THE EVOLUTION OF MANUFACTURING:
AN INDUSTRY CASE STUDY AT ALTECH UEC SOUTH AFRICA (PTY) LTD

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ABSTRACT
South African businesses operating globally are facing many economic challenges. This paper discusses Altech UEC South Africa’s evolution of manufacturing and the importance of adapting to survive. This evolution entails changing facets of the business such as its structure, systems and technology. It requires implementing theories such as design for manufacture, changing the operational structure and the flow of processes, lean manufacturing concepts and investigating alternatives to reduce energy usage. All of these strategies have the goal of reducing operating cost.

An industry case study on the rare event of a factory relocation project, combined with a focus on design for manufacture and importance of corporate culture is investigated. Motivating for large financial expenses is a challenge, with demands changing with the agility of the market and the necessity to stay financially viable against other emerging markets. It is therefore an achievement not just motivating for an organisation-wide change, but also the development and progress brought about by embracing it.
1 INTRODUCTION

How to survive Darwin? It is argued by Enarsson [1] that companies need to transform and evolve into agile organisations, as the market’s needs are fickle and quick to change. Being in the electronics industry and at the rate at which technology changes, this is especially important for Altech UEC South Africa.

There are, however, certain objectives that need to be achieved before a business can embark upon the mission to become agile, one of which is to be a lean or world class organisation, Enarsson [1].

This paper does not serve to present revolutionary academic theories to the manufacturing community, but rather give some insight into the applied integration of a number of common principles, and the results achieved in a case study at Altech UEC South Africa.

It discusses the historical performance of the facility, the strategies for change and the resulting performance evaluation. Strategies involve changing the structure of the company, which includes the facility, corporate culture, and product designs. The system infrastructure and newer technologies are also investigated. All of the discussed strategies are tools that assist in evolving manufacturing and striving to become a world class organisation.

It is estimated that the unit cost would have been 73 percent higher than the current cost, if the changes were not made, Manufacturing Executive [14]. This highlights the achievement that can be brought about by embracing these changes.

1.1 Background

Altech UEC South Africa, as a subsidiary of the Altech Group, is a manufacturer of digital encryption devices in the African and International markets. The main product lines consist of set top boxes for the pay television industry. Flat panel televisions and tracking devices are other lines of business which have been recently pursued. An interview with the Manufacturing Executive on 26 March 2013, revealed that Altech UEC South Africa has manufactured over 16 million devices to date. The set top box manufacturing processes consist of the production of plastic parts, electronic assembly and final assembly of the complete units. The flat panel televisions and tracking devices processes are slightly different, with most of the parts being outsourced and received as a complete knock down business. The printed circuit boards are populated with surface mount technology, then tested and assembled at the final assembly lines.

1.2 The need for cost reductions

Table 1 indicates the cost differences for South African versus Chinese manufacturing, according to Reed [5].

<table>
<thead>
<tr>
<th>Element</th>
<th>SA versus China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour</td>
<td>20 - 40 % more</td>
</tr>
<tr>
<td>Components</td>
<td>10 - 20 % more</td>
</tr>
<tr>
<td>Facilities and equipment</td>
<td>10 - 20% more</td>
</tr>
<tr>
<td>Management overheads</td>
<td>10 - 20% more</td>
</tr>
</tbody>
</table>
In order to stay competitive in the market, Altech UEC South Africa has had to decrease manufacturing value add and bill of material costs with inflation increases. Volume and efficiency gains have been, and still are, required to counter inflation.

Surviving Darwin at Altech UEC South Africa, therefore, required a combination of high level strategies to fundamentally change the structure, systems and technology together with smaller continuous improvements, in order to reduce costs and to be able to compete in the global market as a world class manufacturer.

2 THE EVOLUTION ROADMAP AND STRATEGY

Where does one start to plan a roadmap and strategy that evolves manufacturing in the direction that is required?

Enarsson [1] argues that companies need to evolve and adapt to the current environment to respond to the market’s needs, at the right time and the right price. However, a lean and streamlined facility is required as the foundation. The key to successful and economical manufacturing lies with the manner in which the resources - consisting of labour, material and capital - are controlled and organised. The system needs to be designed in such a manner that everyone in the organisation understands how it works, Black & Kohser [4]. Departmental silos are to be removed in order for this to be achieved.

It is also vital that all the different costs of the business are understood in order to control, anticipate and reduce the costs. Cost management versus cost reduction strategies come into play. Drastic changes such as Kaikaku initiatives are sometimes required to meet cost reduction objectives.

Figure 1 indicates the baseline for a conceptual improvement strategy that can be followed for an incremented improvement and cost reduction approach. Each of the sectors entails one or more Kaikaku activities which take place, followed by smaller Kaizen activities. These Kaikaku activities refer to a paradigm shift, a transformation that affects all the sectors of the organisation. In contrast, Kaizen activities are smaller, incremental improvements on the current state of the processes. However, Kaikaku without a Kaizen culture is prone to failure, and vice versa, Miller [2].

![Figure 1: The conceptual improvement strategy](image)

The structure of the organisation is the first Kaikaku activity that is to be addressed according to the conceptual improvement strategy. This entails, amongst others, re-designing the facility, improving or introducing design for manufacturing tools and possibly redesigning the organogram structure.

The next Kaikaku’s focus lies within the organisation’s systems, followed by a focus on new or improved technologies. The system paradigm shift can include re-designing the enterprise resource planning system, implementing a manufacturing execution system or changing the configuration management systems.
Investigating newer technologies in equipment brings about advantages such as reduced electricity usage, less pollution, improved efficiencies, improved quality of the end product or increased ease of operation.

The chapters to follow explain these organisation-wide changes in the structure, systems and technology areas of the business, implemented at Altech UEC South Africa.

3 STRUCTURE DEVELOPMENTS

The structure of the Altech UEC South Africa facility required a paradigm shift. The business was relying on legacy systems, products were not designed to best optimise manufacturing processes, bill of material costs were steep, the site did no justice to the material flow and the site services’ cost was breaking the bank. The production capacity needed to be increased while the variable labour and overhead costs needed to be reduced. The corporate culture became dormant and inhibited flexibility for change. Moreover, change was required throughout the organisation if the company wanted to be a world class manufacturer to open up opportunities for contract manufacturing and be able to compete against the global competitors. This chapter discusses the changes and benefits of the factory relocation project as well as the corporate culture and product design improvement initiatives, which all assisted in a paradigm shift in the company’s structure.

3.1 Factory relocation project

In 2008, Altech UEC South Africa’s management started working on the vision to relocate the manufacturing facility. It was a strategic move considering all the facility, logistical and staff cost savings to be achieved. It was apparent that this vision was not a small project to embark upon, as the motivation period took approximately three years. In JSE listed companies, there are many shareholders to be considered and such large investments need to be planned carefully.

The following two figures show the layout and movement of stock at the old manufacturing facility. The various material flows are indicated in the aerial view of Figure 2. This diagram was used in the motivation presented to Altech Group’s executive committee. The site layout consisted of numerous different buildings where all the manufacturing departments and areas were situated.

![Figure 2: Aerial view of the old Altech UEC South Africa facility, Manufacturing Executive [11].](image-url)
Work in progress (WIP) from one area had to be palletized and secured in order to be transported safely to the next process. In some instances, the palletized WIP had to be loaded onto a truck to be transported one kilometer away to the other side of the site. The logistical cost to move material was extensive. Moreover, departmental silos were created and the operation was divided. Figure 3 shows some examples of manual movement of inventory, including loading of trucks and storing in areas not suited for such flow.

Figure 3: Material movement at the old Altech UEC facility

Requirements for the new site included items such as available space for future expansion, location in close proximity to the harbour, airport and the sister company Altech Multimedia, which has many dealings with the manufacturing facility. Considering all of the above requirements, a Trade Centre warehouse situated just a few kilometres away was seen as a feasible location.

Considering the following potential cost savings associated with the relocation project, the business case proved to be fruitful. According to Manufacturing Executive [11], the annual savings were estimated as follows:

- Site services: R5 272 380
- Offsite storage: R1 000 000
- Direct labour: R3 600 000
- Total annual savings: R9 872 380

Allowing for the estimated relocation cost and the increase in the annual lease expense, the payback period indicated to be 1.82 years, Manufacturing Executive [11].

The site services savings included costs such as gardening, cleaning, security and waste removal. Offsite storage was required due to insufficient space onsite and direct labour savings included mainly the logistical operator savings, moving and transporting goods from one area to the next. Annually, 4000 tons of material, excluding waste, needs to be transported, Manufacturing Executive [14]. The energy and time required to do so is significant, and improving on the layout of the site confirmed similar for the benefits.

Figure 4 depicts an aerial view of the new manufacturing site in Siphosethu drive, Mount Edgecombe.
3.1.1 Results and current state

Referring to Figure 4, all the departments and manufacturing areas are now under one roof, a start in becoming a world class manufacturer. Months were spent on the planning, and the efficient execution demonstrated the fruits thereof.

During an interview with the Manufacturing Executive on 26 March 2013, it was found that the benefits realised up to date are the following:

- Variable costs reduced, although fixed costs increased.
- Headcount per unit produced ratio, improved from 1:1500 to 1:5600.
- Annual capacity increased from 1,800,000 to 2,800,000 units.
- Distance travelled per unit from beginning to end reduced by a third.
- Site service cost reduced drastically.
- Departmental silos were removed.

It is important to note that the company’s bottom line will only experience the cost benefit when the monthly production quantity exceeds 200,000 units, Reed [5].

3.2 Corporate culture

Lather [7] argues that corporate culture is an important factor to consider when managing an organisation-wide change. Even with the most detailed and planned projects, an organisational change must include not only improvements in structures and processes, but also develop the corporate culture. The theory states that “organisational culture creates both stability and adaptability for organisations”.

Figure 4: Aerial view of new Altech UEC South Africa site
Lather [7] mentions that organisational norms are developed from organisational values, which determine the actions and attitudes of employees. These norms become entrenched when employees get used to their environment, which may often lead to the slowing down of innovation and an idle acceptance of what happens around them. One great success of the factory relocation was to build up new ideas and disrupt many of the bad practices that may have previously become norms.

The facility was moved just a few kilometres from the previous site, so displacement of employees was not a factor for consideration. The move to the new premises has provided a more comfortable, safe and pleasant working environment and it has therefore achieved a substantial amount of buy in and willingness. A priority has been given to becoming an employer of choice. The facilities include the following:

- A staff restaurant with outside eating area and coffee machines.
- A clinic with a full time registered nurse for day-to-day ailments and a doctor visiting once a week.
- Lockers for personal items.

During the project, each department was given a large degree of responsibility and ownership in the design, capacity and physical layout of their areas. This has helped in bringing a certain degree of pride into the work area for shop floor managers, which in turn has the potential to reach the operators in their everyday activities. To maintain this sense of ownership, “green areas” have been placed at each manufacturing area on the factory floor. This is an open space with pin up boards showing targets, achievements, productivity history and statistics. Some personal and motivational posters are also encouraged. Daily meetings are held in each of the areas, where production matters and targets are discussed.

The layout of the office area allows for better communication between departments, as it is open plan. The idea was that this will minimise the common problem of departments working in isolation.

The new factory environment has allowed for significant changes during the relocation, but almost more importantly, has set up an environment and structure that promotes continuous adaptation.

### 3.3 Product design

Numerous factors need to be considered to achieve low cost manufacturing. There is a close relationship between the design of the product, material, equipment, process selection, tooling selection and design, Black and Kohser [4]. This is the reason why design for manufacturing is a key component of evolving the products and reducing manufacturing costs. Benefits include less labour intensive processes, reduced bill of material costs and shorter cycle times.

The graph in Figure 5 gives an indication of the decreasing trend in piece parts for the fascia and sleeve assembly for set-top boxes. The product unit cost reduced with an impressive 63 percent over five years, Process Engineering Manager [15].
Fundamentals that were considered to reduce the manufacturing costs include:

- Merging the fascia and sleeves in the moulding process.
- Reducing the painted plastic parts by moulding the parts in the required colour/s.
- Introducing hot runner technologies in the injection moulding plant.
- Moulding the buttons into the fascia/sleeve part.
- Eliminating screws in the final assembly process.
- Replacing steel bases with plastic bases, which made a clip-in design possible.

Design for manufacture has remained a focus of the company. New areas to be investigated lie in the tooling design for the plastic moulding plant. It has been identified that a greater involvement in the design stage is required. Many cost saving opportunities may be realised if there is a focus on the moulding tool material and design to reduce the cooling times, as well as the part design.

Figure 6 demonstrates the relationship between the typical moulding stages, the largest proportion being cooling time, Kimerling [3]. A scientific approach to the tool design will assist in optimising moulding cycle times while still achieving the required part functionality.
Efforts to reduce cooling times include re-thinking the tool material selection and tool design. These entail selecting a better heat conductive material and increasing the cooling channels, while keeping the channel close to the part. An illustration of such improvements is shown in Figure 7, where the second image shows the improvements.

The trend in industry has been that tool design and manufacturing are outsourced to the East, with a larger disconnect between manufacturing and designers as a result. The ultimate cost of outsourced tools is yet to be investigated at Altech UEC South Africa. Expensive moulds make inexpensive parts and it is estimated that a 60 percent more
expensive mould could have a three second cycle time improvement, paying back the costs in as little as two months at Altech UEC South Africa according to Engineering and Facilities Manager [13].

4 SYSTEM DEVELOPMENTS

A full time systems manager has been employed to investigate the improvement of the current infrastructure. The goal is to implement an integrated manufacturing execution system (MES) to close the loop between the enterprise resource planning (ERP) system and real time data from the machines on the factory floor. As it stands there is minimal real time data input reaching the ERP system, Systems Manager [12].

The Instrumentation Systems and Automation Society (ISA) - 95 International Standard of Integration of Enterprise and Control Systems lays out the ideal infrastructure and data flow for a manufacturing facility, Manufacturing Execution System [8]. Referring to Figure 8, five levels of data control are discussed. Through the design of applications, a track and trace system and a shop floor data collection system (SFDC), a valiant effort has been made in providing for an effective platform to work with.

![Figure 8: ISA - 95 International Standard of Integration of Enterprise and Control Systems, Manufacturing Execution System [8]](image)

4.1 Current state

The inherited track and trace system has been custom designed for a much smaller transaction volume than the growing company has come to deal with. The Delphi (Legacy) applications have been converted into a .net framework. Even though this is an improvement, the .net framework still struggles to cope with a large volume of transactions. An estimated 700 000 transactions have been performed in 2012 for television manufacture, and more than 18 million for set top box manufacture, Systems Manager [12]. With continuous growth and improvements required in the facility, an average of three new applications has been developed per month in the period 2011 to 2013. Figure 9 shows the new application requirement each year, with at least four new Kanban applications being
implemented. The rest of the applications have been for modification and improvement of processes, and for the introduction of television manufacture in 2011.

Figure 9: Additional applications required from 2011 to 2013, Systems Manager [12].

The ability to achieve a higher transaction volume would be expected to have a direct effect on productivity. In 2012, a total of 288 production support requests were received by the systems team. At an average of two hours downtime per request, this approximates about 48 hours of downtime per month, Systems Manager [12].

The facility runs a twenty-four hour operation, which calls for the need to have convenient methods of support from technicians and the systems team. A web track and trace system is currently being developed to allow for remote control and visibility of the systems as they run. This is a centralised server for all the applications. The aim of this is to allow the applications to be accessed over the web, and perform maintenance and adjustments according to the level of clearance the user has, without having to be on the premises. The web system is in the phase of site acceptance testing, with the hope of being implemented by mid 2013.

4.2 The capacity of the current systems

The shop floor data collection system (SFDC) has provided insight into the state of inventory and production statistics in each department. The combination of track and trace and SFDC, however, still has fundamental limitations. In Figure 10 a general idea of Altech UEC South Africa’s infrastructure is demonstrated. The production lines have certain critical modules that output information to the SFDC system. There are, however, some modules that do not have any interface, and this information needs to be captured manually. Other production elements have interfaces into the track and trace system. As noted in the diagram, the file transfer from the machines to these two systems can be unreliable. The interface to each machine needs to be customised in order to communicate with the various software types in machines from different suppliers. This complexity has been shown in Figure 8, demonstrating how the system needs to be more refined when communicating with levels 0, 1 and 2 of the controls system integration.
Another limitation comes from the fact that the track and trace system does not have an interface with the ERP system. So the information from track and trace has to be accessed and used in parallel, which is not necessarily an efficient task.

4.3 Manufacturing execution system

To address the discussed limitations, a major focus lies with the implementation of an MES system. MESA International [9] says that “with MES the manufacturing process becomes information driven and a stronger contributor both to overall productivity and to the financial viability of the company.” This is seen as the fundamental element that will drive a process change and improve control with real time information. Due to the discussed data accuracy limitations, a new ERP system would encounter the same shortcomings as the current ERP system. This means the drive to improve the data collection interfaces needs to be rooted in the investigation of the MES system.

The functions covered by the ERP system include the following:

- Master Production Planning/Manufacturing Requirement Scheduling
- Warehouse management
- Finance
- Sales
- Human resources and customer relations management

These functions require all the inputs to be supplied by the MES system, from which it may use the information and feed back some form of response. Figure 11 shows how the MES system would fill the gap required. With a reliable interface to manufacturing equipment,
real time data capturing may be accomplished. The motivation for this system is rooted in the advantages that are discussed below.

**Figure 11: Proposed data flow improvement demonstrated by MES, Systems Manager [12]**

### 4.3.1 Downtime management and analysis
According to studies in the US manufacturing industry, International Atomic Energy Agency [10] says that approximately one third of maintenance costs may be attributed to unnecessary maintenance. An automated analysis of a machine breakdown is useful, as it provides the technician with real time and detailed information of the error, straight from the machine interface through condition based monitoring. This includes monitoring key performance points and trends of the machines. Critical milestones of machine life are analysed, helping preventative maintenance procedures.

### 4.3.2 Management of raw materials within each work centre
The inventory levels at each work centre may be closely managed. This will provide material and production planning teams with accurate information regarding what material is required where and when. Together with the knowledge of machine status and production requirements from the ERP system, production planning may be optimised.

### 4.3.3 Quality and repair management
Quality measures can be controlled, with statistical process control being automated and continuously monitored. This helps the production team to fix problems as soon as they arise, reducing the defect rate. This is also a useful tool for the engineers during new product implementation.
Visibility on the material, build state and machine parameters can be achieved. With this information in the system, it is also possible to automate the generation of work instructions for the operator.

4.3.4 High processing power
A good MES system will allow for a large number of transactions to be performed at any time. This will be a noticeable improvement with respect to the current track and trace systems which struggle with the high volume of transactions.

4.3.5 Standardised reporting
With the collation of all the information that the MES system will process, reporting procedures may be automated. This has the benefit of quicker response times to daily production problems that may occur, and a summary of operations for management.

4.3.6 Execution plan
The implementation of the new system is in its final stages of approval at executive level. Many options have been considered and a decision has been made on the MES provider that is known to be well suited for electronics manufacture. The project is expected to be executed over two phases.

Phase one is expected to take approximately six months to implement. It will include automation of equipment interface, real time data capturing, setting up the centralised data repository, and fine tuning the operating equipment efficiencies structure. The second phase is the implementation of the MES system that will perform the three management roles:
1. Production management
2. Quality management
3. Efficiency management

The payback period for the MES expenditure is expected to be 1.1 years, Systems Manager [12]. As part of a survey performed by MESA International [9], findings show that the payback period of implementing an MES system range from six months to two years, with an average payback period of 14 months. This indicates that the Altech UEC business case is a strong one.

5 TECHNOLOGY DEVELOPMENTS
This Chapter discusses some of the current work in investigations within the technology domain. Although this has not yet been implemented at Altech UEC South Africa, unlike the other Chapters, it forms part of the holistic strategy as discussed in Chapter 2.

5.1 Automation
Automating certain processes or process steps can bring about benefits like consistent cycle times, reduced variable labour costs and increased production up time. Moreover, when considering the implementation of a MES system, both the systems are complimented by the two-way feedback loop. Some level of automation is required by the MES system to facilitate the interface requirements that have been discussed. The consistent cycle times achieved by automation also assist in master production and fixed finite scheduling.

5.2 New technologies
Although effort is often spent on reducing labour, other costs such as fixed and variable overheads are not to be overlooked. Figure 12 indicates where most of the cost and the biggest focus on saving generally lie for the injection moulding plant at Altech UEC South Africa. These costs should be understood to best control and possibly reduce.
Engineering and Facilities Manager [13] stated that drastic unit volume increases are the basis for the increase in overhead costs and can be negated by implementing newer technologies. This is achieved by reducing operating costs of machines such as power usage, maintenance and efficiency.

![Cost Breakdown vs Focus of Efforts](image)

**Figure 12: Cost breakdown versus focus of efforts in reducing costs, Engineering and Facilities Manager [13].**

In the surface mount and plastic injection moulding areas, technologies such as dual SMD reflow ovens and electrical machines can be considered respectively. These are known to reduce electricity usage, improve cycle times and allow for better control.

Faster change over times are essential in increasing the machine availability. As other business opportunities bring about additional capacity increases, production up-time optimisation is essential.

All of the above assist in building the sound foundation to become a world class manufacturer.

6 CONCLUSION

The global market’s needs are changing rapidly, resulting in reduced product life cycles, and possibly increases in demands and variety of products. Globalisation also demands competitive pricing from the manufacturers in order to stay financially viable against other global emerging markets. This paper discussed the need for manufacturing to evolve at Altech UEC South Africa. This evolution included changes in the structure, systems and technologies of the business.

The capital expenditure for the structure developing projects has not just met the expected benefits, but exceeded them. The production capacity increased by 55 percent, headcount per unit ratio improved from 1:1500 to 1: 5600 and the distance travelled to produce 1 part decreased by a third. Design for manufacturing initiatives showed a reduction in the unit cost of 63 percent over the past five years.

Other opportunities for cost reductions and improvements were identified in the systems, whereby implementation of a manufacturing execution system can assist in improving the current infrastructure. The payback for the capital expenditure is estimated to be 1.1 years.

The advantages that may come from implementing newer technologies for processes such as injection moulding, include reduced electricity usage, improved control and reduced cycle times.
With Altech UEC’s current unit price being 73 percent lower than the projected price over five years, it is a testimony of the substantial benefits lying in the cost reduction initiatives discussed in this paper.

7 REFERENCES


