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**C a m b a s h i** Limited

## **Delivering Better Product in Less Time**

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**Background**

Cambashi researches the use of Information and Communication Technology. Our goal is to understand

- the business reasons that drive investment decisions,
- the technology that addresses these issues,
- the market mechanisms that bring users and vendors together, and
- the impact of deployment of applications and infrastructure.

We thank IBM for the sponsorship of this white paper and the opportunity to document our research on reducing design cycle time and improving time to market in the mobile equipment and machinery sector, the competitive advantages that arise from these strategies, and the role of Product Lifecycle Management technologies in this area.



## 1 Introduction

*Companies involved with mobile equipment and machinery that are slow to market may find that by the time they have introduced their products, demands have shifted to the next generation.*

*Innovation is used to be first in a new market, and also to win share in a developing or mature market. There is intense time pressure on the new product introduction and engineering change processes, because faster cycle times deliver better business results.*

*Companies with extended cycle times find that they don't have the time to develop extended bid differentiation, and costs are higher due to mark-ups to cover unforeseen product risks and potential downstream changes.*

### **Innovation is key**

*"...firms that were rated as highly innovative by a panel of executives and analysts produced returns to shareholders that were nearly four times those produced by the least innovative firms over the period from 1987 to 1996. These results compared favourably with those cited from cost reduction programs and merger/acquisition activities."*

*Arthur D. Little survey, 1999*

## 2 The Challenges of the Mobile Equipment and Machinery Industry

The key differentiator between competitors in the mobile equipment and machinery sector is performance. There is a race to be first to exploit technologies and process but in their application it becomes increasingly difficult to compress design cycle times.

The resulting challenges arise from many sources, and affect most mobile equipment and machinery companies, including those involved in volume and assemble to order manufacture, with examples as diverse as mobile forestry equipment and production line maintenance machinery.

The shared root of these challenges, and indeed, the key to their solution, is that to decrease time to market and improve offerings in ever shorter timescales requires a clear understanding of the forces that drive delays and complexity into products and processes.

This paper focuses on the resulting issues that, despite the diversity of the sector, are relevant to all involved management teams. Of course there are differences in, say, market dynamics, technology, and key success factors between businesses such as mobile material handling (e.g. cranes, lifting equipment), agricultural equipment (e.g. harvesters, sprayers), industrial trucks (e.g. fork-lifts, AGVs), hand-held machines (e.g. saws, grinders, welders), cleaning equipment (steam and water jet cleaners), mobile mining machinery (e.g. drills, pumps) and instruments (specialised maintenance devices, general purpose sensors). But examine their design, engineering, manufacturing and value chain processes, and there is a shared core of business topics, and it is these that will be discussed.



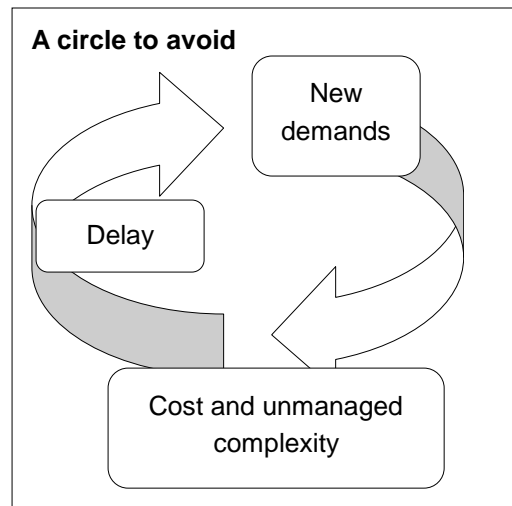
Product price and performance must improve to cater for increased customer demands. But simply keeping pace with the market is not sufficient. It is also necessary to differentiate. This requires increased offer and product differentiation not just in performance, but also factors such as service, supply, and even aesthetics.

The widely quoted McKinsey study of 1988 provided high visibility for the profit impact of a number of factors, in particular the way in which a six month delay in new product introduction leads to a 33% loss of overall profit. Since then, related studies have confirmed and refined this concept, for example, in <sup>(1)</sup>, an alternative cost and sales model is used, and the result is a predicted penalty of a 7% reduction of Return on Sales resulting from an equivalent six month delay in product launch.

Despite the sensitivity of this figure to the specific business environment, in every situation it is a pointer to a vicious circle - demand for more product features increases product complexity which must generally be delivered with little or no price premium. Greater complexity increases the risk of product failure or delays, and maintaining or improving quality is an increasing burden.

This is compounded by increasing customer demand for more customised products, extending cycle times to the point where the market needs more product features.

It is not only the need for new product capabilities that can drive new demands. Customers want their products to work first time and last longer. Often these products must operate in unforgiving environments. This requires improvements in design, simulation, test and value engineering. Together with improvements in quality and durability, these must be achieved without sacrificing costs and time to market.



Furthermore, companies are increasingly required to conform to stringent local regulatory requirements. To add to this, products may be used across many locations, worldwide. This necessitates the need to design and manufacture in conformance with international as well as local standards. Regulations relating to materials usage and design for end-of-life force companies to guarantee product and process traceability.

Design and manufacturing resource from emerging economies offers opportunity to reduce costs. Greater distribution of customers, and disparate design and manufacturing resource challenges companies to improve collaboration and stakeholder interaction. Delays in knowledge transfer and problems of miscommunication cause development delays and increase costs.

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<sup>1</sup> <http://www.pdma.org/visions/oct97/dutton.html>



Subsequent sections of this paper set out to address these challenges and discuss opportunities to reduce cycle times by the appropriate use of product lifecycle management solutions.

### 3 The Opportunity for Change

In order to meet demands for reduced time to market and improved bid cycle times, change is essential. Change must deliver visible and positive cashflow in ever decreasing timescales. Improvement must be made in line with profit objectives and must reduce risk.

As companies strive to deliver shareholder return, increasing importance is placed on delivering unique and improved value to customers. This means change projects must not only deliver increased differentiation but also must remove waste and inefficiency from product and process. This necessitates focus on key company values, increased product innovation, improved portfolio management, and improved productivity.

Internal initiatives must relate to changes in customer requirements and socio-economic situations. Examples of this are the increased demand for more stylised product in mobile equipment products and increasing volatility of demand seen by production line manufacturing companies.

To improve differentiation and encourage greater profit, companies need to embrace change and manage related complexities. It is expensive human resource that is so often the source of significant differentiation – in design, or in flexibility and responsiveness of operations. It is important to provide the people involved with an environment which encourages innovation and performance, and does not force them to waste their energies on non value-adding tasks. This will enable them to capitalise on their time and knowledge, and enhance company performance.

For example, the flexibility to accept and efficiently deal with change late in development or bid cycle is a source of advantage, whether the change is a result of modification or unanticipated developments in customer or regulatory requirement, or new design and configuration ideas. People equipped with the right tools will make this happen.

To cope with increasing demands for customer choice in the machinery and mobile machinery markets, companies need to encourage greater use of product variants. This demands a change to more modular product definition and rigorous bid and design procedures to maximise use of available modules while meeting customer needs with minimal “one-off” design, production, and operations costs. The result is a step towards

#### **The Disappearing Corporate Comfort Zone**

*“Organizations of today and tomorrow are faced with intense global competition, demanding customers with rapidly changing desires, shrinking response times, more rapid product life cycles and demanding employees. Add e-commerce and the trend accelerates exponentially. All the comfortable corporate frictions--geographical distance, price opacity, unquestioning brand allegiance and so forth--that preserved organizational inefficiencies and status quo jobs are quickly disappearing.*

*In response to the current trend, the best companies are forced to become fast, flexible, and participative and must focus on customers, competition, teams, time and processes.”*

*Kevin McKormack, American Society for Quality*



custom built machines, with controlled costs and without negative impact on lead times or quality.

These opportunities for change lead to business initiatives to manage complexity and improve cycle times which fall into the following categories:

- Re-use knowledge and human assets
- Process efficiency
- Design and development effectiveness
- Quality and test
- Communication and interaction

**Time or Quality?**

*"We often have cut a few corners to achieve time sensitive targets"*

*Design Manager at a large mobile machinery manufacturer*

In the following sections, each of these categories of business initiative will be discussed in turn.

**Re-use knowledge and human assets**

To improve the effectiveness of people, development environments must encourage innovation and efficiency. Mundane tasks and administrative duties, which can be the bane of an engineer's life, must be automated and simplified to encourage greater individual performance and allow time for creativity.

Reengineering wastes time. Information re-use improves efficiency. By using past products to develop new offerings companies are able to decrease time to market and simultaneously reduce development time and increase the time available for innovation. This enables increased differentiation and reduces risk. Using a known working part as the foundation for new developments helps ensure appropriate quality.

**People count**

*"Our people are what differentiate our company and products. They enable us to stay one step ahead of the competition"*

*Project Manager at a large machinery manufacturer*

There are three principal factors that form the foundation of improved information re-use:

- Definition and capture of information
- Search and integration of knowledge and constituents into new products
- The ability to understand and rapidly modify re-useable information

Information exists in many forms, both tacit and explicit. Content can encompass sales, process and project information, specification, product data, simulation information, manufacturing quality and test results.

The initial definition of information underpins subsequent re-use. Modular product definition and careful forethought helps to develop more easily categorised and re-useable information.



Efficient re-use requires making information more accessible. To encourage this requires mechanisms to allow for simple and fast search and retrieval of data. Product lifecycle management ('PLM') solutions deliver significant value in this area.

Important information is often ineffective because it's difficult to re-apply. It's essential that the purpose, intent and function of retained information be clearly defined and delivered in a form that encourages its re-use. This demands up-front effort in appropriate definition, documentation and training.

Integrating tacit company knowledge into the development process enables a wider set of resources to capitalise from past experience. To do this requires the holders of the tacit knowledge to have access to ways in which they can embed their knowledge into shared tools that support the development process. This improves the quality of deliverables, enables new participants to become productive sooner, and enables senior and experienced participants to focus on tasks which need their skills.

#### **Don't re-invent the wheel**

*"As companies under pressure to reduce costs and development times work to realize the design-anywhere manufacture-anywhere concept, a company's ability to compete globally will depend upon how well it can leverage existing knowledge sources. Mechanisms need to be developed for encoding, indexing, retrieving, and using this knowledge."*

*from "The role of knowledge in next generation product development systems" by Simon Szykman and Ram D. Sriram, National Institute of Standards and Technology Manufacturing*

#### **Process efficiency**

Re-use and efficiency of process is essential in reducing time to market and bid times. The effective reapplication of efficient processes, and the ability to automate these can provide companies with dramatic improvements in time to market and profitability.

One of the greatest sources of process improvement is achieving an increase in the re-use of processes. This is intimately linked to re-use of product. Even for component variants, when there is a shared original component, then re-use of downstream processes and assets such as test procedures and manufacturing tooling is more achievable. This improves returns, quality and production efficiency.

So one starting point for process improvement is to re-evaluate product and part configurations. The goal is to define more modular product constituents. Redefinition improves clarity of core values and often forms part of more wide ranging product rationalisation initiative. Increased standardisation in product and greater use of platform and portfolio management enhances re-use and encourages more mass customised product manufacture based on standard processes.

For companies involved in bid to order businesses, it's essential that the bid process be managed efficiently to deliver optimum bid differentiation and success. This demands improvement in product and offer formulation in challenging timescales.

The bid process involves interaction amongst many stakeholders. It's important to encourage improved interaction between all parties to ensure efficient use of resource. Improved collaboration and integration with downstream processes encourages



enhanced profitability and quality through the bid to delivery process. For example, if sales teams can find reasonable base data for estimates, then competitive, yet profitable, pricing becomes more achievable. This can be a real challenge. Often estimates are simply based upon previous estimates, without any systematic feedback on their accuracy. If interaction and collaboration is improved, then sales teams work with more accurate estimates, and give design and delivery teams at a good chance of delivering a profitable project.

### **Design and development effectiveness**

Increased competition within a challenging commercial climate requires companies to shrink the timescale of design and development schedules and at the same time improve their rate of innovation. Companies are required to achieve profitable return more quickly than ever, as the window for profitable sales of a particular capability gets smaller.

In bid to order environments the challenge is to deliver improved bids in short timescales. Compelling offerings require differentiation in both product and process. Having the best product does not guarantee a win, since differentiation can be developed in many areas important to customers such as price, performance, trading terms and customer service. Designers must be encouraged and enabled to take a 'whole-life' view of their designs, so that they are able to consider innovation in operational issues from storage and transportation to maintenance and upgrade, as well as delivering innovative capabilities.

#### **Innovation and profit**

*"Some new economy theorists claim, in fact, that innovation will be the only source of profit left."*

*J. Spencer Lanthier, former Chairman and Chief Executive KPMG Canada, KPMG International Executive Committee and Board*

Extending the use of enabling technologies and a more inclusive design philosophy improves quality and efficiency. Engaging skills and participation from the wider set of stakeholders from sales through design, manufacturing and test improves deliverables. Constructive involvement of customers and the extended product team reduces errors and misunderstandings.

Increasing the capability of products increases product and process complexity. This complexity manifests itself not only in increased volumes of product information but also in increased rates of flow of information between individuals and groups. The use of Information Technology to manage this complexity encourages improved performance and efficiency in people and processes.

### **Quality and test**

Improvement in design and bid cycle times cannot be made at the expense of quality. In addition, demands for improved traceability and end of life disposal increase complexity of design processes. Internal processes must encourage more automated and manageable processes with early discovery of problems in order to deliver quality as standard. In encouraging designers to consider the whole-life of the machines they design, design for testability – both in production, and in service - is a key element.





However, a primary quality focus is to ensure that testing can be minimized. This is achieved by increased efforts in early planning stages which ensure the reliable outcome of each process step. A critical aspect of quality assurance know-how is the ability to judge the trade-offs in this area. Clear evaluation of impact and effects must be made at early stages to ensure that maximum value is achieved throughout the development process.

**Change now, not later**

*The exact numbers are particular to each specific situation, but all practitioners agree that the cost of change increases dramatically through the life of a product.*

*Say that implementing a change during detailed design costs one unit. The same change during prototyping or while designing the manufacturing process will cost ten units. Wait until production is in progress, and there are units in the field, and implementing the change may cost 100 or 1000 or even 10000 units.*

Source: Cambashi

Increasing demand for regulatory compliance and demands for improved compliance with product specifications requires companies to better manage the requirement to test process. Management objectives must be to minimise overhead, and maximise the contribution of regulatory demands to real quality improvement.

**Communication and interaction**

Developing great products requires great people. Increasingly, these people are in specialist, third party companies rather than in-house departments. The past process where an internal expert was assigned to a project for specialist tasks such as stress analysis is outmoded.

Demand for improved company efficiencies has driven internal engineering specialists to take on broader ranging skills. The resulting knowledge dilution could lead to reduced performance. To counter this, companies are becoming more reliant on readily available external expertise.

By increasing the interaction of internal resources and third parties, information management and control becomes more challenging. This is further exacerbated by the disparate nature of the design and manufacturing networks that many companies use. In order to improve product cycle times, close collaboration is essential. Access and version control of information is essential.

Recent developments in computing and telecommunications have provided valuable collaboration infrastructures to

**Say no to isolation**

*"Since product and process design have such a major influence on the competitiveness of the enterprise, it is especially critical that the design function be better integrated with the other functions of the enterprise. This means integration within the engineering function (e.g., integration of both product design with process design and integration of electrical, mechanical and software design), integration of the design and engineering function with the rest of the enterprise, and integration of the engineering function with external organizations (customers and suppliers)."*



enable companies to capitalise on extended stakeholder networks. Effective application of these technologies depends on recognition and implementation of the business value of working with third parties to execute specific tasks.

## 4 Product Lifecycle Management

Creating an environment in which, on demand, information is delivered to all pertinent stakeholders, and used efficiently, is fundamental to reduced time to market and improved cycle times. This requires investment in people, processes and the technology. Technology as the enabler of change cannot succeed in isolation.

Yet technology is a critical part of the way forward, and can be the enabler of change needed to implement new ways of working.

Product Lifecycle Management (PLM) systems support the management of a portfolio of products, processes and services from initial concept, through design, launch, production and use to final disposal. PLM environments help co-ordinate product, project and process information throughout new product introduction, production, service and retirement, linking the various players, internal and external to the company, who must collaborate to bring the concept to fruition.

This PLM vision can be achieved step-by-step. Orthodox business review can prioritize problem and opportunity areas, and, the appropriate elements of PLM can be considered in order to achieve improvements in handling of product information in each area of interest.

The nature of benefits offered by PLM technologies can be considered in relation to the categories of business initiative introduced earlier in this document as follows.

### Re-use knowledge and human assets

- Capture and re-use of knowledge and manufacturability rules in the design process. This enables companies to disseminate design and manufacturing knowledge to a broader

audience, or indeed deskill complex tasks. Embedded design for manufacturability rules in areas such as sheet metal manufacture improves time to market and eliminate costly errors and changes in manufacturing.

#### Technology alone is not enough

*"It is a common belief in management practice today that one of the most effective ways to shorten development cycles is through the collaborative work of cross-functional development teams. But if anything is easier said than done, it is that marketing people, development engineers, and manufacturing engineers should collaborate rather than 'throw product specifications over the wall' to one another."*

*The Return Map: Tracking Product Teams, Harvard Business Review, Charles H. House and Raymond L. Price.*

#### Right first time

*"..we foresee fewer problems in manufacture by using better design facilities"*

*Project Manager at a large machinery manufacturer*



- Re-use part information. By using PLM to simplify classification and searching, companies can increase re-use and thus dramatically reduce the effort and costs incurred in delivering new products and proposals. Re-use of proven parts and assemblies in new designs improves quality of finished product, reduces development risk and decreases development times.
- Support for bid preparation. By simplifying access to both historic and planned configuration and cost information, bid preparation and associated document preparation can become more efficient and more accurate, resulting in more profitable projects.

### Process efficiency

- Fewer delays. PLM systems provide workflow automation and change and configuration management throughout the product lifecycle. This accelerates workflows, sign-off procedures and engineering change management, reducing cost and improving efficiency. The need to involve expensive human resource to sort out misunderstandings, for example, when wrong versions are communicated, is reduced.
- Re-use of workflows. Capitalising on existing procedures reduces process risk. Increased profitability is developed by extending this into operational areas such as manufacturing, assembly and test.
- Comprehensive product structure management. This allows early availability of information such as bill of materials information which, when integrated with enterprise applications can provide early project costing. This allows rapid response in the bid cycle and improved offer accuracy.

#### Fewer Fumbles

*"The first challenge is to get rid of unnecessary delays and costs. This is done by eliminating 'fumbles' - bottlenecks, changes, rework, and unnecessary work."*

*Lightning Strategies for Innovation, Willard I. Zangwill*

### Design and development effectiveness

- Virtual (digital) mock-up and product simulation. PLM solutions help validate product operation and part fit. This reduces rework at late stages of manufacture and can eliminate prototype cycles.
- Handling of late changes. Customer satisfaction is improved by efficient management of late changes. Increased differentiation can be encouraged in reduced timescales or products delivered sooner.
- Product information management for product and portfolio management, improving return on investment capital and improving development effectiveness.

#### Electrical and Mechanical integration speed

*"...greater use of digital mock up will help with integration of mechanical and electrical disciplines and speed up our design process"*

*Design Manager at a large mobile machinery manufacturer*



### Quality and test

- Simulation and Analysis. Advanced design environments offer these capabilities, which enable validation and test of parts and assemblies earlier in the development process. When embedded into a PLM environment, the use of the right data and appropriate review of results is supported. This maximises the value of the analysis, both by encouraging innovation through rapid what-if analysis, and reducing the probability of redesign and manufacturing rework.

### Communication and interaction

- Secure and efficient management of product and process over extended networks of stakeholders. Leading PLM solutions offer facilities to manage people, processes and information over interdisciplinary boundaries, throughout the extended enterprise.
- External parties including customers and sub-contractors can be securely integrated. Specific subsets of information are delivered on demand, as required.

## 5 Implementing and Growing with PLM

Although increased functionality in PLM solutions encourages productivity, it is useable functionality that delivers true increased performance. Tools must be driven by the user, not the other way round. Simple interface, flexibility and easy access to advanced functionality improve user productivity. Good training and access to support help lines from trusted and knowledgeable suppliers provide a sound foundation for efficiency. Step-by-step deployments allow benefits to be assimilated with minimum disruption. The importance of investments in training cannot be stressed enough as this is key to enhanced productivity and reduced time to value.

When implemented with appropriate working practices, PLM technologies can help ensure that design variants, enhancements and modifications no longer require in-depth reverse engineering of initial design information. By combining this simplification of access to existing designs with new facilities such as product 'morphing', designers find they can re-use existing designs to deliver new variants with minimum overhead and maximum speed.

As re-use delivers extended value and improved productivity, leading PLM solutions provide open systems interface and access for improved communication with third part applications. This includes areas such as enterprise resource management and service after sales. For mobile equipment and machinery companies, these integrations can facilitate business strategies to extend their share of the lifecycle revenues associated with their products.



## 6 Conclusion

Mobile equipment and machinery makers can gain competitive advantage by embracing change, and preparing themselves to compress cycle times even further, especially in new product introduction.

Implementations of Product Lifecycle Management technologies are one component of a change process that must also consider people, processes and partners. While this change is needed just to manage the tendency towards product and process complexity, it can also deliver product and process improvement, especially through workflow efficiency and improved re-use of designs.