Cellular Manufacturing Implementation: An Exploration of the Implementation Benefits

Mugwindiri K[1], Chinguwa S[2], Chikuku T[3]

[1]Department of Mechanical Engineering, University of Zimbabwe
PO Box MP 167, Mount Pleasant, Harare, Zimbabwe
kmugwindiri@eng.uz.ac.zw

[2]Department of Mechanical Engineering, University of Zimbabwe
PO Box MP 167, Mount Pleasant, Harare, Zimbabwe
chinguwa@gmail.com

[3]Department of Mechanical Engineering, University of Zimbabwe
PO Box MP 167, Mount Pleasant, Harare, Zimbabwe
tchikuku@eng.uz.ac.zw

Abstract: ***This paper proffers a possible avenue of implementing Cellular Manufacturing (CM) and the possible benefits that can accrue from the same implementation. It uses the results of a study using questionnaires undertaken in the UK furniture industry in 1994 and also knowledge that has been acquired since then. From the companies that were studied and using the findings on CM in the furniture industry in particular, general solutions proposed by the industry to the problems encountered within CM are given. The paper further proposes specific recommendations on key areas that concern CM, taking into account, lessons learned from the companies using CM, knowledge gained from similar studies mainly in the engineering industry and knowledge gained from available literature on Group Technology.***

Keywords: cellular manufacturing, group technology, batch manufacturing, automation

1. Introduction

It has always been a hurdle or hassle for companies to decide whether or not to implement Cellular Manufacturing (CM). Cellular Manufacturing (CM) is a manufacturing philosophy that seeks to improve productivity by grouping parts and products with similar characteristics into families and forming production cells with a group of dissimilar machines and processes. Frederick Taylor introduced Cellular Manufacturing in 1919 as a way to improve productivity. It is viewed as:

- An essential step in the move towards factory automation.
- A necessary step in maintaining a high quality level and profitable production.

Figure 1 below, is a flowchart diagram summarizing steps that can be used in the implementation of Cellular Manufacturing within batch manufacturing

2. Methodology

Steps for implementing CM are shown in Figure 1.

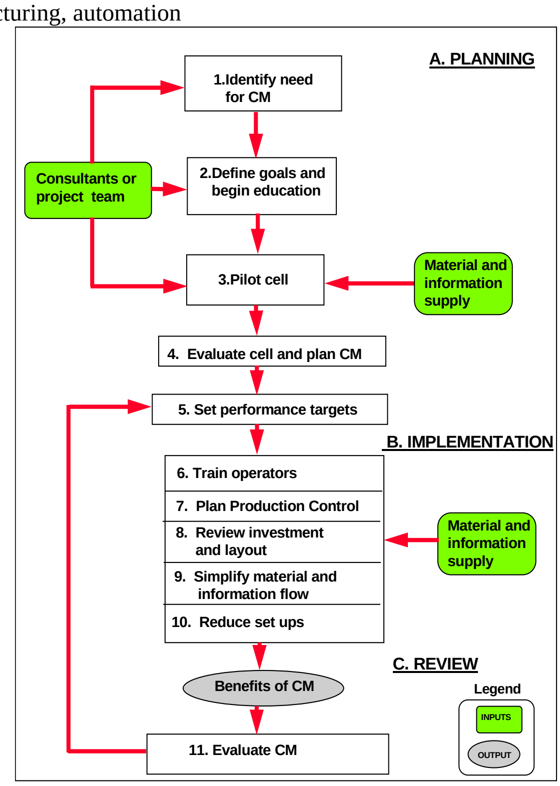

Figure 1: Flowchart for implementing CM

CM's success depends on the commitment of all employees, but its success on the shop floor depends more on the operators than anyone else. Although education in CM should be emphasized at the shop floor level, it is necessary that all employees in the organization are aware of CM and educated as to its benefits and how it operates. Whilst cells can pull products out of the factory, distribution should also deliver products to customers equally quickly. These internal partnerships also extend to maintenance, sales and production control departments, which can easily compromise the benefits of CM, such as increased parts flow, by not working to the same pace as the cells or through inadequate workmanship. For CM to be successful it is crucial to educate employees on its benefits and ways to achieve this include:

- Videos on Cellular Manufacturing: one company visited used a video of the Toyota Motor Company showing how they introduced CM, and the benefits of the programme.
- Reading articles: it is important to invest money into writing and buying articles on CM.
- Recruiting personnel from other companies with experience of CM, using outside consultants or sending operators to companies using CM.

2.1 Pilot scheme

Implementation of a pilot scheme varies from one company to another. Differences arise on whether CM should be tested in the high or low volume section of the factory or in the low or high value product section. The advantages of testing in a section making inexpensive products is that the financial effects are not great if the programme is not implemented well, bearing in mind that the pilot cell is a trial of CM in that company. Within the pilot cell, supplier partnerships and rationalisation should be investigated. The pilot cell should then be evaluated with a view to implementing CM in the rest of the factory. Although the period of implementation of the pilot cell would vary from one operation to another, it should not be too long, taking into consideration industry's emphasis in one year pay-back periods.

3. Implementation

The implementation period for the full CM programme also varies from one company to another. From this study, companies started to reap benefits within three years of implementing CM, such as shorter lead times and improvements in supplier relationships. The period of full implementation ranged from one year to three years. This study recommended a period of two years for the furniture industry taking into account the nature of its operations and returns expected from investment, which traditionally has long pay-back periods (1.5 years in this study). Traditionally, pay-back periods have been one to one and a half years (Ingersoll Engineers, 1993). This, however, is not adequate to reap the full benefits of CM as most of the financial gains of CM accrue towards the end of the implementation period (Ingersoll Engineers, 1993). Two years seems a reasonable period to wait for returns, taking into account that this study reported improvements such as:

- Reduction in set-up times of up to 97%
- A stock turnover of 8
- An increase in manufacturing lead time of 50%.

CM can also be introduced as part of a Group Technology (GT)/Just in Time (JIT) programme or even as a Total Quality Management (TQM) programme. Within CM, throughput times and delivery lead times are reduced, which is the basis of JIT. Service and product quality also improve with dedicated product manufacture, which is the basis of a TQM programme.

Layout changes can improve space utilization if properly designed. Companies should carefully consider what the layout within CM should be. This should take into account existing equipment, new machinery, stores, operator positioning and administrative areas. All jigging, handling equipment and tooling should be situated at the point of use where practicable, to reduce handling and work-flow distances moved. The space that is freed by CM as a result of an efficient rearrangement of equipment and machinery can be used to diversify into other products or growth.

4. Work in Progress reduction

A reduction in WIP is important in that it helps to reduce stocks, which increases a company's stock turnover and at the same time achieves the business objective of reducing financial gearing.

The following are methods that can be used to reduce WIP:

- In batch manufacturing, companies should reduce batch sizes and increase manufacturing or cycle frequencies.
- In both batch and line manufacturing, companies should form cells to reduce WIP levels - traditionally associated with end-of-machine operations in functional layouts.

5. Performance targets

With an increase in demand and competitiveness, there is pressure on companies to continuously review targets. Performance targets should be defined and quantifiable and can include:

- Increasing stock turnover.
- Reducing manufacturing lead time. This can be achieved by reducing batch sizes and subsequently increasing delivery frequency to customers on a JIT basis.
- Reducing set-up times.

Specific figures will vary from one company to another.

Companies should set performance targets against averages for other industries, such as the engineering industry which has a higher usage of CM (71% in the 1993 Ingersoll Engineers survey). International standards such as those set by Japanese motor companies, notably Toyota, which uses CM extensively, (Schonberger, 1986) can also be used as a basis of comparison. It is important however that:

- Financial performance measures take into account the non-linearity of returns in a CM programme.
- Operational performance measures should satisfy the soft aspects of HRM, namely operator autonomy, empowerment and team working, without which the harder performance indicators such as reduction in lead time and cycle times are difficult to achieve. An example of this symbiotic partnership would be in achieving customer satisfaction through improved

product quality. With empowerment, operators can be responsible for the quality of the products they make, resulting in job satisfaction and ownership.

5.1 Production Planning and Control

For Production Planning and Control, companies should simplify processes by combining high level planning techniques such as MRP or MRPII with simpler production planning techniques such as Kanban or PBC. At this low level materials are usually delivered by suppliers to the cells either on a JIT delivery basis as in Kanban control, or on a standard call-off period as in Period Batch Control. Companies could:

- Make to order, which can be considered as the so called stock-less production system of JIT.
- Where make to stock is unavoidable, stocks should be kept to the bare minimum that corresponds to manufacturing lead times, unless external factors such as seasonal demand dictate otherwise.
- Create a route sheet for each part if using PBC or a Kanban card if using Kanban Control, each showing detailed operations and specifications such as BS 5750/ISO 9000.

Production Planning and Control is important in any manufacturing system; and because of this, it is necessary that it is simple and well understood by the users. The objectives of this simplification, especially on the shop floor, are:

- To remove the random and seasonal variations in the receipt of sales orders and to produce a production programme which gives a reasonably even load on production capacity.
- To ensure that assembly achieves the plan given in the production programme, and that the parts required for the assembly are available.
- To ensure that materials are received from suppliers before the times they are needed for processing (Burbidge, 1979).

5.2 Supplier relationships

When companies start rationalizing suppliers, the choice of supplier is critical, as materials are not ideally counted or inspected on delivery in an efficient supply chain partnership. This reduces the need for paperwork and expediting. With supplier relationships, companies should:

- Reduce the existing supplier base to a few major suppliers for any given product.
- Consider the proximity of suppliers to the company if quality is guaranteed.
- Start supply partnerships to share pipeline information on orders, deliveries, quality specifications and any WIP if it is present.
- It is also important that concurrent engineering is established within company departments so that information to and from suppliers and customers is shared between departments (internal supply partnerships).

5.3 Result Set-up time reduction

There are various ways of achieving set-up time reductions, the important points that should be considered in a CM programme are:

- Set-up time reductions during the design of CM.
- Identifying critical pieces of equipment where set-ups can be reduced.
- Implementing set-up time reduction methods. This can be achieved through jig and tool rationalisation, bringing jigs and tools to their point of use; automation through CNC machines and robot welding centres; sequencing, product rationalisation, and operators checking their own set-ups. This assumes a higher degree of operator competence, which is possible with multi-skilling.
- Continuously reviewing set-up time reductions, with changes in operations and technology as appropriate.

5.4 Results of Operators

Since operators are crucial to the success of a CM programme, companies should consider the following issues:

- Incentives for multi-skilling, although achieving various skills is, itself, an incentive.
- Have regular team briefings by team leaders with both top-down and bottom-up information and feedback.
- The design, implementation and posting of a skills matrix where it is visible to all operators in the cell. The skills matrix should be periodically reviewed.
- Create an environment where operators are free to discuss operations and targets with managers.
- Managers should walk the shop floor, listen to operators ideas and advise on operations and targets, as well as personal issues.
- The team leader should have autonomy to prioritise jobs from production control, for the day.
- Teams should not be too large or too small to achieve operations meaningfully. This survey reported an average of six although this would vary from one company to another.

6. Results of survey

This section discusses results from the questionnaire survey on cell characteristics, production planning and control techniques and investment into CM and the reasons for introducing Cellular Manufacturing. The performance of cells in the companies completed the questionnaire is also discussed including critical success factors in cells
Incentive schemes considered within CM include: skill attainment, departmental, cell and individual bonuses. The changes within CM in the numbers of direct, indirect, support and supervision employees, and effects on company performance are also discussed.

6.1 Results Number of years using Cellular Manufacturing

Findings from the postal questionnaire indicate a wide difference in the number of years companies have been using Cellular Manufacturing. The length of time varies from ten months for a company making hospital beds and trolleys to twenty years for a company making upholstered furniture.

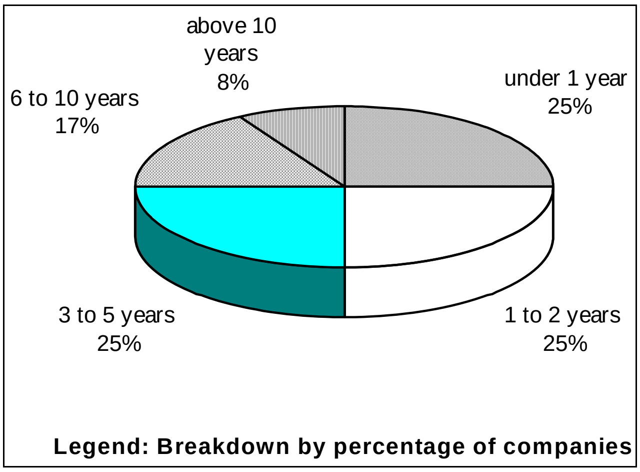

Figure 6.1: Number of years using CM

The average number of years the respondents have been using CM is 5.3 years. 75% of the companies that have been using CM for five or fewer years have an average of 3.1 years experience of CM amongst them.

6.2 Results Number of cells

The average number of cells in the factories surveyed is seven with a standard deviation of three. This means that the actual number of cells in a typical company could vary between four and ten. The number of cells in a company varies with company operations. One company making a single product type had two cells only; machining and sub-assembly.

6.3 Results Number of machines in cells

The average number of machines in a cell is 6.6 ranging from zero for assembly cells to ten for machining cells. A survey by Metsios, (1982), into Group Technology in the engineering component industry reported an average of 15.4 machines in a cell. Assembly cells have few or no machines at all, whereas machining cells can have many machines

6.4 Results Number of operators in cells

The number of operators in a cell varied from a minimum of one in an assembly cell (Company F) to twenty in a company making vehicle seats (Company I) which is labor intensive. 55% of the companies had over ten operators in more than one cell, and 73% of the respondents had less than five operators in more than one cell. These figures were obtained from analyzing data on the maximum and minimum number of operators in a cell respectively. When asked for the average number of operators in a cell, responses varied from two to twelve, with an average of 6.1 operators

6.5 Results Machine to operator ratio

The machine to operator ratio in this survey calculated to 1.08. A survey of 145 cells in twenty companies by Metsios, (1982) reported an average of 11.8 operators in cells. In the same survey, Metsios reported a machine to operator ratio of 1.3. Pullen, (1976) in a survey of 99 cells in 14 companies also reported a machine to operator ratio of 1.3 with an average of 10.7 operators in cells.

It is interesting to note that the machine to operator ratio of 1.08 is less than the 1.3 quoted by Metsios, (1982) and Pullen, (1976) for the engineering industry.

6.6 Results of Level of automation in cells

From the 11 companies analyzed, six or 55% are either using Numerically Controlled, NC or Computer Numerically Controlled, CNC machines. This level of CNC usage is a significant move within cells towards automation and its associated benefits of lower operational times and accuracy, compared to traditional methods of machining using turret lathes, milling machines and drilling machines. This finding on CNC usage within the cells supports the statement that CM is the basis of Flexible Manufacturing Systems (Offodile, 1992), with its associated benefits of rapid response to product and order changes.

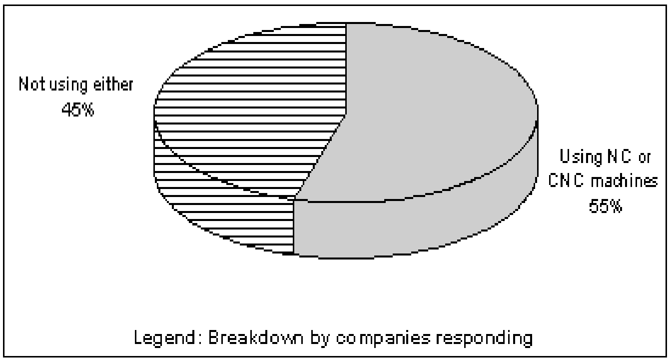

Figure 6.2: Usage of NC and CNC machines in cells

6.7 Extent of CM usage

This survey found out that there were no companies that had used and abandoned CM. This compares well with the success rate of CM in the engineering industry, where only one out of 51 companies responding had abandoned CM (Ingersoll Engineers, 1993). CM has worked well for those companies using it with total commitment to the program also weighing heavily towards this success. Having realized the benefits of CM, companies expressed a desire to expand cells and to form new ones.

The survey targeted 96 companies. Out of 30 replies received, 14 or 15% of the total sample size reported using CM, of which eleven completed the questionnaire. Three had just implemented CM and were not in a position to complete the questionnaire in a meaningful way. Of the remaining 66 companies, the author succeeded in contacting 32 by phone concentrating on the large companies that did not respond. Figure 6.3 shows the breakdown of the sample used.

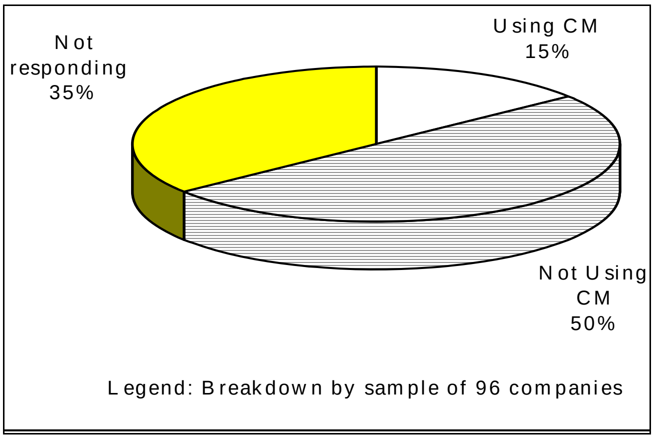

Figure 6.3: Extent of CM usage

The low percentage usage of CM is not surprising, as 82% of the companies responding have only been using CM for less than five years. The 1990 Ingersoll Engineers survey reported a 51% usage of CM in the engineering industry. A follow up survey in 1993 reported a 71% usage of CM, showing an increase in CM users in the engineering industry. The low usage of CM in the furniture industry is attributed to such factors as lack of appreciation of the benefits of CM and a belief that CM is not suitable for high volume manufacturing.

6.8 Investment

From the postal survey, 6 or 55% of companies using CM invested into implementing CM and the remaining five or 45% did not. Of the five not investing in CM, one moved to a Greenfield site and started off with a cellular layout. The other just revised their shop floor layout.

Figure 6.4 shows the breakdown of investment when implementing CM. Other costs which are common to all segments are not shown. These are investment into training, production loss during implementation and consultancy fees.

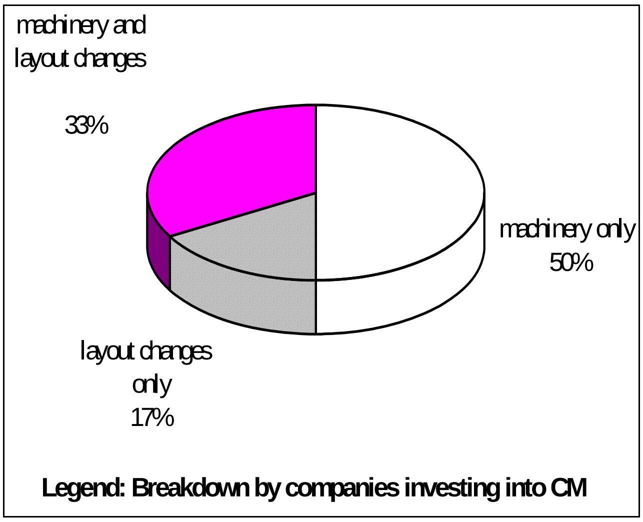

Figure 6.4: Investment into Cellular Manufacturing

Investment in extra machinery was necessary to meet the demands of CM re organization, including the need to increase cell efficiency and throughput by automation. Burbidge is of the opinion that it is not necessary to buy new machines when introducing CM (Burbidge, 1979 and 1994). This investment was primarily purchasing CNC routers. These have reduced the number of machines in the cells as most operations of drilling, routing, shaping and planning can be done on the CNC machines. The companies shown as having changed the layout only introduced CM by just redesigning the shop floor layout only, which agrees Burbidge's statement.

Of the six companies reporting investment to implement CM, the average total investment is £150 000, (1993 rates). The average annual turnover of these companies is £25 million per annum, (1993 rates). The investment to implement CM represents 0.6% of total annual turnover on average. The highest investment by any one company was £320 000 in purchasing CNC routers for use in cells. This was 0.02% of the annual turnover. It can thus be concluded that CM can be introduced with very little or no investment, but by just redesigning the shop floor layout.

6.9 Production planning and control method

The most predominantly used method of production planning and control in cells in the companies responding is Material Requirements Planning (MRP), as shown below in Figure 5.5. 54% of the companies completing the questionnaire were using MRP for production planning and control, 45% were using Kanban control in a Just In Time environment, and 27% were using Period Batch control. There is no unique production planning and control system in any given furniture sector. Thus, whilst one company making bedroom and living room furniture makes use of PBC, another in a completely different furniture sector making hospital beds and trolleys also uses PBC.

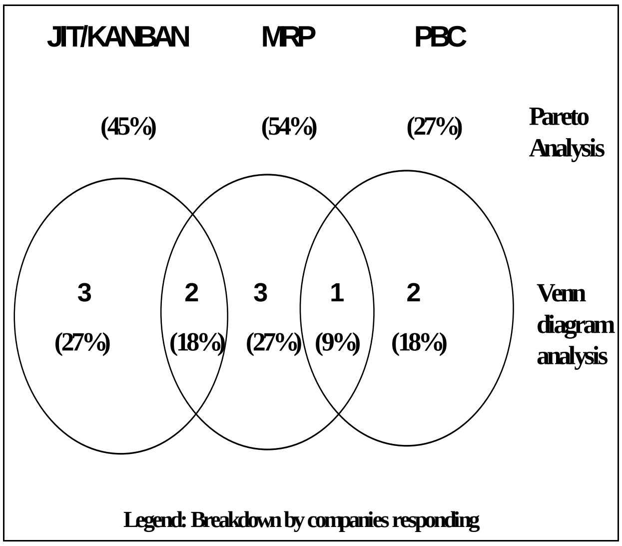

Figure 6.5: Method of Production Planning and Control

Two companies or 18% of the respondents are using both MRP and JIT/Kanban control, and one is using both MRP and PBC for production planning and control.

Of the companies responding, nine or 82% are using computers for production planning and control in cells, broken down as five for MRP, two for period batch control and two for JIT/Kanban control. This result would seem to indicate that computers are necessary for production planning and control irrespective of the system used.

6.10 Parts manufactured in cells

Figure 6.6 below shows the percentage of parts manufactured in cells. This is also an indication of the level of cellularisation. Although two companies reported 75% as the percentage of parts manufactured in cells, the average is 23.5% for all the respondents.

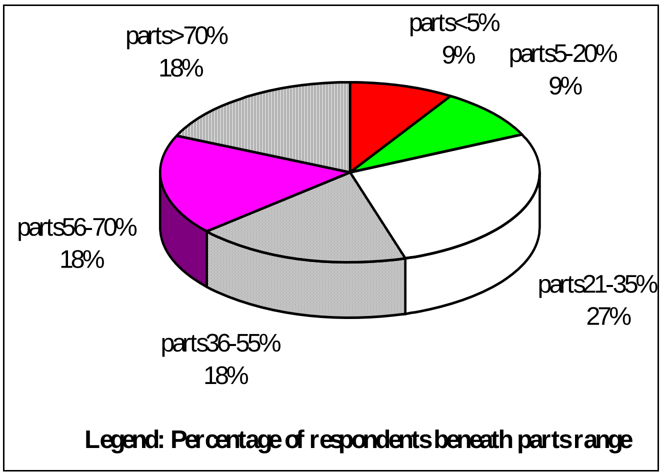

Figure 6.6: Proportion of parts manufactured in cells

The percentages with text indicate the range or proportion of parts manufactured in cells and the percentage figure at the bottom is that of companies responding for that particular range. This finding confirms the notion that CM is still in its infancy in the furniture industry. The remainders of the parts are still being manufactured in a functional layout. This is not an indication that CM cannot be used in the other areas, but of the experience with CM. Visits to companies showed a desire to complete the cellularization of the whole factory.

6.11 Result stocking policy

Figure 6.7 shows that 62% of the companies make parts or products to order, whilst 25% make to stock and 13% make to sub-assembly. Companies generally realize that stocks are expensive to run or keep, and hence the companies are manufacturing to order.

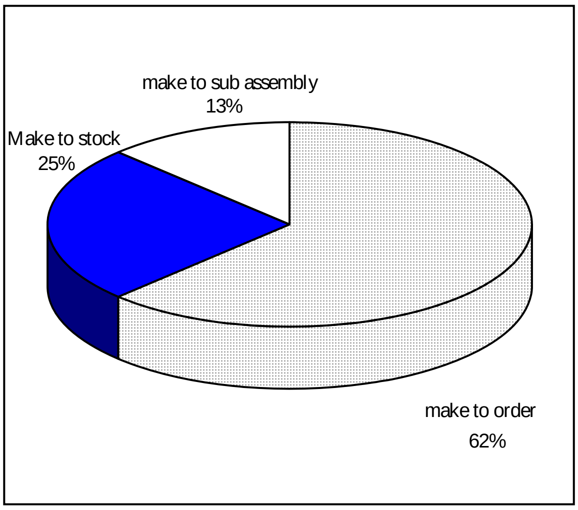

Figure 6.7: Stocking policy

The fact that companies are increasingly manufacturing parts to specific orders is in line with a shift to a pull production system that responds to demand as opposed to traditional manufacturing which emphasizes stocking to meet fluctuations in demand. Within CM, flexibility to demand is achieved through short throughput times, multi-skilling and automation for example use of CNC machines. When these are in place, it is relatively easy to manufacture to order as demand changes can be met easily.

6.12 Discussions Reasons for introducing CM

All the respondents implemented CM for more than one reason. The most important ones were to improve material flow and the quality of product and service as shown below in Figure 5.8.

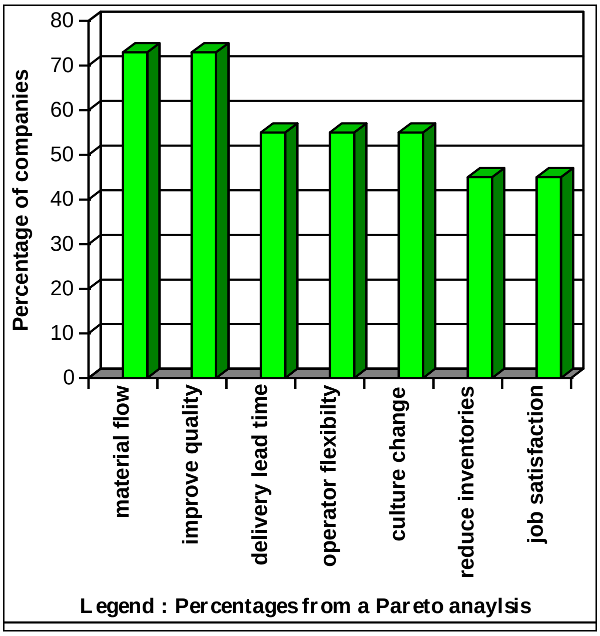

Figure 6.8.: Reasons for introducing Cellular Manufacturing

CM has the advantage that throughput times are reduced by faster material flow because machines are close together and there is little material handling.

With increasing emphasis on product and service quality by customers, companies can ill afford poor quality. It is against this background that CM offers a real manufacturing alternative for producing quality products reliably. This fact is substantiated by an emphasis on quality as a driving force to introduce CM in this survey.

Operator flexibility and delivery lead time were also considered to be important reasons for introducing CM. Delivery lead time should be the barest minimum whilst ensuring quality. Parts flow faster in a cell layout than in functional layouts (Ingersoll Engineers, 1990). It is thus not surprising that the postal survey revealed that reduction of delivery lead times was one of the major reasons for introducing CM.

Indeed, CM is more than a technological change in manufacturing; it is also a radical change in organizational philosophy (Burbidge, 1979) that offers competitive advantages in company performance and employee development. Hence the finding that 55% of the companies responding to the postal questionnaire introduced CM as a culture change among other reasons, such as improvement in product quality and delivery lead time, is not surprising.

Although job satisfaction and reduction of inventories were the least important reasons for introducing CM among the companies surveyed, these are some of the major benefits accruing from a successful CM program. Not surprisingly, most companies reported significant benefits in the job satisfaction and inventory reductions

6.13 Cell performance

The most important success factors in cells came out as operator flexibility, training and team working: the "soft" issues of manufacturing.

Results for operator flexibility

Operator flexibility is primarily the ability to carry out various operations within a cell, from using several machines to doing productive maintenance. This was substantiated during the industrial visits, in which multi-skilling was emphasized as an important factor for successful cells.

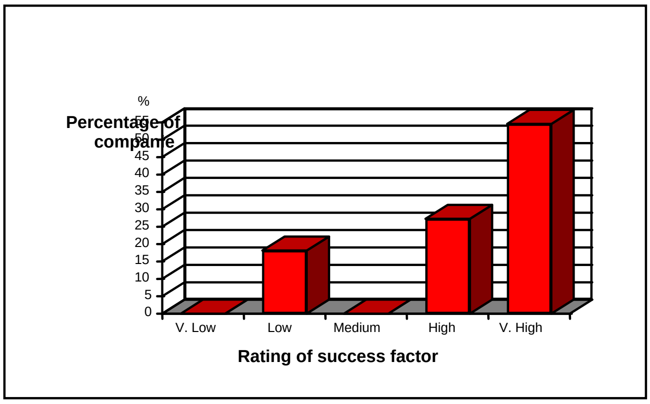

Figure 6.9: Effect of operator flexibility on cell performance

55% of the companies responding rated operator flexibility as having a very high effect on the performance of a cell. This is expected with more emphasis being placed on multi-skilling and the softer aspects of manufacturing before substantive benefits in the "harder" aspects of lead time reduction and increased throughput can be realized. Section details methods that were used to acquire operator flexibility, such as multi-skilling and training.

6.14 Results for training

Before operator autonomy can be achieved within teams, training of operators in operational and indeed human skills is necessary. It can consist of training in the skills necessary for doing the job on the shop floor to training in communication and finances. This survey determined that companies had realized that training of operators was a source of competitive advantage in meeting lead times, and working with suppliers and customers.

77% of the mail questionnaire respondents rate training of operators as an important success factor for the performance of a cell. Of these, 42% think training is a very high success factor and the other 35% only consider it as high.

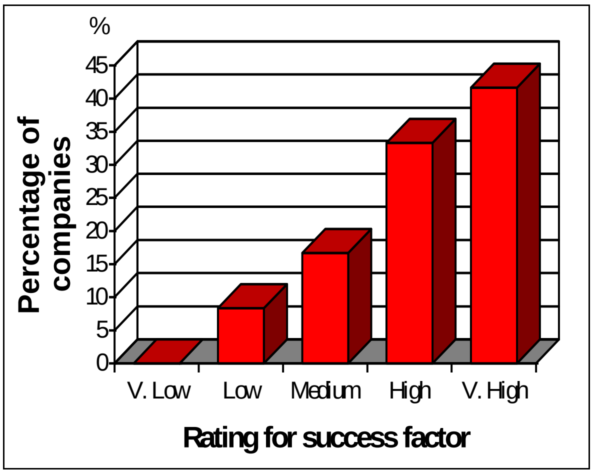

Figure 6.10: Effect of training on cell performance

6.15 Results for team working

Team working came out strongly as one of the most important success factors, with more 70% of the respondents rating team working as a very high factor in successful cells. This is not surprising as CM brings both operators and machines into one area which operators can identify with. Figure 5.11 below shows the effect of team working on cell performance.

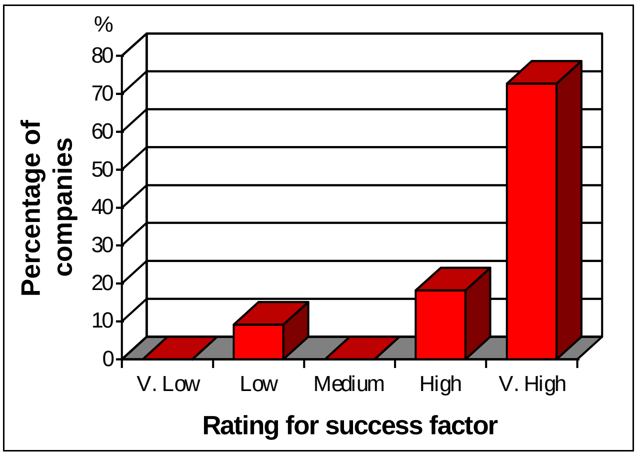

Figure 6.11: Effect of team working on cell performance

The team spirit is fostered as the cell is accountable for its own quality targets, machines and operations. This finding on team working agrees with the results on operator autonomy discussed below. Section 6 reports findings on team working in companies visited.

6.16 Results for operator autonomy

As a team, members are accountable for their decisions within cells. This has the advantage that operators' job satisfaction improves with the benefit of continuous improvement being achieved.

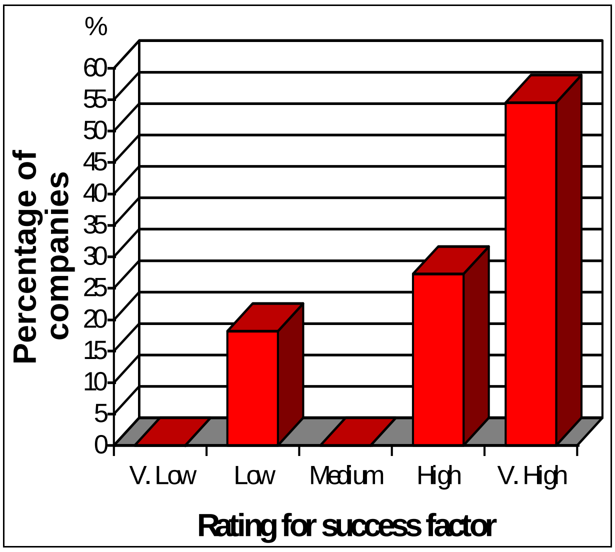

Figure 6.12: Effect of operator autonomy on cell performance

55% of respondents believe operator autonomy is crucial to the performance of cells. It is interesting to note that the 1990 Ingersoll Engineers report also identified training and operator flexibility of the team as key factors in successful cells (Ingersoll, 1991). According to Human Resources (HR) studies, (Huczynski, 1987) it is these "soft" issues which are very important in achieving competitive advantage. Although the "hard" business objectives are the drivers for CM, it is the "soft" people and planning factors which will ensure success (Ingersoll Engineers, 1990).

6.17 Results Benefits derived in product handling

This section describes the actual benefits derived from using CM. It was expected that most companies would indicate a reduction in product handling. This is because machines are close together in cells and parts move from one machine to another in cells quickly, reducing handling. Figure 6.14 below indicates that more than 70% of the respondents have witnessed a reduction in product handling of more than 20%. More than two thirds of these have witnessed a reduction of more than 50%.

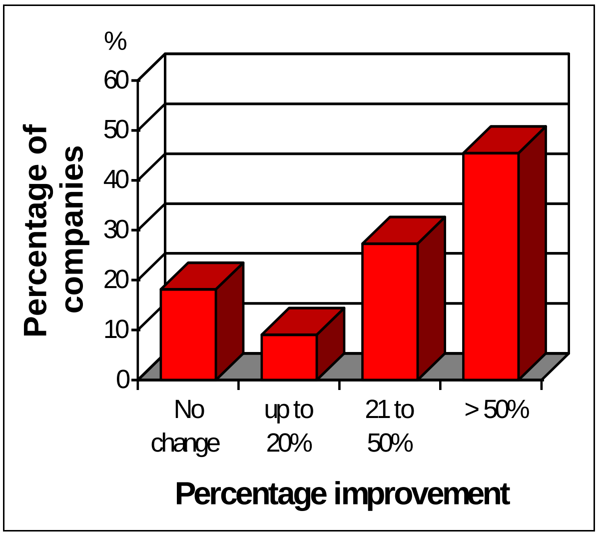

Figure 6.14: Improvements in product handling

The result compares well with the Ingersoll Engineers report of 1990 which reported that just under 50% of respondents obtained significant reduction in product handling. This finding supports one of the basic premises of CM that material handling decreases in CM as dedicated dissimilar machines come together in a group or cell (Burbidge, 1975)

6.18 Results Improvements in work flow distance

Another result that confirms the reduction in product handling is the decrease in work-flow distances. Figure 5.15 shows that 70% of the respondents reported a reduction of more than 20%, whilst 50% recorded more than a 50% reduction in the distance parts move between operations.

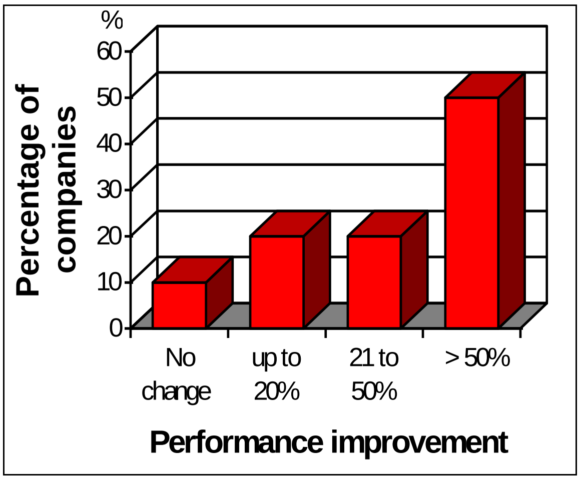

Figure 6.15: Results for work-flow distance

In the 1990 Ingersoll Engineers survey, close to 60% of companies reported significant improvements in work-flow distances. However, 10% of the respondents in this survey reported no change in work flow distances. These were the companies not changing the layout with CM, and the Greenfield manufacturing sites that were started with CM.

6.19 Results on Work in progress (WIP)

Work in progress refers to work that is still in the process. Figure 6.16 indicate that more than 43% of the respondents have witnessed a reduction in work in progress of more than 20%. 18% of the respondents recorded a reduction of more than 50% for WIP.

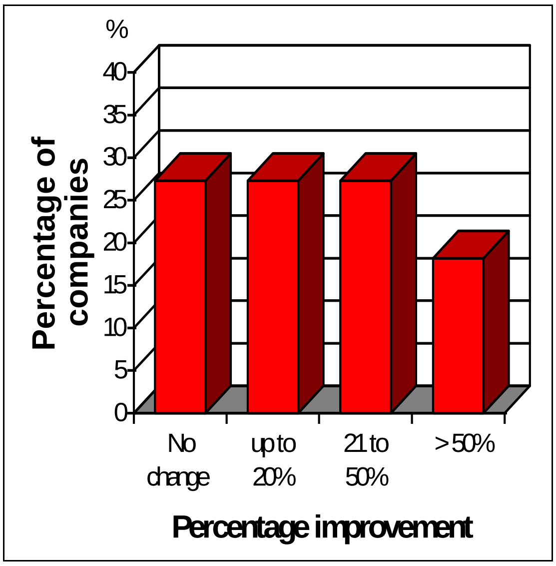

Figure 6.16: Results for work in progress (WIP)

The reduction in WIP is a direct result of CM; this is directly attributable to companies manufacturing to demand and marrying traditional push systems such as MRP with pull systems that react to product demand like Kanban control. Cellular Manufacturing runs in small batches, reducing both work in progress.

These findings on work in progress were expected because CM runs in small batches. Of note however is that 25% of the respondents indicated that there was no change in WIP with CM. The explanation is that these companies were still using high batch quantities to manufacture in CM. A reduction in WIP leads to a reduction in finished product stocks.

6.20 Results for lead times

Lead times are among the hard driving forces for adopting CM. The manufacturing component of lead time is reduced within CM by having machines close together and thereby decreasing work-flow distances and part handling.

However, this is not necessarily true as parts are shipped out of cells as quickly as they come in, and with automation it is possible to have a cell making various products at the same time.

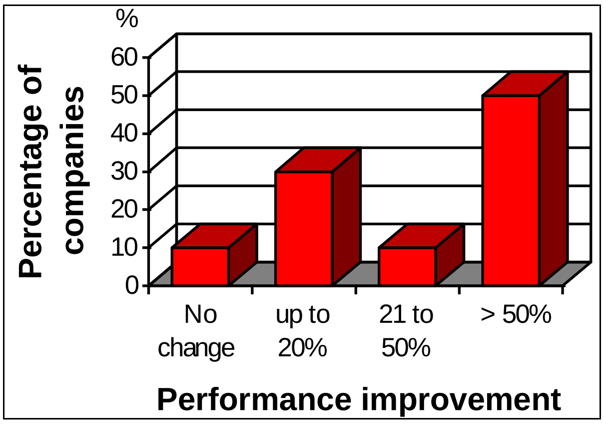

Figure 6.17: Results for manufacturing lead time

Figure 6.17 shows a 50% reduction in manufacturing lead time reported by 50% of the respondents whilst 40% reported reductions of less than 50%. These were primarily due to shorter cycle times of operations experienced within CM and also due to automation.

Figure 6.18 indicates that 50% of respondents reported a reduction in delivery lead time of more than 50%, whilst 30% of the respondents recorded less than a 30% improvement. The former is consistent with the reported 50% improvement in manufacturing lead time.

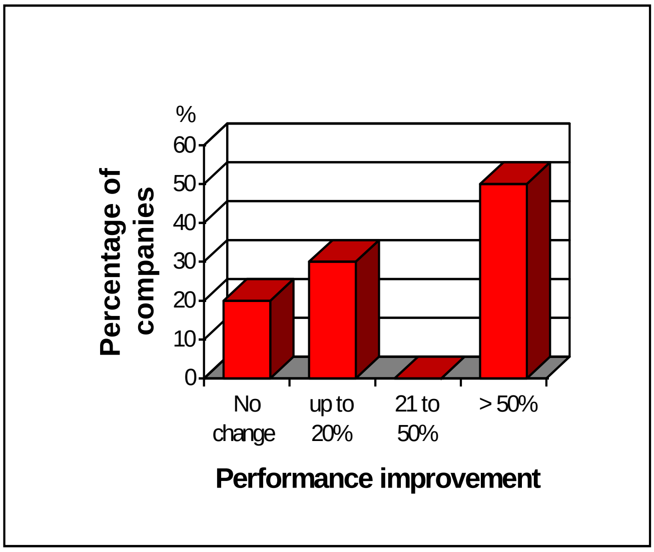

Figure 6.18: Results for delivery lead time

It is interesting to note from Figure 6.18, that 20% of the companies did not notice any improvement in lead times. An analysis of these companies reveals that major benefits were in the softer areas of job satisfaction of up to 50% and operator flexibility of up to 50% as well and that lead times were already high. The average score for all companies was a reduction in delivery lead time of 44% with a standard deviation of 19%.

6.21 Results Benefits derived by other indicators

The other benefits reported are shown below in Figure 6.19 and include product quality, scrap reduction, overall competitiveness, sales and output, operator flexibility and job satisfaction.

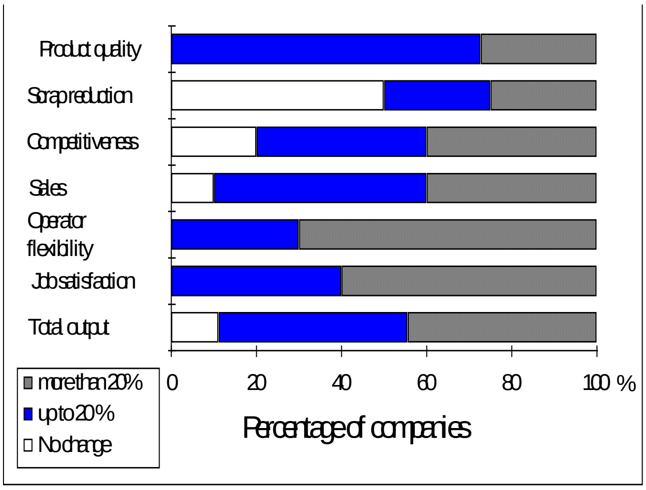

Figure 6.19: Results for other performance indicators

More than 70% of the respondents experienced an improvement in product quality of up to 20%, which agrees the finding that product quality was one of the most important reasons to introduce CM. The significant improvement in product quality is due to improved supplier relationships through partnerships and the basic CM tenets of reduced handling and improved accountability.

The findings on product quality improvement and scrap reduction are not consistent. More than 70% of the companies report an improvement in product quality of up to 20% and more than 50% indicate that there has not been any improvement in scrap reduction.

The emphasis on more efficient space utilization agrees the major reasons for introducing CM in the companies responding, namely: product handling, work flow distances and lead times reduction. Besides the accelerated parts flow, better factory utilization also releases shop floor area for other operations. Equally important is the emphasis on operator involvement as a necessary condition for achieving the harder benefits of lead times and quality of product and service.

7. Discussions Benefits derived from using CM

Results obtained by most companies concern reduction in work-flow distances moved, reduction in product handling, WIP and stock levels and hard performance indicators such as lead times.

7.1 Discussions Lessons learned

- More rationalization of product and improvement of tool changes to reduce downtime.
- More thought to space utilization, health and safety and inclusion of specialists into cells.
- Better factory layout, reducing manual handling between cells.
- Good choice of reliable hardware and dedicated operators.
- Integration of capacity planning with training.
- Greater operator involvement.
- Better inter cellular communication.
- Investment into layout

8. Conclusion

The furniture industry as represented by the sample studied shows that there is little experience of CM within the industry, although there were some cases of proven CM usage. Companies have been using CM for 5.3 years on average although 75% of these companies have an average of less than three years experience with CM. The average number of machines in a cell is 10.9, and the ratio of machines to operators in a cell is 1.6. The survey reported an average factory cellularisation of 23.5% in 15% of the sample surveyed using CM. In the research, operator flexibility was considered a critical factor in the performance of cells. Cycle times are reduced within CM due to manufacturing a single product at any one time and by running lower batch quantities. Companies using CM reported an average reduction in delivery lead time of 44%. The main reasons for introducing CM were to do with improving material flow and product quality but It was encouraging to note that companies reported significant benefits in operator flexibility and job satisfaction, although job satisfaction was one of the least important reasons to introduce CM in the companies surveyed. There were significant reductions in move distances and product handling reported by companies using CM due to machines being closer together and the number of operations reduced due to automation within cells. Due to the fact that parts are started and finished within cells, there is no intermediate storage of work or piece parts within cells leading to a reduction of work in progress and ultimately stock. CM as opposed to functional or traditional manufacture runs with small batches and higher frequencies and hence the work in progress at any one time is lower than the latter.

References

[1] Burbidge, J.L. The Introduction of Group Technology. Heinemann Ltd, London, 1975.
[2] Burbidge, J.L Group Technology in the Engineering Industry. Mechanical Engineering Publications Ltd, London, 1979
[3] Burbidge, J.L Production Flow Analysis for Planning Group Technology. Oxford University Press, Oxford, 1989.
[4] Burbidge, J.L Lecture notes in Group Technology. School of Industrial and Manufacturing Science, Cranfield University, Bedford, 1994.
[5] Burbidge, J.L. and Dale, B. G. Planning the introduction and predicting the benefits of Group Technology. Engineering Costs and Production Economics, Vol. 8, 1984. pp 117- 128.
[6] Financial Times. Cellular working reassessed. London, 11 January 1994.
[7] Ingersoll Engineers. Competitive Manufacturing, the Quiet Revolution: A survey of Implementation and Performance of Cell Manufacture Across British Manufacturing Industry. Ingersoll Engineers, Rugby, 1990.
[8] Ingersoll Engineers. Financial Pathos: Cellular Manufacturing Gone Wrong. Ingersoll Engineers, Rugby, 1991.
[9] Ingersoll Engineers, The Quiet Revolution continues: a Survey of Implementation and Performance of Cell Manufacture Across British Engineering Companies. Ingersoll Engineers, Rugby, 1993.
[10] Mugwindiri, K. A Survey of Cellular Manufacturing Users in the UK Furniture Industry. School of Industrial and Manufacturing Science, Cranfield University, Bedford, 1994.
[11] Schonberger, R. World Class Manufacturing: The Lessons of Simplicity Applied. Collier Macmillan Publishers, London, 1986.

Author Profile

Mugwindiri K did Bsc Mechanical Engineering Honours at the University of Zimbabwe, and Masters in Manufacturing Systems at Cranfield University, England. He is currently teaching Engineering Management at the University of Zimbabwe.

Chinguwa S is currently a lecturer at the University of Zimbabwe majoring in Engineering Thermodynamics, CADCAM and TQM. He obtained B.Eng (Honours) Degree in Industrial and Manufacturing Engineering with National University of Science and Technology and an MSc in Manufacturing Systems and Operations Management with the University of Zimbabwe.

Chikuku T did Bsc Mechanical Engineering Honours and Masters in Manufacturing Systems at the University of Zimbabwe, He is currently teaching mechanical Engineering design at the University of Zimbabwe.