University–Industry Technology Transfer in the UK:

Emerging Research and Opportunities

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Chapter 6
Manufacturing Companies

ABSTRACT

One of the most debated areas regarding the introduction of new technologies into companies of all sizes is ERP systems implementation. These integrated software packages normally encompass the main transaction processing and information reporting requirements of a company, spanning sales order processing, financial management, human resource management, stock movement, and inventory control. It has led to a widespread debate in the literature regarding the respective merits of procuring and implementing an ERP system or deploying individual standalone software packages. The increased take-up of packaged software also coincided with the spread of business process re-engineering (BPR) to improve efficiencies and reduce overheads. The two became closely linked as BPR projects were frequently combined with the introduction of new software solutions. In this chapter, three such cases are reviewed, all involving major new packaged software implementations in manufacturing companies and all associated with varying degrees of process change.

BACKGROUND

The development of packaged business software to support all main business processes has been a major development in information systems over the past two decades. Packaged software for most mainstream business processes came to market in the 1990s as the spread of the UNIX operating system as a *de facto* standard for mini computers and the increasing dominance of the Intel

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chipset led to a massive surge in the packaged software market. Building on the earlier MRP packages, other packaged software provided modules for sales order processing, ledgers, payroll and personnel as well as MRP, sometimes combined into one integrated package from one vendor – the ERP software suites of Oracle and SAP, for example.

Benson et al.'s (1992) "staple yourself to an order" example in the early 1990s illustrated well the potential for process improvement and introduced many practitioners to the concept of function vs. process. This was developed further in the 1990s by Michael Hammer and others (Hammer & Champy, 1993) who argued that process change was essential to business survival and acknowledged that this could be associated with new information systems. Hammer argued that there was no scientific definition of processes, but that there were three main business processes that could fit most company operations: "obtain a customer order", "fulfill the order" and "new product development".

These concepts were further developed by the emerging ERP software houses as they expanded the functionality of their products and started to differentiate between "process" manufacturing and "discrete" manufacturing, with different ERP products suiting their different requirements. Process manufacturers (for example, food and drink companies) would typically have short lead times, make to forecast and aim to hold minimum inventory. Discrete manufacturers (for example, the automobile companies and engineering companies) would have longer lead times, and often manufacture to fulfill specific orders. Chapter 1 provided two examples of technology transfer which centered on ERP products in contract packaging companies, these companies being akin to the process manufacturing model. In this chapter, the introduction of new systems in three manufacturing companies is discussed, two of which (at Dowty Propellers and Fixing Point) involve ERP products. Dowty Propellers, with its long lead times for specific orders for propeller blades, represents the discrete manufacturing model, whereas Fixing Point, a manufacturer of roofing and cladding components, aligns more with the process manufacturing model. In fact, Fixing Point elected to implement the same ERP product as that chosen by Brecon Pharmaceuticals in Chapter 1.

The third case study is of SKF AeroEngine Bearings, an engineering company in the aerospace sector. Whilst many such companies have deployed ERP products, the introduction of new systems and process thinking paralleled the development of the concept of full product life-cycle management for engineered products, from concept through design and engineering, to manufacturing, delivery and even product performance on client sites, spanning the new product development and order fulfilment processes identified by Hammer. This gave rise to a new set of information systems - Product Lifecycle Management (PLM) systems, which provide a framework for the monitoring and control of the product lifecycle in a particular business or product area. It is a compilation of business rules, methods, processes and guidelines as well as instructions on how to apply the rules in practice (Saaksvuori & Immonen, 2002). The PLM concept encompasses several systems. Ameri and Dutta (2005) described change management, document management, workflow management and project management as PLM systems that support concurrent engineering and streamlined product development processes. PLM seeks to fill the gap between enterprise business processes and product development processes.

The engineering industry also uses a range of other specialist (largely standalone) systems including Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Engineering (CAE) packages, which are often interfaced with ERP, MRP and data warehouse/ business intelligence systems. Many of these types of systems feature in the technology transfer project at SKF AeroEngine Bearings discussed below.

ERP SYSTEMS AND PROCESS INTEGRATION AT DOWTY PROPELLERS, GLOUCESTER

Company Background

Dowty Propellers is a part of Smiths Aerospace. This was a division of Smiths Group when the project was undertaken, but is now part of General Electric. Smiths Aerospace is a leading global provider of innovative solutions to builders and operators of civil and military aircraft, from transport to fighters, from unmanned aerial vehicles to helicopters and regional jets. Smiths Aerospace then employed about 11,000 people in around 40 countries. During the 2005 financial year, it reported circa \$2 billion revenues in Europe and North America.

The company was part of the mechanical systems business of Smiths Aerospace, with over 60 years' experience in the production of aircraft propeller assemblies. The company was recognized as the industry leader in the manufacturing of composite blades using resin transfer molding technology. At the start of the project in 2004, the company had 181 staff, and could thus be considered an SME, albeit being also part of a larger international group. There were two main divisions in the company - the manufacture of original equipment (OE) and the aftermarket business, which mainly concerned Dowty Propellers repair and overhaul (DPRO) operations, where the repair and warranty work and the overhaul of the propeller systems was undertaken. 70% of the business was related to OE and the remaining 30% came from DPRO.

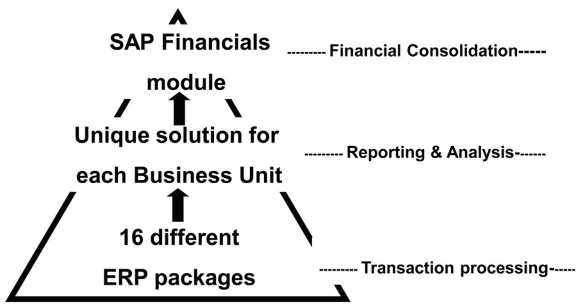
An ERP system (Syteline) had already been installed in Dowty OE, but DPRO was functioning under a different ERP system (Fourth Shift). The company wished to integrate the two divisions from a process and systems perspective, via standardization on one ERP product. Combined with this, there was a broader initiative at Group level to migrate the company over a period of years to the SAP ERP product.

Group IS Strategy and Project Objectives

A key objective of Smiths Aerospace overall business strategy at the time was to strengthen their position as a "Tier 1" global supplier of integrated aircraft systems. Both Smiths Group as a whole and Dowty Propellers recognised the need to underpin their business strategy with improved systems and business processes. Smiths Aerospace was undergoing a major re-structuring with departmental functions such as human resources, finance and IT being centralised as "shared services". SAP had been chosen as the ERP solution that would ultimately support all of the Group's main functions and processes, although initially this was to be implemented to run the finance function only. The plan was to migrate all major businesses across the Smiths Aerospace division to the new "shared services" by 2008, and hence implement the SAP Financials module and integrate it with their existing business systems. This was to be the first step in the staged migration to the entire SAP suite. As regards the Dowty Propellers ERP project, as the Final Report (Momenta, 2006) noted, "this created an entirely new focus and plan for the project and also a new urgency, as the SAP implementation was very high priority and planned to tight timescales" (p.3).

This was undoubtedly going to be a difficult and lengthy process involving a number of interim solutions and short-term interface developments. As a result of company acquisition over many years, Smiths IT portfolio included

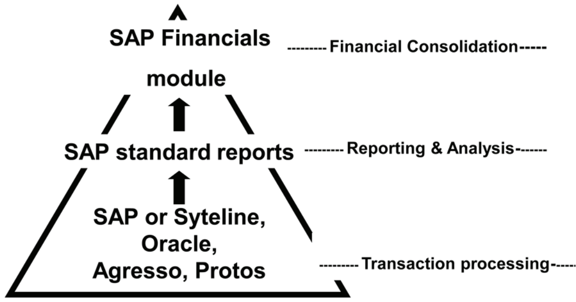
Figure 1. Main components of Smiths Group systems architecture 2006



no less than 16 different ERP packages (Figure 1). A significant first step in rationalisation was to select just 4 of these 16 ERP packages that could co-exist alongside SAP, and would integrate, for the mid-term, with the SAP Financials module. These four packages are shown in Figure 2 and included, significantly, the Syteline ERP package, but not Fourth Shift.

The Syteline ERP had been implemented in the Dowty Propellers OE business in 1998, and was generally successful in supporting core business processes, albeit with significant package modification. DPRO had previously been located in a different part of the Smiths organisation, and had implemented the Fourth Shift ERP product. Dowty Propellers wanted to re-engineer its business processes around the two main value streams emanating from the OE manufacturing company and the DPRO "aftermarket" operations. A common IT platform was identified as a fundamental building block of the re-engineering process. In addition, Dowty Propellers had been identified within the Group for the roll out of the SAP Financials module. The business had to undergo extensive business process change to allow for a smooth implementation of Syteline and decommissioning of the Fourth Shift product,

Figure 2. Rationalisation of Smiths Group systems architecture 2006-8

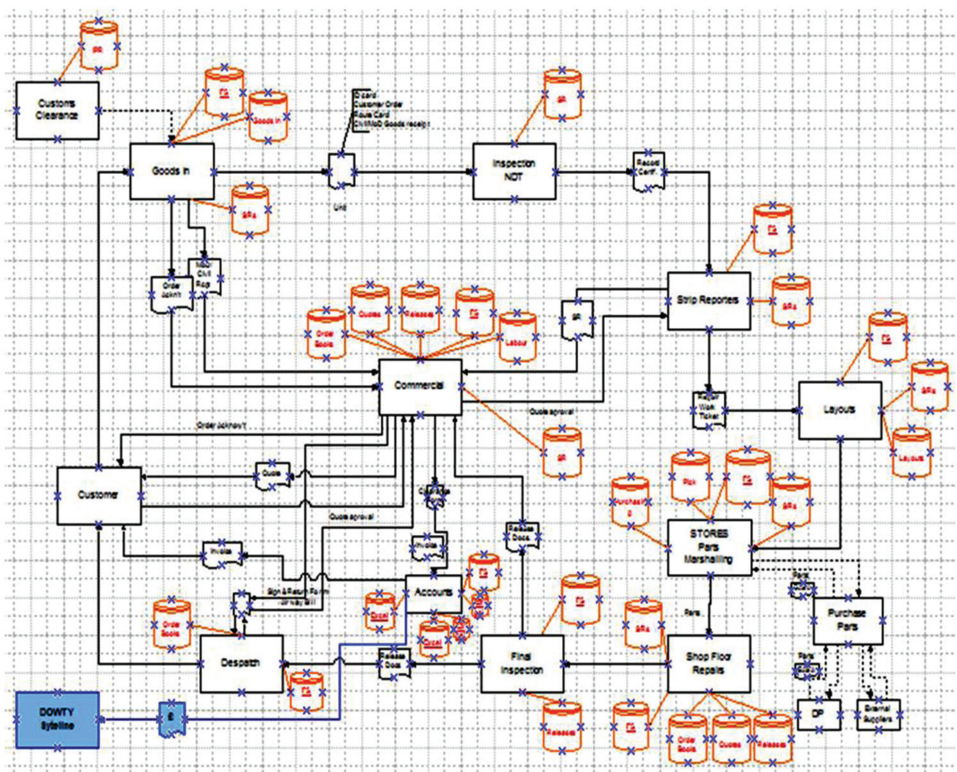


so that the SAP roll out could encompass both business units – Dowty OE and DPRO – with both businesses running on the Syteline system. The challenge was compounded by the fact that the version of Fourth Shift being run was very near to being "out of maintenance" (i.e. not supported by the software suppliers), adding more urgency to completion of the project. Process re-engineering, alongside the implementation of the Syteline ERP system at the DPRO business, were at the centre of the technology transfer project.

Project Implementation

Business analysis was carried out at an early stage of the project to identify the current status of the IT architecture at DPRO; this was necessary to determine and plan how best to link the two businesses together within the given short timescales. The business analysis revealed a system that had grown organically to support the needs of the business as it experienced a period of rapid growth. As Fourth Shift was unable to fulfil all business

Figure 3. End-user databases at DPRO in 2004 (indicated by the cylindrical symbol)



information requirements, enterprising computer end-users had developed over thirty standalone databases to help them run the business (Figure 3). Whilst this supported business operations reasonably well at the time, the company's management recognised the need to rationalise and simplify the company's information systems as the company entered a new phase of growth: the improved functionality of Syteline would reduce the reliance on end-user databases.

The proliferation of these databases had increased the support demands on the IT department, and the department had also lost much of its Fourth Shift expertise. The migration to Syteline therefore made support easier to deliver, and this was within the core IT skill set of Smiths Aerospace. It also facilitated change control and standardisation of the IT architecture. By adopting Syteline, the DPRO business was better aligned with Group IS strategy.

The project reviewed, improved and standardised core processes across the two businesses so that both companies could be supported by one configuration of Syteline. Gap analysis was carried out to identify the business requirements and map these to the functionality of the Syteline ERP system. Wherever possible, system changes were kept to a minimum, as Syteline had already been mapped to SAP in the OE business. A new IT architecture was devised and the number of peripheral databases was drastically reduced, leaving just four end-user Microsoft Access databases connected to the main ERP system. Communications between the two sites in Gloucester was also improved by linking the DPRO site to the ERP server hosted at the OE site. Systems piloting, user acceptance testing and training were progressed in accordance with the project plan.

The system was delivered as per plan and in time to allow work to continue integrating Syteline at the OE site with SAP. The new system went live at DPRO in March 2006, and no major problems were reported after go-live, only teething issues that were directly related to system configuration and user access rights. This was recognised as a potential issue on the plan as there was not enough time to cater for all the necessary system administration work before the go-live date. Business management agreed to compromise in some areas in order to have the DPRO business integrated into the OE business by the agreed date, but a post-implementation project phase was authorised to address these minor issues.

System Benefits

Systems integration across the two businesses helped Dowty Propellers to align IT with their business strategy. At the same time, the move to Syteline allowed compliance with Group policy of implementing SAP as the main financials package, without this representing a challenge to the two hitherto separate businesses, which could have involved sacrificing profitability, transparency and internal control.

An integrated systems strategy - instead of discrete, project-based activities managed as separate functions in departmental silos - enabled the company to achieve agility and improve revenues, enhancing productivity and ultimately optimising business performance. Integrating the two businesses on a unified systems platform allowed the organisation to reduce its IT complexity and obtain more business value from their IT investment, by allowing the DPRO business to be included in the SAP roll out.

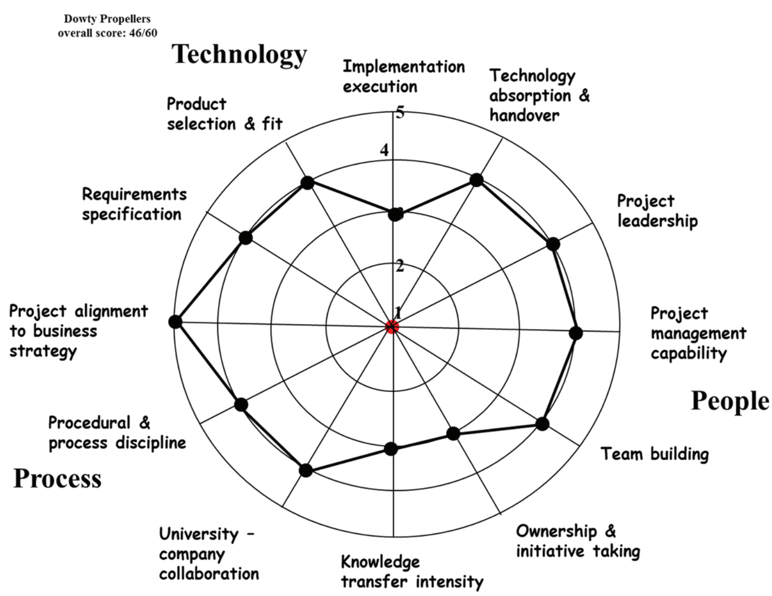
In summary the main business benefits drawn from this systems and business integration project were:

- Processes were re-engineered and aligned to corporate business strategy; operations were streamlined and the use of corporate resources was optimised.
- Customer service was enhanced by providing one point of contact within Dowty Propellers.
- The complexity of the existing IT infrastructure and architecture was reduced by integrating the two business functions around one ERP system.
- Data and information were consolidated and standardised across the two businesses, facilitating improved access and reporting.
- It supported and progressed the Group information systems strategy, by preparing the businesses for an SAP implementation, and also ensured the flow down of benefits from the Group SAP project to the Dowty Propellers' business.
- IT efficiencies were improved by reducing the number of databases and systems requiring support.

Analysis

This project was given a B grade by Momenta, the UK Government funding body, and it generally delivered well against its stated objectives. There were nevertheless a number of difficulties that required particular focus to allow the project to progress. These included very tight timescales, as the project was on the critical path for the rollout of the SAP Financials module, and hence was constrained by the go-live date of the latter project. This did not allow enough time to complete a thorough re-engineering of business processes, and in addition the scope of the system implementation had to be restricted to the minimum to achieve the project end date. In these circumstances, project management capability and team building were of particular importance, and the project scored well on these factors; but implementation execution was nevertheless impaired by these constraints. Due to the tight time frame, there was very little contingency built into the programme, so any unexpected or unplanned for issue could have put the overall project at risk. The project go-live date was delayed on two occasions due to external factors, but the resultant small slippage had no significant knock-on impact on the SAP Financials project.

Figure 4. Change factors in the Dowty Propellers ERP project



One major issue that put the project in jeopardy was the large number of parallel-running projects that were going on at Smiths, all competing for the same resources. The centralisation of both the finance and IT departments, the need for system changes to support a significant new customer of Smiths Aerospace, and the support of day-to-day business operations, all required certain key resources, which were all also involved in the DPRO systems project. Prioritisation proved to be a great challenge as the business had to constantly revise the allocation of resources and take decisions that allowed all projects to move forward at an acceptable pace. In these circumstances, the alignment of the project with overall business strategy was a key strength in arguing for resources, and the finance director noted that one major benefit of the liaison with the university was the availability of "a dedicated resource to manage key initiatives to drive the business forward" and that the Associate "played a significant role in systems delivery" (Monk & Wynn, 2008, p.1). Business leadership and commitment were also strong, with the finance director taking personal charge of the project, and chairing the project steering groups. This was particularly significant in resolving prioritisation and resourcing issues, and coordinating activities in the two business units.

This summary overview is reflected in the change factors diagram for the project (Figure 4). Project alignment to business strategy was crucial in underpinning the final successful implementation of the project, even if implementation execution was hampered by a number of business issues. The project scored well on all other factors. Although knowledge transfer intensity was only moderate, the university supervisor and Associate had wide experience of ERP projects and project management methodologies, and this contributed to the continuity of the project when problems were encountered and creative solutions needed to be found.

ERP IMPLEMENTATION AT FIXING POINT, CHELTENHAM

Company Profile

Fixing Point is a family business based in Cheltenham that designs, manufactures and distributes a wide range of non-standard, high quality, technically advanced products to the roofing, cladding and walling sectors of the construction industry. When the project started in 2006, the company had 53 staff and turnover that year was £5.4m.

Project Rationale

Fixing Point had implemented a number of standalone information systems using different technologies and running on disparate unconnected hardware platforms. The functionality of these systems was limited in a number of areas, notably in product costing, and management information was produced from a number of standalone packages and a range of spreadsheets, across four main sites around the UK. This was labour-intensive and produced data discrepancies, which impacted on customer service. Stock management across these sites was also problematic, and resultant "out-of-stocks" and inadequate resource capacity to meet deadlines resulted in unacceptable customer service levels.

A major project objective was the integration of order processing, manufacturing and stock control for the flashing and fabrication product group. In order to achieve this objective, Fixing Point elected to replace their legacy systems with one integrated package - an ERP system - and re-engineer business processes to support the company's growth plans. Fixing Point wanted to establish a common hardware platform and associated technical standards across all three product divisions, using standard procedures and practices which would aid the culture shift to a "one team" approach within the company. The new system needed to reduce the amount of duplicated processing and eliminate the need for spreadsheet based control systems. A significant improvement in the quality and availability of data was required.

Package Selection

The project commenced in July 2006 with an original planned duration of 18 months (Figure 5). The overarching objective was "to implement a new Enterprise Resource Planning system that will support the current and future information requirements of the company and its main business partners" (Momenta, 2005, p.2). Acquiring an ERP package that matched user requirements was considered critical to achieving project success, and after discussion with colleagues from the university, the Project Board (comprising senior management from the company and three university staff) agreed to use a combination of standard methodologies to guide the package selection process and related project management issues. A simplified version of the PRISM Buy-Build methodology (Figure 6) was used in conjunction with some elements of the PRINCE2 project management methodology. First,

Figure 5. The initial 18 month project plan for the Fixing Point ERP implementation (Momenta, 2005, p. 38)

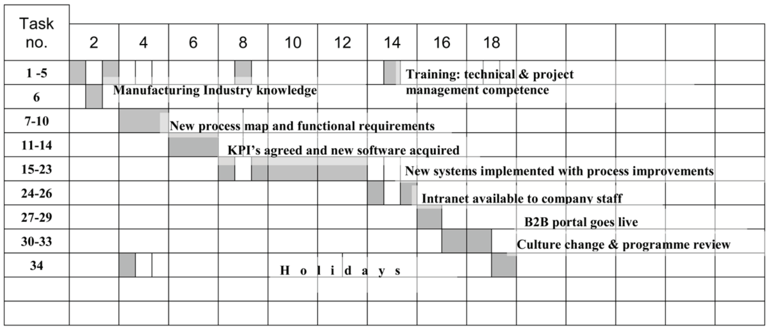
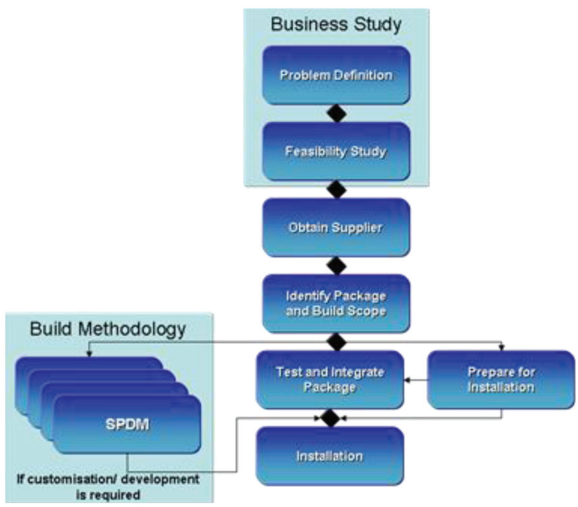


Figure 6. Elements of the PRISM Buy-Build Methodology used at Fixing Point (Wynn et al., 2009)



business processes were mapped at a high level and key users were interviewed to establish what systems currently existed, how they were performing, and current and future information needs. This allowed the project team to identify issues and information gaps in the company. Questionnaires were used to establish where and how key data items were treated – particularly product and customer data. Of the current systems, where were these key data items entered, processed and reported upon? Were there problems with data inconsistencies, and why? The findings were used as the basis for the production of key areas for improvement, KPIs and the list of user requirements for circulation to potential suppliers. Suitable ERP vendors for a manufacturing SME were selected and invited to send proposals. These activities took about 3 months in total.

An initial short-list of preferred vendor proposals was drawn-up from which four vendors were selected for a systems demonstration; from here, the preferred final two suppliers were requested to make further presentations. Structured workshops and detailed discussion on functionality, user requirements and price negotiation followed. This process took a further 5 months. At the end of this phase, Fixing Point chose the EFACS E/8 ERP system from Exel Computer Systems Ltd. This is a component based ERP package that allows some customisation and flexibility in the way it is implemented - the package can be adapted to fit specific functional requirements, which was considered of significance given the company's specific requirements for product costing.

Project Implementation

Training was arranged for the main users on the key functional aspects of the new system, and the Associate took responsibility for mapping the new system's capabilities against Fixing Point's business processes. Activities during this period included unit testing of the main systems modules, migration of key data to the new system, customisation of the system where necessary, and a range of additional workshops for training, enrolment and decision making. All these activities were overseen by the Project Board. The implementation phase was completed within 6 months, albeit with some delays incurred by competing business priorities and unexpected events. For example, changes in staffing meant that systems users were not able to complete their testing within the planned time frame. The Project Board elected not to rush with the implementation, but rather to ensure a high quality implementation. Systems testing was done thoroughly, and adequate training for all users was provided to underpin a smooth transition to the new software and a successful embedding of new processes across the company. The system went fully live after a month of parallel running in July 2008, this approach ensuring that users had ample time to familiarise themselves with the new system and associated procedures. The lengthy package selection process had a knock-on effect of extending the project end date by 6 months. This was agreed by the university in conjunction with the Government funding body and the company themselves.

Project Benefits

The EFACS ERP software suite effectively supported the Fixing Point business operations at the time, which saw a 10% growth in sales year on year, with turnover growing to over £8.0m in 2009/10, and a steady continued increase in profits and margins. The new system allowed the integration of data and information processing in the main business functions of the company – materials flashing and fabrication, pricing, sales, manufacturing and financial management. Data entry was streamlined, eliminating costly duplication; and stock management was done more quickly and more accurately, minimising over-stocking and under-stocking problems across the company's four UK sites. The training programme was continued and systems users in key departments were given the skills to become expert in report generation and business intelligence gathering from the ERP database. Key users were also trained to become systems administrators to maintain and manage the system.

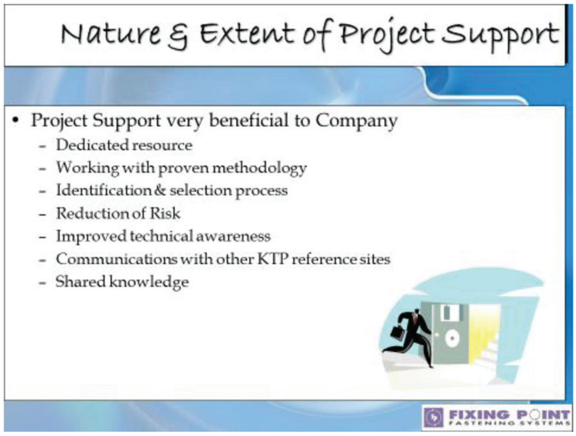
Analysis

The project at Fixing Point delivered a major systems implementation, which is not an easy task. As Koch (1999) humorously remarked "the inherent difficulties of implementing something as complex as an ERP is like teaching an elephant to do the hootchy-kootchy" (p.4). It was this achievement that warranted the B grade given to the project by the Technology Strategy Board, and the project management and technical capability of the Associate was significant in achieving this success. This is indicated in Figure 7, which is taken from the company finance director's presentation at one of the Project Board meetings. Nevertheless, there were a number of internal and external factors that impacted project timescales, resulting in a 6 months slippage. The Final Report noted:

"The problems encountered during the project and their solutions were as follows:

- *Selection of the supplier. Fixing Point did not want to choose in haste as they were making a 10 year investment. Thus, a more careful approach was taken where all decision makers had to be comfortable with the selection of the supplier.*

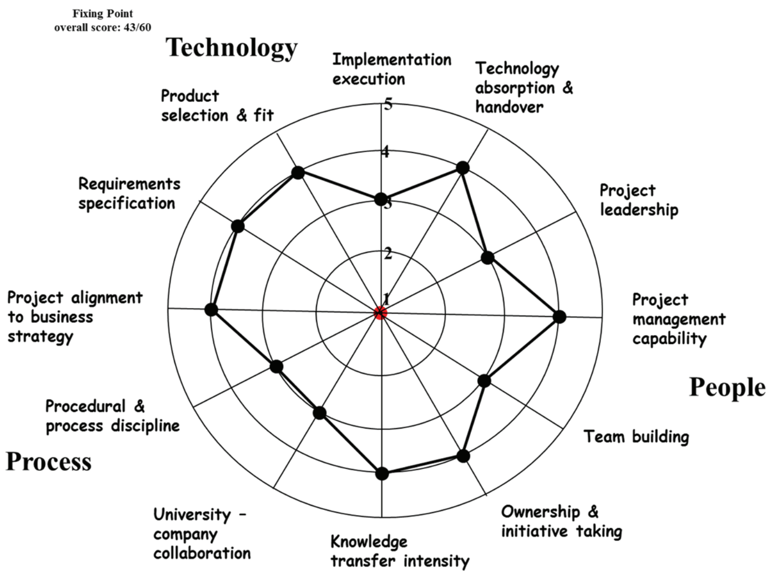
Figure 7. Project support benefits to Fixing Point (University of Gloucestershire, 2007)



- *Restructuring of chosen supplier. The unexpected circumstances of the chosen supplier had pushed the initial target of implementation from March 2007 to June 2007.*
- *Flooding. In July 2007, Cheltenham, Gloucester and Tewksbury suffered their worst flooding ever following severe heavy rain lasting several days. The training and user workshops that had been scheduled for July with external consultants were postponed until September.*
- *Staff changes. Some key users were identified to lead testing, but were unable to do so because of unexpected staff departures. Thus, the schedule was revised to accommodate the new staffing situation.*
- *Inertia. There was some reluctance to switch from the old, familiar system to the new, unfamiliar one. Thus a special effort was made to visit all of the branches to introduce and explain the new system" (Technology Strategy Board, 2008, p.2).*

The change factors diagram (Figure 8) indicates the relative strengths and weaknesses of the project. Most factors scored well, but the technical and project management aspects were strongest, underpinning an effective specification of requirements and software package selection. The durability of the Associate and her project management knowledge and experience were important in getting the project "over the line" when a combination of internal and external factors threatened project delivery. The alignment of the project with the company's business strategy meant that there was no turning back once underway, and sponsorship of the project by, and general

Figure 8. Change factors in the Fixing Point ERP project



support of, the finance director were equally important in providing continuity and additional funding when required. Nevertheless, decisions made by the company's senior management in the broader interests of other company priorities impacted negatively on project implementation, team building and procedural and process discipline. Knowledge transfer intensity was high and technology absorption and handover were well executed with extensive training and sound product documentation. With hindsight, the diligent and thorough specification of requirements, which resulted in the selection of a package well able to support the specific needs of the company (notably in supporting a complex product pricing process) was of particular importance in the eventual success of the project.

ENGINEERING SYSTEMS INTEGRATION AT SKF AEROENGINE BEARINGS, STONEHOUSE, GLOUCESTER

Company Background

When SKF AeroEngine Bearings UK (SKF) embarked on this technology project in 2007, it employed 250 staff and had an annual turnover of circa

£17m. The company, which was part of the SKF Group, had 7% of the world market in aero engine bearings, the majority of which derived from major aircraft engine manufacturers. The project proposal (Technology Strategy Board, 2007) noted that "to retain existing market share and create opportunities for new business, the company needs to be more efficient in providing engineering data and more cost effective to be price competitive" (p.2). A major upgrade of their shop floor engineering systems and associated technology infrastructure was seen as essential if the company was going to be more effective in a highly competitive market. The company were also the first in the Group to implement such an upgrade, and thus product selection and implementation on the shop floor would set a precedent for other Group companies.

The project involved the upgrade and integration of a range of systems specifically geared to shop floor manufacturing operations, notably programmable logical controllers (PLCs) and associated supervisory control and data acquisition (SCADA) systems and computer aided design (CAD) tools. The project also encompassed Product Lifecycle Management (PLM) systems, which had evolved from earlier Product Data Management (PDM) systems. A PDM system can be seen as a subset of a PLM system. In the 1980s, engineers had recognized the need to manage the increasing volumes of design data produced by, and contained in, a range of automated and semi-automated systems, such as CAD files, specification and requirement documents, and CAM and CAE analytics. PLM and PDM systems allowed the user to store and control all product data, manage document issue levels, maintain Bill of Materials and immediately visualize the relationship between parts and assemblies.

Project Objectives

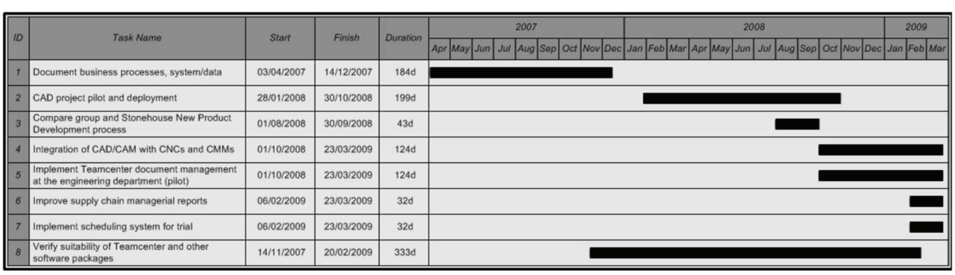
The overarching aim of the project – named "Engineering Systems Integration" (ESI) - was to develop and implement integrated engineering information systems to support future business competitiveness based on improved customer responsiveness. The implementation of a new PLM system as well as new CAD/CAM packages, both linked with ERP and shop floor data systems, was seen as essential to support the company in delivering big contracts to its main customers. The main software products that were acquired were NX (CAD/CAM) and Teamcenter (PLM), which were to be implemented and integrated with other systems over a two year period. More specifically, the objectives of the ESI project were to:

- Create a business process map which encompassed the company's main business processes
- Implement NX (CAD/CAM) and manage the NX project pilot
- Manage the basic Teamcenter (PLM) implementation
- Evaluate and cost justify the need for, and benefits of, other software packages
- Define and implement the integration of NX and Teamcenter with CMMs and CNCs
- Implement managerial reports using business intelligence tools (Cognos Pro-IV)
- Implement a shop floor planning system

Project Implementation

The project comprised 8 stages (Figure 9) and elements of the PRINCE2 project management methodology were used to run and control the project (Wynn, Shen, & Brandao, 2008). At the first meeting of the Project Board, it was recognised that for the project to be successful, there would need to be three parallel running and inter-related streams of work – Process, Technology and People/Training streams. Each of these streams was allocated a senior manager to act as overall owner and coordinator. The initial stage focused on industry knowledge gathering, and process mapping. The Associate held a series of workshops with management and shop floor staff to get agreement

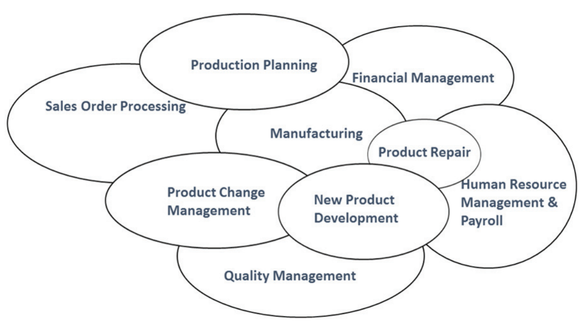
Figure 9. Project timetable for ESI project at SKF (Robert James Howlett, Innovation Through Knowledge Transfer Smart Innovations, Systems and Technologies, 2010 Springer –Verlag Berlin Heidelberg reproduced with permission of SNCSC)



to the process maps and start to identify areas for process improvement. Some Six Sigma techniques (such as spaghetti diagram and lead time analysis) were applied in order to understand where priority focus was required. Other sites (and even competitors) were visited and analyzed, to ascertain what technologies were used to address each of the company's issues, thereby establishing the Associate's credibility and role brief with the company's engineers.

In stage 2, NX - the new CAD system - was implemented on the shop floor, moving users to a three-dimensional CAD environment for the first time. This reinforced project momentum and broadened support for the project as a whole. As part of stage 3, the process maps (Figure 10) were revisited, and the project team spent some time examining the overall group processes for product development and manufacturing, and the implications of Group software strategy (which favored the NX/Team Centre PLM software combination). Stage 4 then refocused on software implementation and developed links between the CAD/CAM functions and the shop floor machines (CNCs and CMMs), where the major focus was on product quality and precision after each iteration of the product's development. The initial raw material underwent a sequence of operations that involved CNCs and/or manual machines shaping the component, with CMMs verifying whether those machines achieved the tolerance required by each stage on the product line. To have a machine program downloaded to the CNC, a Direct Numerical Control (DNC) system was used, providing program version control and the logging of program interruptions and necessary amendments. SFK were the first aerospace business within the corporate Group to achieve the integration of the 3D CAD/CAM system with the CNC and CMM machines.

Figure 10. Top-level business processes at SKF

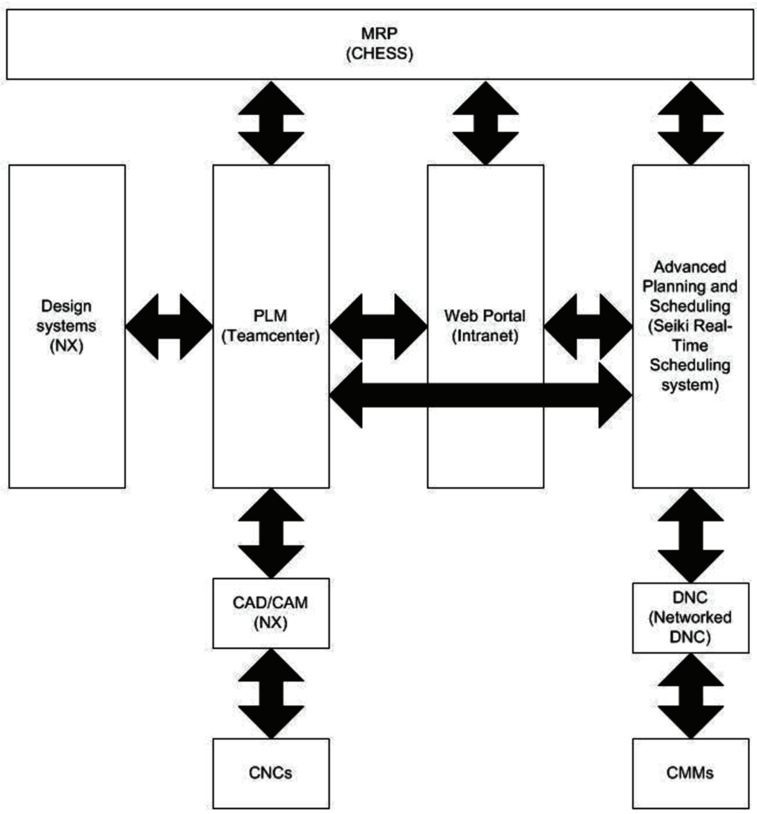


The Teamcenter document management system was installed in the engineering department in stage 5, delivering significant time saving benefits for information retrieval. Until then, the company was still using print copies as their masters for auditing and even for product changes. Through use of the digital copy, with all product information also being held in the PLM system, the management and maintenance of product development and change control became faster and more secure. Stage 6 reflected a change of focus as business priorities and staff personnel changed. The Associate was tasked with assessing possible information improvement across the broader supply chain, and his main achievement at this stage was the development of new management information, using the Cognos Pro-IV business intelligence tool running on the CHESS MRP system.

As regards process change, customer facing product channels were introduced to drive new efficiencies on the shop floor. This divided the product portfolio into categories, and machines were aligned in sequence on the shop floor creating product category lines. Before the introduction of this concept, the shop floor was laid out with the same type of machines being clustered together in cells. The process change team were charged with implementing this element of the overall project, but key information was needed to make the most of the concept. Before the new channels were fully implemented, it was necessary to identify "bottleneck machines" in each channel, so that appropriate redesign of the channel machine configurations could be made. The Cognos business intelligence tool was used to generate the daily reports required by the channel implementation team.

The supply chain function was further developed in stage 7, where the Associate undertook package evaluation for other supply chain processes, notably scheduling, leading to the selection and pilot implementation of a new scheduling software package. Prior to this, lead-time calculations were difficult to estimate due to the number of orders, the quantity of operations for product development and the limitations of the corporate MRP package in visualizing the impact of any changes on the shop floor. Due to a long lead-time for aerospace product development, some customers were providing forecast orders for the following 3 years and, to be able to secure these orders, the company had to prove it had available capacity over that period. The new scheduling system provided the ability to simulate those conditions and report an accurate picture of future capacity. This stage completed a major overhaul of the company's IS portfolio (Figure 11).

Figure 11. Selected software solutions and systems architecture at SKF. Software packages implemented at SKF were CHESS (MRP), Teamcentre (PLM), NX (CAD/CAM) Seiki (Advanced Scheduling) and Cognos Pro-IV (Business Intelligence/Reporting). (Robert James Howlett, Innovation Through Knowledge Transfer Smart Innovations, Systems and Technologies, Springer –Verlag Berlin Heidelberg reproduced with permission of SNCSC)



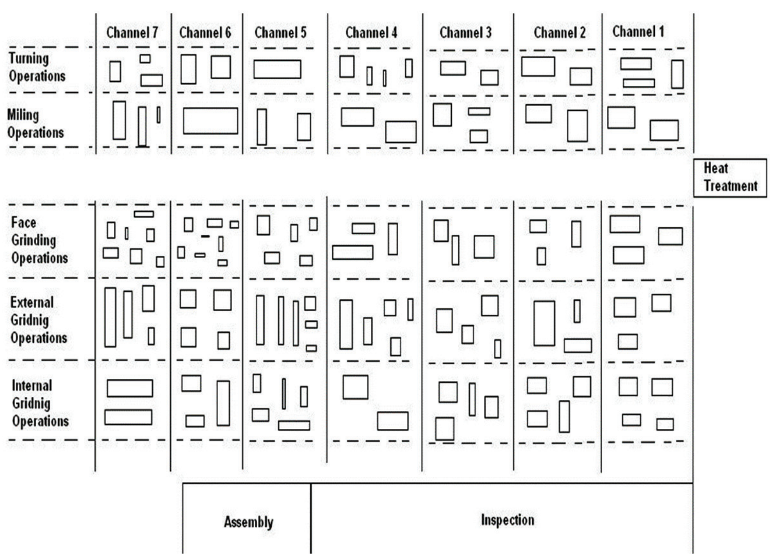
Project Benefits

In terms of technology transfer, new knowledge was generated, transferred and acquired in the process mapping, software package evaluation and implementation processes. The creation and validation of process maps fostered a better understanding of the relationships between departments, which was used in a customer audit to demonstrate new development flows. The re-organization of the design manuals in the design portal improved document management and provided a tool for document retrieval. "The integration of the CAD\CAM system with the CNC and CMM machines was the first site of the aerospace group division to achieve this integration and provided technical knowledge of machine programs implementation that can be used elsewhere in the group" (Technology Strategy Board, 2009, p.4).

Hitherto, the company had very little in-house IS resource, but the project helped develop new staff capabilities to further embed the new CAD and Teamcentre systems; and the comparative analysis of company business processes with those at Group level facilitated alignment of processes and software deployment across the group. The new PLM system provided document management, 3D visualization, and process management functions. Document management was used across the business while the 3D visualization was mainly used in the engineering design department and on the shop floor.

The implementation of this new systems portfolio was accompanied by a reorganization of the shop floor to halve product lead times for bearings from 90 days to 45 days, with a forward target of 30 days. This involved a radical change in shop floor structure from an organization that reflected management

Figure 12. Shop floor process alignment around channels at SKF (Robert James Howlett, Innovation Through Knowledge Transfer Smart Innovations, Systems and Technologies, Springer, 2010–Verlag Berlin Heidelberg reproduced with permission of SNCSC)



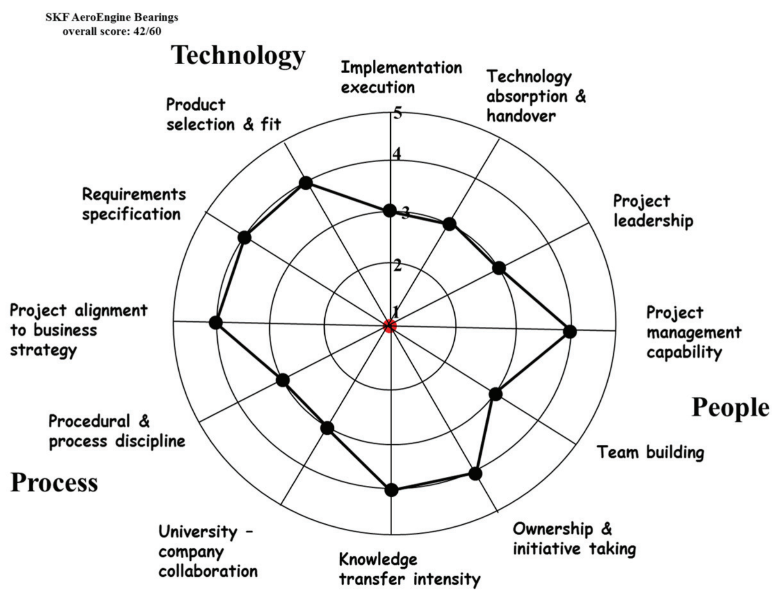
functions to one based around product-customer channels, in which 80% of operations required for product development and delivery were contained within each channel. Seven main channels were identified that crossed and utilized elements of the old functions (e.g. heat treatment, grinding, final view-assembly, inspection - Figure 12). This resulted in faster product flow and less work in progress, and eliminated product data on systems not linked to specific orders.

Savings achieved by implementing the CAD/CAM and PLM systems were predicted to payback the investment cost within three years and exceed a £1m net benefit within 10 years. The implementation of the new scheduling and capacity planning system allowed the company to take new contracts worth £1.5m per year in 2010, 2011 and 2012. The working relationship and availability of information on the company's engineering database between departments was substantially improved as a result of the project.

Analysis

This project introduced new systems and re-engineered processes in a complex shop floor engineering environment and also delivered new and improved

Figure 13. Change factors in the engineering systems integration project at SKF

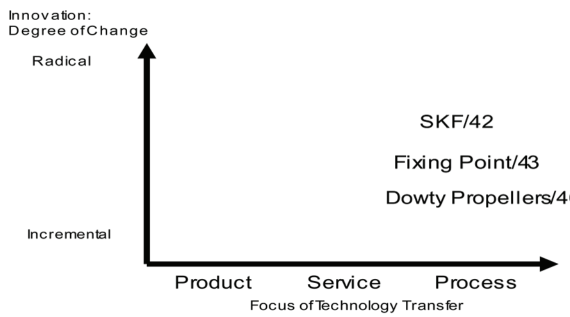


management information. It was rated as a B by the Technology Strategy Board, and the change factors diagram (Figure 13) highlights the relative strengths and weaknesses of the project. There were several staff changes in company management directly involved in the project across the two year period, and this had a negative impact on project momentum and direction. Team building and procedural discipline suffered somewhat, and the project changed focus several times. However, due to the flexibility and all round ability of the Associate, knowledge transfer intensity was high and new software products were appropriately selected and well implemented; and overall the project was closely aligned to the company's strategic direction, which ensured continued support despite the managerial changes.

The project involved change in processes and procedures, and training was necessary on a number of implementation fronts: design/development, programming, new product development, and change management. Significant effort was dedicated to helping engineers to come to terms with, and embrace, the new processes and systems, which in the end produced the institutionalization and embedding of new ways of working. Not surprisingly, there were difficulties in implementing some of the new technologies. For example the CAD/CAM system was geared more to automotive businesses, and some difficult design shapes needed in the aerospace industry had to be converted from the old 2D system to the new 3D CAD/CAM system. Another example was the PLM system and its data classification solution. The level of detail handled by the classification was limited in comparison with the levels of detail needed by an aerospace business, and systems customizations had to be made to attend to this requirement. Implementation execution proved difficult, but ownership and initiative taking was strong overall, notably by the Associate, and this helped ensure overall success of this a multi-faceted project.

In summary, the project exhibited a high degree of technology expertise that supported the selection, implementation and integration of new engineering systems, allied to significant process re-engineering on the shop floor. However, the changes in senior management staff affected project direction and overall continuity to some extent, but the alignment of the project to overall business strategy and the project management capability of the Associate and his business colleagues ensured a successful project outcome.

Figure 14. Manufacturing companies: technology transfer focus and degree of innovation



CONCLUSION

The three projects at these manufacturing companies all involved major systems implementations allied to significant process change. None of the projects was especially radical, although the project at SKF was perhaps more so given the degree of change involved (Figure 14). In these circumstances, the role of the Associate was critical, being a dedicated knowledgeable resource to instigate, promote and manage key initiatives to drive the technology transfer forward.

The right balance needs to be struck between delivering new technology and undertaking the associated process change. McAfee (2003), with reference to major software package implementations, noted that "the coordination, managerial oversight and marshaling of resources needed to implement these systems make for a change effort like no other" (p.83). Process re-engineering can help large projects such as those discussed in this chapter to deliver major benefits in terms of efficiency gains and customer service, but there is a danger that it can delay implementation and stall the project. At Dowty Propellers, the need to go live with Syteline to meet the SAP Financials module roll-out meant that process re-engineering was curtailed, and at SKF there were a number of such delays, in part because of the extensive training needed to support staff in new ways of working; and at Fixing Point, it was the package selection process, in particular, that pushed back the project end-date by 6 months. These cases evidence the need to build in contingencies, in terms of both timescales and required resources, in projects of this nature and scale.

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KEY TERMS AND DEFINITIONS

Business Process Re-Engineering (BPR): An approach to change management pioneered in the 1980s and 1990s that often went hand-in-hand with major information systems implementations. The tasks required to obtain a specific business outcomes were often radically redesigned, and could result in speedier response times, less manpower, and lower inventories.

Computer Numerical Controls (CNCs): A method for automating the control of machine tools (drills, boring tools, lathes) through software embedded in a microcomputer attached to the tool.

Computer-Aided Design (CAD) System: A software system used by engineers (and other professions) to create precision drawings or technical illustrations. The output can include both two-dimensional (2-D) drawings but also three-dimensional (3-D) models.

Computer-Aided Engineering (CAE): The deployment of a range of computer software to aid in engineering analysis. This may include the use of computer software to simulate performance to improve product designs, and the optimization of products, processes, and manufacturing tools.

Computer-Aided Manufacturing (CAM): The use of software to control machine tools in shop floor manufacturing. It uses computer software and machinery to facilitate and automate manufacturing processes. The concept overlaps with CAE and is sometimes seen as its successor. It is often used in conjunction with computer-aided design.

Computerized Maintenance Management System (CMMS): Computer software designed to simplify maintenance management operations. It schedules, tracks and monitors maintenance activities to provide a range of reports and information on cost, component items, and personnel activities.

Direct Numerical Control (DNC): A general term used in shop floor operations to mean the networking of CNC machine tools.

Product Data Management (PDM) System: Used to manage product data and process-related information. It may include data generated by computer-aided design (CAD) systems. A PDM system may be part of a Product Lifecycle Management (PLM) system, which has a wider range of functions.

Product Lifecycle Management (PLM): A systematic approach to managing the various steps in the lifecycle of a product, from its design and development to its sale and indeed its ultimate disposal. A PLM system can integrate data relating to the product, relevant human resources and business processes. It may integrate with a company-wide Enterprise Resource Planning system.

Programmable Logical Controllers (PLCs): Ruggedized shop floor computers used for industrial automation. They can be deployed in the control, monitoring and automation of specific machines or production lines. Data gathered in PLCs is often uploaded to SCADA systems.

Supervisory Control and Data Acquisition (SCADA) Systems: Data collection and reporting systems that provide information on shop floor production and packaging processes. They are usually linked by network to monitoring devices like PLCs and other electrical controls.