success can be assured through increased competitiveness and improved long-term sustainability.

4. The fitness index

Figure 1 identifies the key elements of the “Fit” manufacturing paradigm. From here, it is now possible to define “Fit” in an analytical form. Doing so provides the foundations upon which a “Fitness Index” may be created in order for companies to measure their level of fitness so as to help formulate their overall business and manufacturing strategy. In basic terms, the expression for Fitness will take the generic form:

\[
\text{Fitness} = (\Sigma^k + \Sigma^s + \Sigma^{ms} + \Sigma^f) + (\Sigma^l + \Sigma^a + \Sigma^s) + (\Sigma^r + \Sigma^{dsc} + \Sigma^{tpi})
\]

Foundation Elements + Operational Elements + Enabling Elements

where, \(\Sigma^k\), summation of the “knowledge” elements; \(\Sigma^s\), summation of the “strategy” elements; \(\Sigma^{ms}\), summation of the “market/sales integration” elements; \(\Sigma^f\), summation of
the “financial” elements; $\Sigma^1$, summation of the “Lean” elements; $\Sigma^2$, summation of the “Agility” elements; $\Sigma^3$, summation of the “Sustainability” elements; $\Sigma^4$, summation of the “Reconfigurability” elements; $\Sigma^{dsc}$, summation of the “demand/supply chain” elements; $\Sigma^{tpi}$, summation of the individual “technology/process innovation” elements.

The basic Fitness Index is calculated by summing the foundation, operational and enabling elements and hence the above expression is split into three distinct sections in order to identify the key elemental groups. Figure 1 and Table I show these elements. The analysis of the “Fit” elements now requires further explanation.

It has been previously stated that fitness is defined as the integration of three major business process strategies namely lean, agility and sustainability. However, in order for the correct application of these strategies, a company must first develop a strong foundation and infrastructure to their business. Therefore, there is a need for any company to develop its knowledge base amongst its workforce, align its various strategies to focus on improving manufacturing performance, and ensure that the company has the financial capability to facilitate change and that its manufacturing system is integrated with other key business areas within the company. Once these foundation elements have been embedded into the company, it is then possible for the company to embark on implementation of the operational elements identified in the model.

Therefore, in the case of the above expression for Fitness, these additional foundation elements have to be added to the lean, agility and sustainability elements of the expression. Also, the effective implementation of lean, agility and Sustainability into a company is insufficient to ensure success. There must emerge from the implementation of lean, agility and sustainability a series of key enabling features (KEFs), which allow the company to enhance its capabilities and performance. As discussed previously, there are three KEFs namely new and innovative technologies and products which will allow the company to break new markets and enhance its manufacturing performance, demand/supply chain balancing which allows the company to meet logistics requirements of their customers now and in the future and finally systems reconfigurability which enables increased flexibility and responsiveness to changes in customer trends and requirements. Again the expression includes these enabler elements as part of calculating the fitness index.

To achieve a fitness expression that can be adopted to different scenarios, the “operational” elements are scaled. This enables greater prominence for the application of lean, agility and sustainability in the fitness concept as appropriate. This is seen as important since effective implementation of these three strategies is the key drivers to achieve manufacturing fitness. The values of the scaling factors can be chosen to suit particular situations. With reference to Table I it can be seen that the “foundation” elements (marketing and sales, strategy, financial and knowledge and skills integration) are marked on a scale of 0-1 and thus contribute a maximum value of 20 to the Index whilst the “operational” elements (lean, agility and sustainability) are marked on a scale of 0-2 and therefore contribute a maximum value of 60 to the index. The “enabler” elements are marked from 0-1 and again contribute a maximum value of 20 to the index thus making the index a value measurable out of 100. The totality of the foundation, operational and enabling elements should lead to an improvement in the overall performance of the company as measured by the following performance index:
where, the performance output elements (p) are given as:

- flexibility;
- efficiency;
- efficacy;
- high productivity;
- mass customisability;
- economic sustainability;
- downtime;
- quality;
- product cost; and
- delivery targets.

Each of the “Performance” outputs is marked from 0-10 thus giving a maximum value again of 100. The Performance Index enables a company to analyse the effect that the foundation, operational and enabler elements have on the performance of the company. This comparison of the effort put in by the company to achieve “Fitness” against the performance values obtained provides for a balanced score card and a profiling tool to enable a company to monitor its performance. As with other types of score card systems (EFQM, 2007) the balance between inputs and outputs is the critical issue.

It is expected that the fitness index and the performance index are directly correlated. Through the choice of appropriate scaling factors and an appropriate time shift between the two Indices, it should be possible to equate them.

5. A case study
To illustrate the development of the fitness index, the score card system is now applied to a company. The subject company is an SME and a manufacturer of specialist casting products. The company’s customer base is wide and its product range is correspondingly large and complex. The company operates within a diverse range of market sectors and so has to respond to a series of exacting customer requirements. Increasing competition from low labour cost countries is the driver that has instigated the implementation of the “Fit” manufacturing paradigm.

An initial “Fitness” evaluation was undertaken in the company and the corresponding performance analysis was carried out. A reasonable correlation of fitness to the performance was seen and is shown below.

Balanced scorecard = “Fit” 37.5 per cent  Performance 41 per cent

Also, a profile chart shown in Table II was created that listed each of the elemental sections and the performance is achieved by the company against each area. This allowed a variance analysis to be created to identify areas of significant weakness or good performance from the company. Table II shows the profile. The sensitivity of the model to improvements in manufacturing performance and its ability to provide a realistic fitness index that reflects the improvement are key to validating the model.
At the time of developing the index, the company was undergoing the first stages of a company-wide TPM development program. It was decided to re-audit the company after six months of TPM implementation to see if the “Fit” Index was sensitive enough to pick up on the improvements from the TPM project. The results of the audit are shown in Table III which indicates that the “Fit” Index was 39 per cent whereas the performance index was 47 per cent.
6. Conclusions
This paper has introduced a new manufacturing paradigm called “Fit” manufacture. The aim of “Fit” is to provide a “total manufacturing” solution to the problems encountered in the current highly volatile and increasingly complex manufacturing environment.

Extending the lean and agile manufacturing concepts, “Fit” integrates key business areas such as design, manufacture, sales, marketing, finance etc to provide a holistic

<table>
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<tr>
<th>Company: xxx</th>
<th>Manufacturing Fitness Profile</th>
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<tr>
<td>Elements</td>
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<td>Agility</td>
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<td>Sustainability</td>
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<td>Reconfigurability</td>
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<tr>
<td>Technological Innovation</td>
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<td>Demand / Supply</td>
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<tr>
<td>Total</td>
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Table III.
Re-audit of company operations during and after TPM

Production machines and systems

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systems approach to manufacture. Unlike other strategic approaches, “Fit” not only develops a company’s capacity to meet customer demands and break into new markets, it pro-actively seeks new markets whilst ensuring a company’s technological and strategic infrastructure is tuned to meet new market sector requirement. Furthermore, “Fit” will enable a company to identify accurately a customer’s requirements quickly and effectively thus ensuring new customer relationships are developed rapidly and sustainability is achieved.

The paper proposes a means for measuring the fitness index for a specific company and progresses this idea to provide a profiling tool and comparison between the systems required to develop “Fit” and the results expected from the application of the paradigm. The presented case study shows The profiling tool facilitates the identification of weaknesses in the company’s manufacturing system. For instance, the level of Leanness in the subject company was lower than that of agility and sustainability in the “Fit” measure. This will allow the company to adopt a series of initiatives to develop greater “Leanness” within the company.

References


Corresponding author
D.T. Pham can be contacted at: phamdt@cf.ac.uk

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