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Journal:	*International Journal of Production Research*
Manuscript ID:	TPRS-2006-IJPR-0296.R1
Manuscript Type:	Original Manuscript
Date Submitted by the Author:	01-Dec-2006
Complete List of Authors:	Tiwari, Ashutosh; Cranfield University, Enterprise Integration Sackett, P; Cranfield University, Enterprise Integration Rehman, Shahwar; Cranfield University Linton, Howard; BOC Edwards
Keywords:	HUMAN RESOURCE MANAGEMENT, JOB SHOP, WORLD CLASS MANUFACTURING, SHOP FLOOR CONTROL, CELLULAR MANUFACTURE, HUMAN FACTORS, OPERATIONS MANAGEMENT, CONTINUOUS IMPROVEMENT
Keywords (user):	SUPERVISOR ROLE, ACTIVITY PROFILES

Good Operations Practice Supervisor Profiles in Cell-Centric Manufacturing

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Abstract *The selection and implementation of good operations practice cannot be undertaken in isolation; it must consider the enterprise context. The aim of this paper is to describe a robust process for the development of specific environment good operations practice role profiles for supervisors, and illustrate this through a case study within a complex cell-centric manufacturing environment. The approach identifies the activities undertaken by a cell leader and team leader in a given manufacturing organisation, and also by a good operations practice cell leader and team leader in a relevant external organisation. Then via a survey of operations managers and functional managers, those activities that a cell leader and team leader should do within the given manufacturing organisation are identified. The approach enables the contextual adoption of good operations practice, develops supervisor role profiles which allows them to be proficient within their task domains, contributes to attaining agreement amongst operational and functional management, and has applications across cell-centric manufacturing. The potentially significant impacts available across cell-centric manufacturing are illustrated by the finding that following this examination of operations practice in the case study company two-thirds were classified as requiring change.*

Keywords *Operations Management; Cell-Centric Manufacturing; Good Practice; Activity Profiles; Supervisor Role; Operations Interface*

1 Introduction

In response to increasing global competition over the past three decades many manufacturing enterprises have organised their operations around cell-centric technology. Enterprises have tended to focus on the technical aspects of cell design, such as cell layout and tooling, without due consideration of the strategic context and socio-technical dimensions such as job design and operational policies. Furthermore, enterprises have attempted to 'blindly' introduce what is perceived to be best practice, with a particular emphasis on Japanese techniques such as Kaizen and Kanban, without consideration of whether they are appropriate to their operations management. Using a view of cell-centric technology which encompasses the macro-level organisational and socio-technical dimensions the work described can ensure that organisations adopt those good practices that are appropriate to their environment and their operations management.

The aim of this paper is:

- To describe a robust process for the development of specific environment good operations practice role profiles for supervisors.

The proposed process is illustrated through a case study within a complex cell-centric manufacturing environment which identifies:

- What a cell leader and team leader does within a given manufacturing organisation.
- The practices undertaken by a good operations practice cell leader and team leader.
- The roles a cell leader and team leader *should* do within a given operations management environment.

The authors focus on activities undertaken within existing and established cell-centric units, i.e., "an independent group of functionally dissimilar machines, located together on the floor, dedicated to the manufacture of a family of similar parts" (Ham *et al.*, 1985). The scope of the activities addressed corresponds to the activities that are undertaken within the organisational levels of cell leaders and team leaders. Elements that are outside the scope of this study are organisational levels not stated above, changes to cell layouts or cell design, and changes to reward and compensation schemes.

This section presents the aim and structure of this paper. Section 2 presents previous work related to that addressed within this paper. Section 3 explains the process proposed in this study. Section 4 explains the development, implementation and demonstration of the process within a high performance complex manufacturing environment. Sections 5 and 6 respectively discuss the findings / future research and conclusions.

2 Previous Related Work

This section reviews key related studies associated with the aim and objectives of this study.

Critical Roles

A fundamental premise of cell-centric manufacturing is that 'superior performance is ultimately based on the people in an organisation' (Hayes and Wheelwright, 1988).

The successful execution of cell-centric technology relies on various roles within the enterprise from senior management through to the shop floor. The importance of considering individual employee profiles and their relationship to productivity has been highlighted by (Schultz *et al.*, 1998). The roles of cell leaders and team leaders perform a pivotal role by utilising human and technical competencies to transform operational policies and procedures in to day-to-day activities. It is their role that realises the effectiveness of a cell by ensuring the joint optimisation of the social and technical systems based upon nine principles (Huber and Brown 1991) illustrated below:

- Compatibility – ensuring involvement of key personnel.
- Minimal critical specification – stipulating only what is required.
- Socio-technical criterion – assigning technical responsibility close to the source.
- Multi-function criterion – supporting flexible multi-functional employees.
- Boundary location – organising effective sequencing of activities.
- Information flow – ensuring feedback of information to effect decisions
- Support congruence – reward systems and training policies
- Design and human values – providing a high quality of work life.
- Incompletion – continuous improvement.

The positive impact of a selection of the above principles within cellular manufacturing is displayed by (Olorunniwo and Udo, 2002) and (Chakravorty and Hales, 2004) supporting the assertion that the correct specification of the roles of cell leaders and team leaders is critical to a cell's effectiveness.

Best Practice

The term 'best practice' is often used both within literature and by practitioners without due consideration of its explicit definition and the complexities associated with its identification and adoption.

The definition of 'best practice' is usually presented as either self-evident or is defined in terms of its effects, (e.g., superior performance or sustainable world-class outcomes in cost, quality or flexibility). This lack of explicit and detailed definition may explain some widespread misconceptions of best practice amongst practitioners, for example, that best practice can be implemented enterprise-wide irrespective of its context. Content based definitions of best practice in literature are almost always stated as a list of components, (e.g., planning, customer focus, quality), which differ significantly amongst authors deeming them unsatisfactory (Beaumont, 2005). Motivated by an interpretation of best practice as a mechanism to express and implement manufacturing strategy, (Ketokivi and Schroeder, 2004), a more appropriate definition is one which reflects the three contextual aspects of best practice (Beaumont, 2005):

- Operational best practice – operations on the factory floor focussing on cost, quality and time optimisation.
- Internal best practice – optimisation and alignment of organisational structure, staffing, systems and culture.
- External best practice – optimisation of relations with external parties such as suppliers and customers.

This approach is also supported by (Ungan, 2005) who identifies the contextual nature of best practice as three separate elements; best practice factors, organisational factors and environmental factors.

The contextual nature of best practice presents significant challenges in its identification and adoption, which is effectively highlighted by (Laugan *et al.*, 2005) who identify key widespread limitations of existing studies:

- Incomplete set of practices – The identification of a comprehensive set of practices as 'best' is made difficult because existing studies tend to focus on either a particular practice in isolation or a limited set of practices without justification of why those practices and not others have been chosen. This is also identified by Beaumont (2005) in his examination of best practice definitions.
- Justification of selection of practices – Studies tend not to justify why particular practices and not others have been selected within their portfolio of best practice.
- Justification of practices as 'best' – Best practice implies superior performance, however, many studies postulate practices as best without linking practice to performance.
- Generalisation of practices – Many studies assume the premise that best practice is generic and can be applied across enterprises and even across industries without consideration of, for example, the type, size, nature and culture of the organisation.

These limitations are evident in many previous studies which have used literature, both industrial and academic, as a source of 'best practice', in particular where references to best practice tend to be superficial and incomplete, (Fitz-enz, 1997) (Forza, 2002), or idiosyncratic to a given scenario (Voss *et al.*, 2002). The lack of detail displayed in specifying and describing best practice means that it is unlikely that all industrialists understand fully how the best practice are determined (Hughes and Smart 1994), what they mean and the strategic contingencies involved in adopting and implementing the specific practices (Ketokivi and Schroeder, 2004).

An effective best practice study must justify the source and selection of its portfolio of practices, investigate them holistically and within their specific context, (Davies and Kochhar, 2002).

Comprehensive Frameworks for Cell-centric Technology

The adoption of cell-centric technology by an enterprise is typically a decision undertaken as part of a manufacturing strategy to secure competitiveness. Indeed, cell-centric technology best practice successfully implemented enable enterprises to realise the benefits of improved operational performance, e.g., (New and Szwejczewski, 1995). However, the full benefits of cell-centric technology are often not realised due to a lack of an effective process for the comprehensive consideration of the complexities associated with its introduction, i.e., its adoption and implementation. Existing studies propose frameworks that comprise two key limitations. Firstly, the frameworks focus on a limited subset of the elements necessary for the successful introduction of cell-centric best practice. Secondly, the frameworks tend to be sequential which do not take in to account the complexities of multi-level participative decision-making and the alignment of factors.

(Ungan, 2005) focuses solely on the adoption stage, distinguishing it from implementation, for the introduction of best practice. He proposes a context-driven framework of factors that influence management support for the adoption of best practice:

- Best practice factors – Cost, compatibility and perceived operational benefits
- Organisational factors – Satisfaction with the existing practice and organisational resource availability
- Environmental factor – External pressures

(Davies and Kochhar, 2000) focus on the selection of best practices based on the strength of relationships between practices and performance objectives. They propose a sequential conceptual framework which takes in to account the dependency relationships between practices:

- Identification of best practices for the areas of performance to be improved.
- Prioritise practices based on impact on specified measure of performance.
- Assess the predecessor practices for the practice to be implemented.
- Implement desired practices.

However, the above conceptual framework relies overly on literature as an initial source which, as suggested by (Fitz-enz 1997), may not be a satisfactory source of best practice.

Much of the literature relating to cell-centric technology implementation takes mostly a technical perspective, (Lee, 1997), (Nyman, 1992) with limited discussion of its socio-technical aspects, (Prickett, 1994) and strategic aspects. A comprehensive framework that includes consideration of both the strategic and socio-technical dimensions of cell-centric technology proposed by (Hyer et al., 1999) and adapted by (Chakravorty and Hales, 2004), identifies a seven step approach to the implementation of new cells:

- Establish the strategic context.
- Perform analysis of the existing system.
- Make high-level structural and operational decisions.
- Assign products, processes and people to cells.
- Conduct detailed cell design.
- Implement the new design.
- Continually evaluate and improve the design.

The above model is presented as a series of sequential steps with the final step of continually improving the design as a closed loop confined to detailing and implementing the improved cell design. This procedure for improvement confines cells to micro-decisions and limited levels of improvement because higher-level strategic, structural and operational decisions are outside its scope.

An alternative non-sequential approach to ensuring effective manufacturing operations is proposed by (Voss, 1995) as three overlapping paradigms: competing through manufacturing, strategic choices and best practice which have recently been revisited, (Voss, 2005) and found to be robust. Elements of competing through manufacturing are the establishment of key success factors, ensuring the alignment of capabilities to key success factors and creating a shared vision. Strategic choices relate to those of process and infrastructure whilst best practice is used to ensure superior performance.

An effective framework for the introduction of cell-centric best practice must identify pragmatic and well-tested best practices not purely reliant on literature, be appropriate to the specific strategic and operations management context of an enterprise and enable continual assessment of performance against world-class manufacturing.

Research Focus

Although the performance of a cell can be influenced by technical factors, success is heavily dependent on those personnel who are responsible for the day-to-day manufacturing operations activities – in cell-centric manufacturing environments these are the cell leaders and team leaders. The lack of research focus on human areas within cell-centric manufacturing literature extends to the operations role played by cell supervisors, i.e., cell leaders and team leaders. Therefore there is a research need for a robust contextual process that can enable the participative development of good operations practice supervisor role profiles within a complex and strategically aligned cell-centric manufacturing environment. This is not available within the current literature.

3 Proposed Contextual Process

Figure 1 is a representation of a process for the development of specific environment good operations practice role profiles for supervisors.

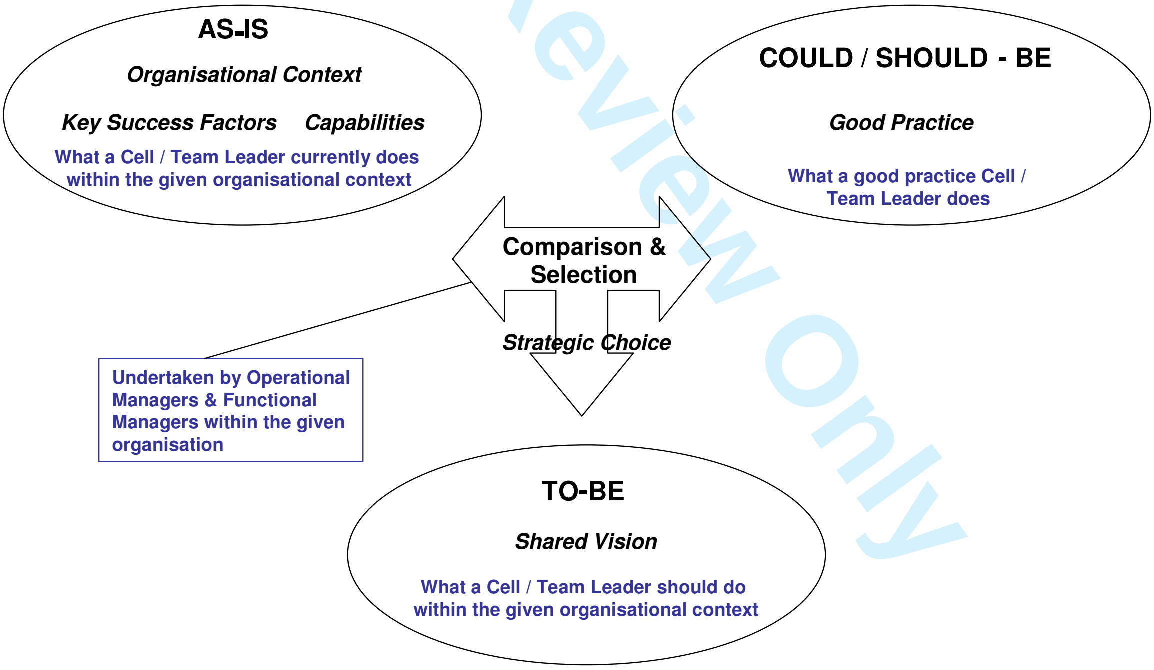


Figure 1: A Process for the Development of Good Operations Practice Role Profiles

Each aspect of Figure 1 is described below:

- *As-is* state - is defined as the complete set of operations activities undertaken currently by a cell leader and team leader within a given organisation. The as-is state is influenced by the context of the organisation, defined by the key success factors (ksf) (such as delivery, quality, cost, flexibility and safety) and organisational capabilities (Hill and Jones, 2001). Competitiveness is maximised when capabilities are aligned to the organisation's key success factors.

- *Could-be* state - is defined as the set of operations activities undertaken by a cell leader and team leader within a relevant good operations practice organisation.
- *Comparison and selection* - is the process for identifying those operations activities undertaken by a cell leader and team leader within a relevant good practice organisation that are 'appropriate' to be adopted by an organisation. 'Appropriateness' refers to several factors, including 'fit' for the organisation, ease of implementation and level of performance improvement. The comparison and selection process is not simple and mechanical; it must take into account the complex aspects of an enterprise's context. In addition, the comparison and selection process must take into account the day-to-day operations as well as its vision of future operations. The complex nature of the process means that it needs to be undertaken at a level where complexity is understood and where the power to make decisions resides. The comparison and selection process should be undertaken at the level that, typically, includes the operations director, operations managers and functional managers. This participative decision making process ensures that there is an alignment of views held by senior management, operational management and functional management. In addition, the participative approach means that it is less likely for an organisation's management to misunderstand good operations practice. The nature of the comparison and selection process means that the decisions undertaken are strategic to operations.
- *To-be* State - is defined as the complete set of ideal operations activities undertaken by a cell leader and team leader within the given organisation. The to-be state includes good operations activities that are appropriate to the context of the organisation and excludes those operations activities that have, either, been replaced by good operations practice activities or those that were previously undertaken and are no longer appropriate. The to-be state is influenced by the context of the organisation. The operations activities undertaken within the to-be state are understood and agreed by all.

4 Implementation and Demonstration of the Contextual Process

The implementation of the process for the development of good operations practice role profiles, Figure 1, is demonstrated within a high performance complex manufacturing environment. The Company is a leading supplier to the world's most advanced industries specialising in gases, services and equipment to the semiconductor industry, and vacuum products. The focus of this case study was on the product ranges that are manufactured and assembled, primarily, in the UK. Four UK manufacturing sites and cell-centric units were within the scope of this study. The process development included the following organisational levels within the Company: cell leader and team leader.

A three phase approach is adopted for implementing and demonstrating the process with each phase corresponding to a process state: phase I (as-is), phase II (could-be) and phase III (to-be).

Research Strategy

The primary research strategy used here is that of job analysis. Although job analysis is used for a number of purposes, (e.g., job classification and workforce planning) and lists have been developed (Ash and Levine, 1980) stating those uses, this study uses job analysis for job redesign. Job redesign is the sorting of tasks or activities to replace old methods of working with new ones. Aspects of job analysis to be undertaken are:

- Kinds of job data collected.
- Methods with which the data is gathered.
- Sources of job information.
- Units of analysis, i.e., what gets analysed, in particular, the level of detail.

The kinds of job data collected refers to the descriptors used for the job data. Identifying what a cell leader or team leader does, typically requires the collection of data about activity descriptions. After selecting the type of data that is required, it is necessary to determine the ways in which that data can be collected. Possible methods for data collection are:

- Reviewing documents.
- Observation of cell leaders and team leaders.
- Interviewing cell leaders and team leaders.
- Questionnaire.

Sources of information are usually indicated by the method of data collection. Some possible methods are:

- Job specifications.
- Cell leaders and team leaders.
- 'Best Practice' consultants and practitioners.
- Other projects, both current and previous.

Having decided the type of data to collect, the means by which to collect it and identified the specific sources of data, it is important to identify how the data will be summarised, analysed and reported. The job data that is collected may not necessarily be the end product that is required. For example, although qualitative activity descriptions are collected, the final output may be quantitative and derived from a scale.

The above job analysis elements form the building blocks of this research strategy. Table I summarises the research methods used within this study. Details of each of the building blocks for each of the phases are provided in the sections below.

Table I: Summary of Research Methods Utilised

	Phase I	Phase II	Phase III
BUILDING BLOCKS	**AS-IS**	**COULD/ SHOULD–BE**	**TO-BE**
Kinds of Data Collected:	Company cell / team leader activity profiles	Good practice cell / team leader activity profiles	Preference for Company / good practice
Methods of Gathering Data:	Documents, Shadowing, Interviews	Documents, Interviews	Questionnaire, Workshop
Sources of Data:	Job Descriptions, Company team / cell leaders	Job Descriptions, 'Best Practice' consultants	Company Operational & Functional Managers
Units of Analysis:	Activity Description, Role and Frequency	Activity Description, Role and Frequency	Activity Description, Role and Frequency

Phase I – As-is

The objective of this phase is to identify and detail the specific activities undertaken by a Company cell leader and team leader with respect to the key success factor categories of delivery, quality, cost and safety. These four key success factors are the competitive dimensions that most manufacturing organisations use to characterise manufacturing effectiveness (BenchmarkIndex, 2002a; 2002b). The output of this phase is a generic role profile for a Company cell leader and team leader.

The starting point of this phase is to identify the specific requirements that the Company has of its cell leaders and team leaders. Job descriptions are identified as a source of role and activity description data. Current job descriptions are obtained from the human resources department at the Company for a cell leader and team leader for three types of manufacturing cells: a machine shop cell, an assembly cell and a remanufacturing cell – in total, six job descriptions were sourced. Each job description contains the following sections:

- Identifiers, i.e., job title, type of cell.
- Summary, i.e., objective statement.
- Duties and tasks.
- Other information, e.g., minimum qualifications, etc.

The activities required of cell leaders and team leaders can be defined as an activity inventory. The natural language nature of the job descriptions and a variation in their structure means that they do not lend themselves easily to formulating activity inventories. A mechanism, based upon sentence structure, has been designed that enables a consistent and comprehensive approach to extracting activity information from job descriptions. In application each sentence within a job description is analysed to identify the:

- Verb – that identifies what action is performed.
- Object – that identifies what is actioned, termed the 'content' part of the sentence.

The subject, i.e., who, is the role for which the job description has been defined, i.e., the cell leader or team leader.

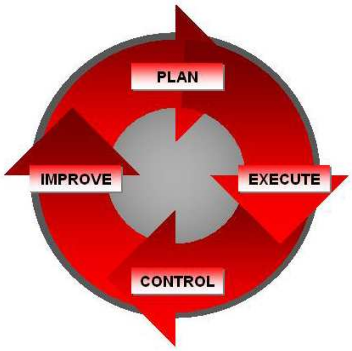


Figure 2: Plan, Execute, Control, Improve cycle

All activities undertaken within a cell relate to a planning, execution, control (i.e., monitoring) or improvement function. The plan, execute, control, improve cycle is illustrated in Figure 2. All activities within a cell at the Company are undertaken in relation to one of four key success factors: delivery, quality, cost or safety. The verb part of the sentence enables the categorisation of the activity as a planning, execution, control, or improvement function and the object part of the sentence enables the activity to be categorised as a delivery, quality, cost or safety activity.

This mechanism is illustrated with an example. A typical sentence from a job description of a cell leader is:
To administer the departmental budget with agreed budgetary constraints.
The verb is 'administer' and is categorised as a 'control' function. The object is 'the departmental budget with agreed budgetary constraints.' and is categorised as a 'cost' key success factor.

An activity inventory is defined for each job description and represented within an activity inventory matrix. An example task inventory for a cell leader – 'control' key success factor category is illustrated in Table II. The activity inventories of the three cell types are collated into a single generic activity inventory for each of the cell leader and team leader roles.

Table II: Example Task Inventory for a Cell Leader – Category: 'Control' Key Success Factor

	SAFETY	QUALITY	DELIVERY	COST
CONTROL				
	Ensure requirements of Company health and safety policy are achieved		Ensure resources (manpower, materials and machinery) are available	Ensure inventory control
	Ensure requirements for health & safety and environment legislation are achieved		Manage schedule variation only by exception and agreement with customer	Ensure resources (manpower, materials and machinery) are used in a cost effective manner
			Ensure shortages caused by stock inaccuracies are minimised	Control resources effectively
			Ensure labour	Control purchased

			effectiveness	supplies
			Ensure customer expectations are met in terms of cost, delivery, lead time, quality and specification	Ensure compliance with materials control
			Ensure queries are resolved in a timely manner	Ensure cost effective, efficient and accurate control of inventory within the cell
			Ensure efficient utilisation of kanban, directline feed, test facilities, packaging and despatch	Ensure productivity

Close inspection of activity inventories derived from job descriptions display an important shortcoming if using them to describe a practice. The activity descriptions describe ‘what gets done’ rather than ‘what the employee does’. The distinction is important because a practice cannot be sufficiently expressed by ‘what gets done’ alone. For example, consider the activity description taken from a team leader’s activity inventory, ‘Ensure effective performance of the team in the cell’. At first glance, the activity description seems clear, however, we don’t know *what* the team leader is doing to accomplish the activity.

After exhausting the secondary data available within the Company to identify ‘what the cell / team leader does’ in contrast to ‘what gets done by a cell / team leader’, research methods were identified that enable the collection of primary data. The kinds of data gathered are activity profiles for cell leaders and team leaders within the Company. The main sources of data are cell leaders and team leaders. The units of analysis identified were:

- Activity description – ‘what the cell / team leader does’.
- Activity role – ‘who does it’.
- Activity frequency – ‘how often it gets done’.

The gathering of activity profile data from cell leaders and team leaders is undertaken using a template. Data within the template is structured as illustrated in Figure 3.

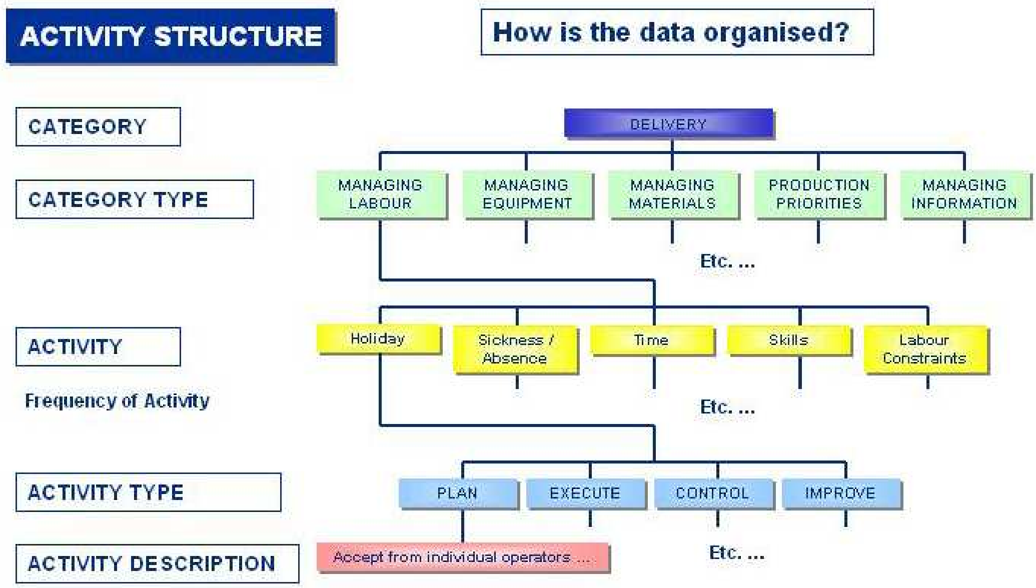


Figure 3: Activity Structure

Activity description, role and frequency data were gathered for each of the categories and activities illustrated in Figures 4, 5, 6 and 7. As an example, Table III presents the as-is activities corresponding to four of these categories.

Figure 4: Delivery Activities *Figure 5: Quality Activities*

Table III: As-is Activities Captured within Four Categories

CATEGORY	ACTIVITY DESCRIPTION	ROLE	FREQ.
Managing Equipment (Consumables)	• Identify, (i.e. count), current inventory / register of all consumables, (tooling and other), within the cell and update the consumables inventory sheet.	Team Leader	Daily
	• Note, (mentally), the urgency of requirement for each individual consumable. • Identify and follow-up those consumables items on the inventory list that have been ordered but not yet delivered. Obtain an estimated date of delivery for outstanding consumables.	Team Leader	Daily
	• Order tool item consumables fortnightly. • Order other consumables as necessary, e.g., via consumables pink fax order card system. Maintain a record of consumables ordered to avoid duplicate ordering.	Team Leader	Weekly
	• Review the efficiency and effectiveness of the consumables supply loop. • Review the items on the tools and consumables inventory for effectiveness. Identify ordering trends to maintain efficiency of consumables inventory.	Team Leader	Weekly

Managing Materials (Component Materials)	• The quantity and frequency of the main component materials items, (e.g., castings), are ordered, automatically, from key suppliers based upon the Supply Chain Plan, (SCP) which is calculated from existing and forecasted product sales orders. The AS/400 MAPICS system displays the main materials items ordered according to the SCP.	Team Leader	Daily
	• Count the quantity of individual component items within the cell area and identify, with the cell engineer, any additional requirement for components based upon the number of component items rejected, reworked or scrapped. Also, identify any additional requirement for components based upon 'off-line' manually revised production schedules, (e.g., due to an increase in the number of product spares orders). • Identify potential component shortages by visually scanning kanban bins.	Team Leader	Daily
	• Accept delivery of component materials on to the cell area and arrange short-term storage. • Update and maintain component item shortage sheet based upon component item inventory and production schedule.	Team Leader	Daily
	• Ensure the correct sizing and effective flow of kanban bins between suppliers and cell areas. • A database, (e.g., porosity database), of rejected components enables the identification of trends of the quality of components provided by suppliers.	Cell Leader	Weekly
Managing Information (Shift Handover)	• Review production priorities and issues. • Read shift handover communications from the previous shift and identify the priority actions to be integrated in to the current shift's production schedule.	Team Leader	Daily
	• Complete the shift handover sheet and communicate to the team leader of the next shift. The shift handover sheet enables the recording of any issues that may impact production.	Team Leader	Daily
Managing Labour (Sickness/Absence/Time)	• Identify operator absence due to sickness or other ad hoc reason, (i.e., unplanned absence). • Update the 'holiday / sickness / absence booking' matrix and the 'short–term manning' plan (i.e., overtime plan). • Review the clock cards / timesheets of individual operators and identify the variance of worked hours against the 'standard working week', taking in to account any absence, (e.g. sickness, holiday or other reason) and overtime.	Team Leader	Daily
	• Identify future labour capacity by, for example, updating a labour capacity spreadsheet. • Review the levels of manpower, (i.e., labour capacity) and skills cover, (i.e., organisation of labour within the cell) available for future production.	Cell Leader	Daily
	• Authorise the filling of any long-term shortfall in manpower levels required in order to maintain production schedules by requesting additional temporary labour, skills training or other appropriate measure.	Cell Leader	Daily
	• Print the up-to-date short–term manning plan, (overtime plan), after revising with all currently available information. Ensure plan is readily available by placing it in the appropriate document folder. • The Labour Efficiency Key Performance Indicator, (KPI), chart displays a historical view of how well labour is utilised.	Team Leader	Daily

Figure 6: Cost Activities

Figure 7: Safety Activities

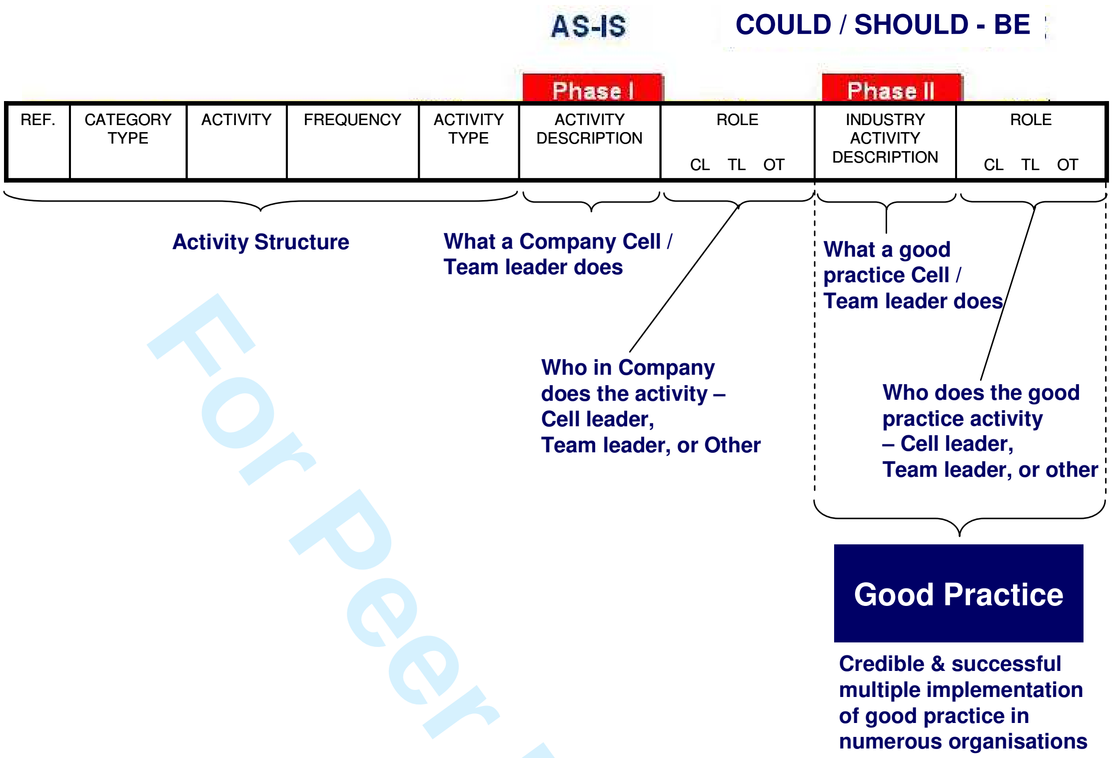
The gathering of data from cell leaders and team leaders was undertaken within the natural setting of their respective cells to ensure a 'real' view of their activities. This aids the quality and richness of the data collected and ensures that it is at an appropriate level of detail. The methods used for gathering data are a hybrid approach of:

- Observation – undertaken during one working day, typically a 10.5 hour shift where the cell leader or team leader is shadowed.
- Semi-structured interviews – an activity template, previously defined, is completed by recording the activities observed during the working day. Whilst observing the cell leader or team leader they are asked about any activities that had not been observed.
- Protocol analysis – whilst observing the cell leader or team leader they are encouraged to 'think aloud' about the activity they are undertaking.

Subsequent to gathering activity data from a cell leader or team leader the completed activity template is validated with the respective cell leader or team leader by reviewing each activity with them. The cell leader or team leader is provided the opportunity to add, remove or amend any activity data. The review process is continued with the cell leader or team leader until an affirmative response is received to the question, 'Is this completed activity template a true and fair reflection of your role?'.

Activity profile data was gathered from a total of four cell leaders and four team leaders at three manufacturing sites of the Company. To ensure rigour of the data collected, triangulation of cells and triangulation of sites is undertaken and a single generic activity profile template is defined for a Company cell leader and team leader. An example generic activity template is illustrated in Table IV.

Table IV: Example Activity Template Structure



Phase II – Could-be

The objective of this phase is to identify and detail good practice activities corresponding to those undertaken by a Company cell leader and team leader. The output of this phase is a generic role profile for a cell leader and team leader within a relevant good practice organisation. The kinds of data gathered are activity profiles for cell leaders and team leaders. The units of analysis identified are the same as those of the as-is phase to enable direct comparison between practices of Company cell / team leader profiles and good practice cell / team leader profiles:

- Activity description – 'what the cell / team leader does'.
- Activity role – 'who does it'.
- Activity frequency – 'how often it gets done'.

The main challenge posed by this phase is identifying a credible source of activity profile data for a cell / team leader within a good operations practice organisation. Key concerns when identifying a credible source for best practice is that the practices are justified as best, are generalisable, practical and can be expressed in detail. A survey identified the Industry Forum (www.industryforum.co.uk) as a source of activity profile data. The Industry Forum is an organisation that is a collaboration between the UK government and the automotive industry. They have been identified as a credible data source because they have undertaken successful multiple implementations of good practice within numerous manufacturing organisations. The Industry Forum has conducted over 200 improvement activities since 1997, (Bateman and David, 2002), and have helped companies consistently achieve excellent outcomes. Generic patterns of sustainable improvement are identified from a knowledge base of numerous companies of varying sizes and technologies, and where appropriate, a practice is detailed with information regarding essential contextual elements, e.g., structure.

Table V: Good Practice Activities Captured within Four Categories

CATEGORY	ACTIVITY DESCRIPTION	ROLE	FREQUENCY
Managing Equipment (Consumables)	• The role equivalent of a cell leader ensures that the local cell area consumables cupboard is stocked sufficiently to meet the requirement of future production schedules.	Cell Leader	Weekly
	• The team leader ensures, on a day-to-day basis, that the operators have all the consumables that they require in order to maintain production.	Team Leader	Daily
	• The chart displaying the quantity used of key consumables is displayed within the cell area. • It is the engineering department's responsibility to ensure that the effectiveness and efficiency of consumables used is improved. This department maintains the overall consumables budget.	Engineering Department	Weekly
Managing Materials (Component Materials)	• The production planner ensures that all component material items are ordered from the supplier to meet future production schedule. A correctly sized kanban system that is aligned to current and future production schedules is utilised.	Planner	Weekly
	• The team leader ensures there is sufficient 'visible' component stock to meet current production schedules. All component materials within the cell are controlled visually with defined locations for each component material and a kanban ticket.	Team Leader	Daily
	• The planner is responsible for ensuring that all component materials are available within the cell at the correct time.	Planner	Weekly
	• All component materials have a defined level of safety stock that is reviewed regularly by the production planner to ensure that it is appropriate to current and forecast production schedules. Each component material has a production trigger point for internally produced components and a maximum point.	Planner	Weekly
Managing Information (Shift Handover)	• A fifteen minute end of shift meeting is held around a Quality-Cost-Delivery board. All the current shift's operators, the team leader of the current shift and the team leader of the next shift attend. Production figures are assessed against the production targets, any issues raised and appropriate actions agreed.	Team Leader	Daily
	• The team leaders of the current shift and following shift sign the board to agree their understanding of what has been discussed.	Team Leader	Daily
Managing Labour (Sickness/Absence/Time)	• Identify operator absence due to sickness or other ad hoc reason, (e.g., unplanned absence notified by telephone call from operator). A swipe card system is used to record attendance and the number of hours worked. Any unplanned absence is noted by the equivalent of the cell leader role.	Cell Leader	Daily
	• A daily report, generated from the swipe card system and supplied by the Human Resources, (HR), department, of the previous day's attendance and hours worked is reviewed by the equivalent of the cell leader role. The daily report is checked for any errors, amended if necessary, authorised and submitted to the HR department for payroll generation. • A monthly report identifying short-term, medium-term and long-term operator absence is supplied by the Human Resources department to the equivalent of the cell leader role for review.	Cell Leader	Daily
	• Any shortfall in production due to absence is filled by using overtime planning. Overtime to produce an agreed number of products in a separate shift is authorised by the production manager. Performance against the agreed targets is reviewed by the production manager after the overtime shift has ended.	Cell Leader	Weekly
	• Each shift has a 'tick sheet' that records particular operations measures including level of absence, level of scrap, etc. The 'tick sheets' are filed and reviewed at KPI meetings by management.	Cell Leader	Daily

The methods used for gathering data are semi-structured interviews with Industry Forum consultants. The consultants have experience of directly implementing good practice. The activity profile template used to gather activity profile data from the Company cell / team leaders is used to gather corresponding activity profile data for cell / team leaders within a good practice organisation. The information collected through the Industry Forum was validated using supporting documentation and by interviewing the Operations Managers within the case study Company. As an example, the good practice information corresponding to four of the activity types is presented in Table V.

Phase III – To-be

The objective of this phase is to identify whether an organisational activity, good practice activity or other activity is best aligned to achieving the organisation's operational aims with respect to its key success factors of delivery, quality, cost and safety. The output of this phase is an agreed generic role profile for a Company good practice cell leader and team leader.

The kinds of data collected are preferences for either the existing practice within Company, operations practice used within the good practice organisation or some other practice. In addition, data regarding the organisational role best placed to undertake an activity and the frequency of activity are collected. The main sources of data are operations and functional managers within the subject organisation, because they are best placed to appreciate the current and future status of operations. The primary method for data collection is a questionnaire survey whose results are validated within a workshop. The units of analysis identified are the same as those of the other two phases to enable direct comparison between practices of Company cell / team leader profiles and good practice cell / team leader profiles:

- Activity description – 'what the cell / team leader does'.
- Activity role – 'who does it'.
- Activity frequency – 'how often it gets done'.

The questionnaire survey is a key input into the diagnostic phase of this study. The questionnaire highlights those areas where there is a difference between Company practice and industry practice. Operations Managers and Functional Managers from around the organisation take part in the survey to help develop a statement of good practice for cell leader and team leader role profiles. For each question the respondent is asked, in their opinion, to select the response that most accurately describes good practice for the Company business.

There is a link between an activity that is undertaken and operations organisational structure. Operations organisational structures of Company and Industry Practice are displayed within the questionnaire and are illustrated in Figure 8.

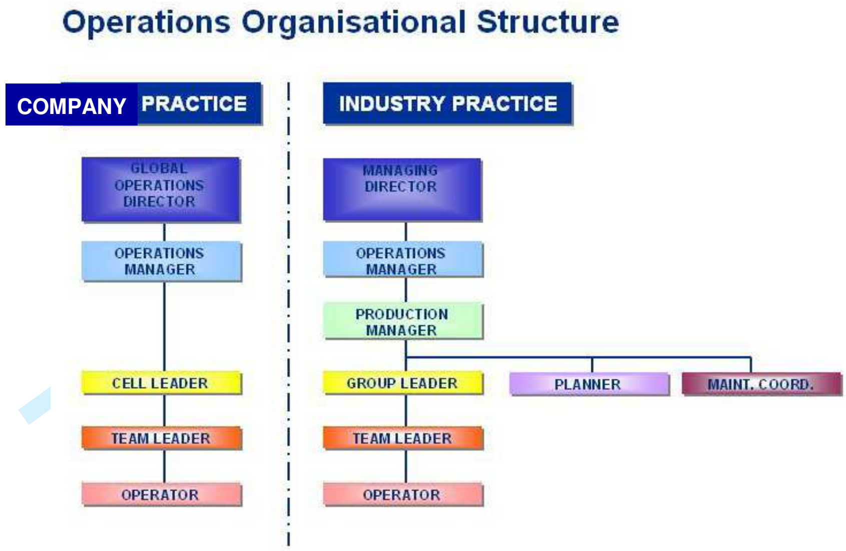


Figure 8: Operations Organisational Structures

Basic information about the respondent is collected: date of questionnaire completion, location of respondent, name of respondent, and title and role of respondent. The questionnaire comprises fifteen questions. Each question relates to an area of operations practice where a difference has been identified between Company practice and Industry Practice (Figure 9).

- Fifteen Areas of Difference Between Company Practice and Industry Good Practice:
  - Managing Labour: Holidays
  - Managing Labour: Sickness / Absence / Time
  - Managing Labour: Skills
  - Managing Labour: Labour Constraints
  - Managing Equipment: Machine Maintenance
  - Managing Equipment: Consumables
  - Managing Materials: Component Materials
  - Managing Materials: Transportation
  - Managing Materials: Component Rejects
  - Production Priorities: Build Shortages
  - Production Priorities: Production Management
  - Production Priorities: Rework
  - Production Priorities: Permits
  - Managing Information: Walkround
  - Managing Information: Shift Handovers

Figure 9: Areas of Difference between Company Practice and Industry Good Practice

First, the respondent is asked to read a description of Company operations practice and a description of Industry operations practice. The respondent is then asked to answer Part (a) and Part (b) of each question. Part (a) asks the respondent to select between each of the two operations practice descriptions that they have just read. The selection is made using a scale of five options listed below:

- Strongly prefer Company practice.
- Prefer Company practice.
- Prefer other practice.
- Prefer industry practice.
- Strongly prefer industry practice.

Part (b) asks the respondent to select how often a sub-activity of the selected operations practice description should be undertaken and who should be primarily responsible for that sub-activity. In addition, an area is provided for any comments that the respondent may wish to make.

Following is a description of the results obtained from a survey of Company operational and functional managers to identify whether Company operations practice, good operations practice or some other practice is best aligned to serving Company operations in terms of its key success factors. In consultation with top-level management within the Company, nine operational and functional managers at the Company were identified with *key* responsibilities within operations management. These managers were identified to receive and complete the questionnaire survey. It is important to note that it is the *'type'* of manager selected to complete the questionnaire that is important, rather than the total number of managers. *'Type'* refers to the nature of their responsibilities and the decision-making power that they possess within the organisation. For example, additional managers could be selected to complete the questionnaire, which would increase the sample size but the 'value' of response may not add to the credibility of results. Indeed, selecting a large, but inappropriate sample size may devalue the results.

Table VI summarises the variance of responses to each of the fifteen areas of operations practice addressed within the questionnaire.

Table VI: Variance of Practice Preference

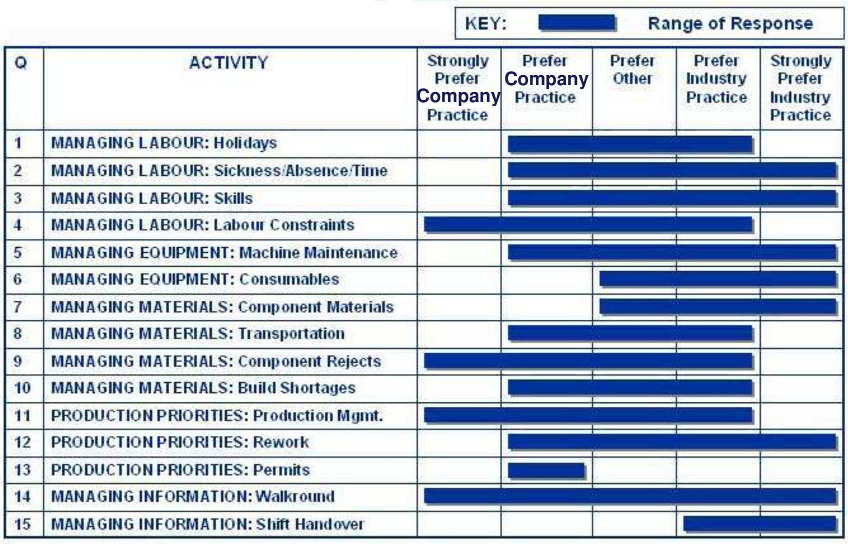


Table VII summarises the number of responses preferring a particular practice covering all the fifteen areas of operations practice addressed within the questionnaire.

Table VII: Summary of Practice Preference

PRACTICE PREFERENCE	NUMBER OF QUESTION RESPONSES
Strongly Prefer Company Practice	5
Prefer Company Practice	24
Prefer Other	11
Prefer Industry Practice	22
Strongly Prefer Industry Practice	11

The results are analysed in terms of variance, and preference for type of practice, i.e., Company practice or other practice. Using Table VI, practice areas can be identified that the Company should:

- Continue doing as they are.
- Change the way they are doing.
- Perhaps, change the way they are doing.

In addition, for each of the first two categories, it can be determined whether there is universal agreement amongst respondents or majority agreement. By definition, the third category has equally split agreement/disagreement as to whether the Company should continue with existing practices or not.

There is universal agreement that the Company should *continue* doing as they are the following practice:

- Production Priorities – Permits

There is majority agreement that the Company should *continue* doing as they are the following practices:

- Managing Materials – Transportation.
- Managing Materials – Component Rejects.
- Managing Materials – Rework.
- Managing Information – Walkround.

There is universal agreement that the Company should *change* doing the following practices:

- Managing Equipment – Consumables.
- Managing Materials – Component Materials.
- Managing Information – Shift Handover.

There is majority agreement that the Company should *change* doing the following practices:

- Managing Labour – Holidays.
- Managing Labour – Sickness / Absence / Time.
- Managing Labour – Skills.
- Managing Labour – Labour Constraints.
- Managing Equipment – Machine Maintenance.
- Managing Materials – Build Shortages.

- Production Priorities – Production Management.

Results display that survey respondents are seeking to change *two-thirds* and retain *one-third* of the practices that have been addressed within the questionnaire. The as-is and good practice activities, corresponding to the categories that exhibit universal agreement for change, are presented in Table III and Table V respectively. These tables also include an extra category (managing labour – sickness/absence/time) that exhibits a majority agreement for change.

It is interesting to note that much of the practice areas that survey respondents are seeking to change, directly relate to delivery performance and, in particular, schedule adherence, i.e., managing production – (production management, build shortages), managing labour capacity, managing machine capacity – machine maintenance. Previous work undertaken by the authors has identified that schedule adherence is an area where the Company is striving to improve (Pierron *et al.*, 2004). Also, much of the practice areas that survey respondents are seeking to continue with, directly relate to quality and, in particular, in-house rectification and scrap, i.e., managing materials – (rework, component rejects), production priorities – permits. Previous work has identified that the Company has an excellent record in in-house rectification and scrap performance (Pierron *et al.*, 2004). In this way, results identified within this study are supported by those from previous work undertaken by the authors (Pierron *et al.*, 2004).

The validation of results was carried out in a workshop setting involving ten key operational and functional managers at the Company. These managers hold key responsibilities within Operations Management in the Company, and were selected in consultation with top-level management. This workshop provided a forum for making participative decisions on areas of differences. The output of the workshop was an agreed role profile for a Company cell leader and team leader.

5 Discussion

Supervisors occupy a key role in exploiting cell-centric technology and the correct specification of their roles is critical to the effectiveness of a cell, factory and, ultimately, the enterprise. Due to this, it is insufficient to consider supervisory practice solely as technical activities confined to the context of the cell. On the contrary, practices must be viewed within the wider context and used as a vehicle for expressing and implementing strategy (Ketokivi and Schroeder, 2004), (Beaumont, 2005), (Voss, 2005).

The process presented within this study recognises and addresses the multiple and complex factors that must be considered when specifying and implementing best operations practice supervisor roles. In particular, our process emphasises the need to consider holistically the complete portfolio of practices for a particular role, the sourcing and selection of best practice, and the contextual nature of practices, (Davies and Kochhar, 2002). In addition, our process acknowledges the dynamic nature of decision-making when adopting and introducing best practice, an aspect which is not reflected in existing sequential frameworks.

The As-is phase builds a complete portfolio of existing practices for a cell leader and team leader using multiple sources within a real world setting from the case study organisation. Although the focus of this phase is on operational practice, (Beaumont, 2005), it is influenced by the context of the organisation defined by its key success factors and organisational capabilities. The capture of cell leader and team leader activities as they occur and their documentation against key success factors provides a valuable and real view of the existing capabilities of the organisation and their contribution to the success of existing manufacturing operations. The treatment of practices as a complete portfolio addresses a limitation of existing studies which, without justification, are selective in the practices they choose to address (Laugan *et al.*, 2005).

The Could-be phase identifies the set of operations activities undertaken by a cell leader and team leader within a relevant good operations practice organisation. Our process addresses two key limitations of existing studies, justification of practices as 'best' and their generalisation, (Laugan *et al.*, 2005).

The use of literature as a source of best practice was specifically discounted due to the significant limitations identified by several authors, e.g., (Fitz-enz, 1997) (Forza, 2002), (Voss *et al.*, 2002), (Beaumont, 2005) and (Laugan *et al.*, 2005). We aimed to identify best practice that was displayed to be best from detailed real world practical experience, identifying The Industry Forum as a source because they have conducted over 200 improvement activities since 1997, (Bateman and David, 2002), and have helped companies consistently achieve excellent outcomes. The identification of The Industry Forum as a source of best practice was undertaken after and independently of the As-is phase within the Company. Best practice is context specific and it is important to either identify generic patterns of sustainable improvement or qualify the practice with detailed information regarding essential contextual elements, e.g., structure, which the Industry Forum knowledge base of numerous companies of varying sizes and technologies enabled us to achieve.

The 'comparison and selection' phase is key to achieving the To-be state of good operations activities that are appropriate to the context of the organisation. It is the process for identifying those best practice operations activities undertaken by a cell leader and team leader that are 'appropriate' to be adopted by an organisation.

Comparison and selection of practices was undertaken within a workshop setting involving personnel at a level in the Company who had full understanding of the organisation's context, i.e., operational, internal and external (Beaumont, 2005), and had the necessary power to make decisions. Personnel at this level in the Company included the operations director, operations managers and functional managers who had detailed knowledge of the operational, internal and external perspectives.

The workshop provided validation of the results of the questionnaire during the participative decision-making process. Acknowledgement of the importance of both the human and technical roles played by cell leaders and team leaders within cell-centric operations was constant amongst both managers and operators within the Company and is consistent with the observations of (Chakravorty and Hales, 2004).

Discussions displayed the complexity of the decisions and the overlapping aspects that needed consideration to ensure alignment of the proposed best practices with the Company's manufacturing strategy. It was evident that managers were drawing on their considerable experience, including tacit and explicit knowledge of both enterprise operations and strategy to agree best practice cell leader and team leader profiles appropriate to the Company. The importance of practical and detailed contextual descriptions of best practice was displayed to be especially important within this phase. Without the necessary level of detail, managers within the workshop may have found it difficult to ascertain the 'appropriateness' of the practice to the organisation. 'Appropriateness' includes, but is not limited to, ascertaining the degree of contextual 'fit'. If there is a close 'fit', managers may decide to adopt the practice, if not, managers may decide to either reject the practice or decide to influence changes to the Company's context to accommodate the best practice. This participative decision making process ensured that there was alignment of views held by senior management, operational management and functional management. In addition, the participative approach meant that it is less likely for an organisation's management to misunderstand good operations practice.

The process presented within this study recognises that successful operations of cell-centric technology are based on complex multiple decisions that involve various personnel. Demonstration of the process in the Company displayed that attaining good practices that successfully lead to improved performance is not sequential, step-wise and mechanistic, but dynamic and highly-participative with continuous feedback and validation amongst personnel.

Accounts of best practice are widely available and imitable and a key question is whether best practices in themselves provide competitive advantage. Demonstration of the proposed process in the Company has illustrated that the key capability for attaining competitive advantage is associated with its adoption and alignment to the enterprise using the knowledge and experience of its personnel.

6 Future Research Directions

It is proposed that future work focus on areas that warrant further investigation:

- The identification of a process that links a particular good operations practice to the performance of an individual organisation. Much work already exists on 'Best Practice' and 'generic' performance.
- For an organisation to remain competitive practices must be continually reviewed and practice knowledge updated. The mechanism should be improved to ensure that the process for adopting good operations practices is continual.
- Operations and functional managers are people with considerable demands on their time. The use of a questionnaire may not be the most effective mechanism to get the correct input from the correct people – alternative approaches should be explored (Sackett *et al.*, 2006).
- An exploration of why managers judge specific best practices as appropriate to corresponding activities within their own organisations.

7 Conclusions

The persons that manage and direct those operations within the manufacturing cell, the cell leaders and team leaders, have the greatest potential for raising operations performance. However, there has been little focus within literature on techniques to realise effective role profiles within cell-centric manufacturing.

The selection and implementation of good operations practice cannot be undertaken in isolation, it must consider the enterprise context. Some aspects to be considered are the operations key success factors, operations capabilities, and degree of participative decision-making amongst the key operations management. Effective practice role profiles are those that are specific to an organisation's context.

A robust contextual process, based on established gap analysis approach, can support the realisation of good operations practice supervisor role profiles for a complex cell-centric manufacturing environment. The process described in this paper provides:

- Alignment of operations and functions – our contextual process defines operational and functional alignment of cell leader and team leader good operations practice.
- Improved proficiency – by specification of good operations practice that is correct for the context of the organisation enables cell leaders and team leaders to be proficient within their roles.
- Increased management effectiveness – by providing a platform for the attainment of participative decision-making and agreement amongst operational and functional management aids the establishment of a shared vision and decreases wasted effort due to mis-communication.

The process has been illustrated in a world class manufacturing context. The potentially significant impacts available across cell-centric manufacturing are illustrated by the finding that following this examination of operations practice in the case study company two-thirds were classified as requiring change.

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