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Industry Knowledge for Business Advantage

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White Paper for
Smart and Synchronized 3DExperience

for
Dassault Systèmes, Industrial Equipment @IE_3DS

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Management Summary

IF WE are able to go beyond concurrent engineering, and apply a smart and synchronized development approach, we will be better able to deliver reliable industrial machinery on time and with less cost.

Increased customer demand and growing amounts of legislation are challenging industrial equipment manufacturers to find improved ways of developing their products so that they can maintain their competitive position.

Historically, development followed a serial process. After the designers had finished detailing the equipment, the manufacturing operation then had to work out how to make it. This approach invariably brought about a flood of late re-works which needed addressing in order to reach a stable design that would meet customer requirements, could be efficiently built and would provide cost effective after-service. Often there would be opposing pressures. In one direction, manufacturers would work to meet tight delivery deadlines. Opposing this, increased rework would stretch out each phase. The longer it took to identify where rework was necessary, the greater would be the amount of time and cost. Although the equipment was comprehensively tested before release, late shipment would typically result, or worse, problems would be detected during customer acceptance.

In recent times, companies introduced a current engineering approach where design, manufacturing and other key disciplines worked closely together to progress the design simultaneously through each stage of the process. For many manufacturers, this has now become a standard way of managing product development, and has contributed significantly towards reducing the amount of rework, shortening development times and lowering project costs.

With increasing complexity of industrial equipment, development processes were progressively enhanced with newer design techniques being explored and adopted. One particular enhancement, which is the focus of this paper, relates to the use of systems engineering for the increasing application of mechanical, electrical, hydraulic and software. Integrated into multi-functional systems, they can address increasingly complex functionality whilst providing greater flexibility and cost savings.

The adoption of systems engineering is becoming an essential approach for many types of products. Through its adoption, an additional challenge faces manufacturers. The IT development of each technology, whether mechanical, electrical or software, is done independently and the product teams have to rely heavily upon physical testing to prove that the overall system performs to the initial requirements. Often problems are only detected at this late stage, and some escape through the net.

With the recent advances made in software applications, it is now possible to develop and virtually test the total system, across mechanical, electrical, fluid and software designs, long before any part of the product has been made. This ability can provide a reduction in time and cost whilst increasing the confidence level that the overall product will perform throughout its full operating cycles without failure. By achieving this, increased customer satisfaction, lower maintenance and greater operational effectiveness for the buyer would result.

Fourth Industrial Revolution

Dassault Systèmes refers to this approach as 'smart and synchronised' and when used with concurrent engineering, it can leverage superior performance (Figure 1).

Smart and synchronised development can take manufacturers up a further notch in addressing today's challenges. An essential factor in making this step is to use some of the latest advances in software which

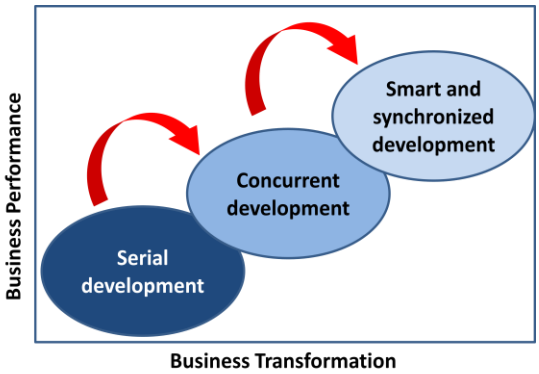

Figure 1: Next step in development performance - Smart and Synchronized

enable multi-functional engineering systems to be designed and virtually tested.

In business advancement terms, the increasing use of smart and synchronized systems is now enabling manufacturers to take advantage of multi-physics systems to address highly complex products and provide greater operational capabilities, reliability, customisable build suited for the mass market, and using low cost set-ups to meet the requirements of the end customer. The availability of this IT technology and the benefits it can provide in all aspects of the product life cycle is increasingly being labelled as the fourth industrial revolution.

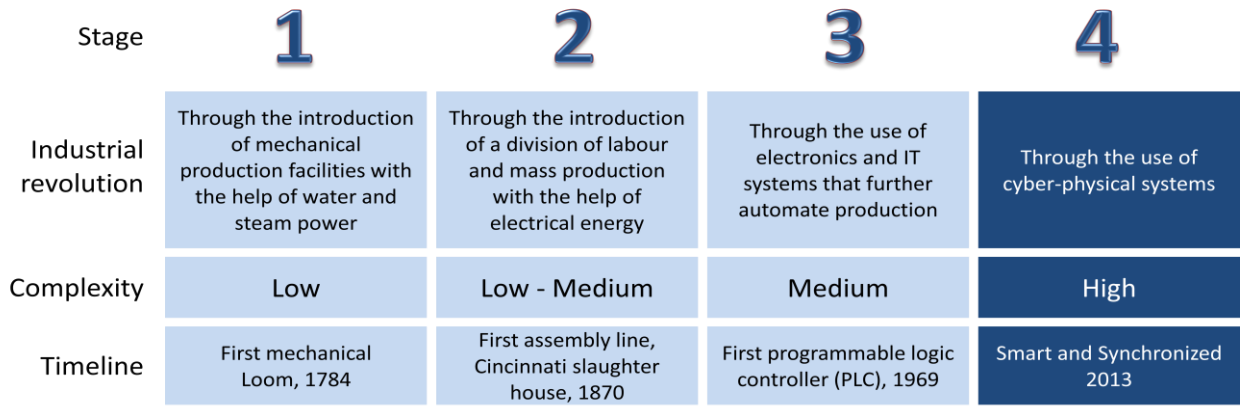

Figure 2 : Stages of Industrial Revolution

Scope

Equipment

This paper focuses on improvements to the development phases of industrial machinery and broadly covers the following equipment segments:

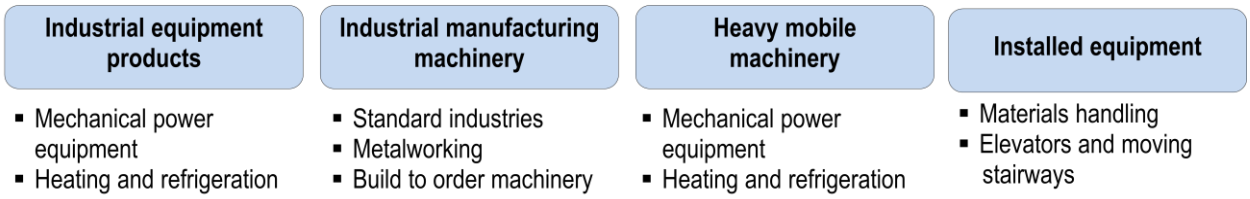

Figure 3: Industrial equipment segment

V-Process

System engineering development usually follows the established V-process (Figure 4 below). On the left side of the V, the design progresses through the different stages from requirements to completion of the design. The product definition is maintained in its virtual (or electronic) form as the equipment design is progressed, viewed, simulated, detailed and digitally validated to ensure that it remains within the contractual requirements. Changes are easy to make in an electronic form and different disciplines can work concurrently to progress the product through its development phases.

The equipment can then be built, tested, and after final inspection, shipped to the customer. This right hand side of the V is referred to as the real (or physical) product. If problems are detected on this right side of the V, it can be expensive to make corrections.

Dassault Systèmes can provide the software capabilities to virtually develop, simulate and test the product and its multi-disciplined systems. There is increased certainty that once built and tested on the right side of the V, its progression through build and test will be right first time. Not only will this reduce testing time, when released to the customer, there will be much greater certainty that in will operate to the contractual requirements.

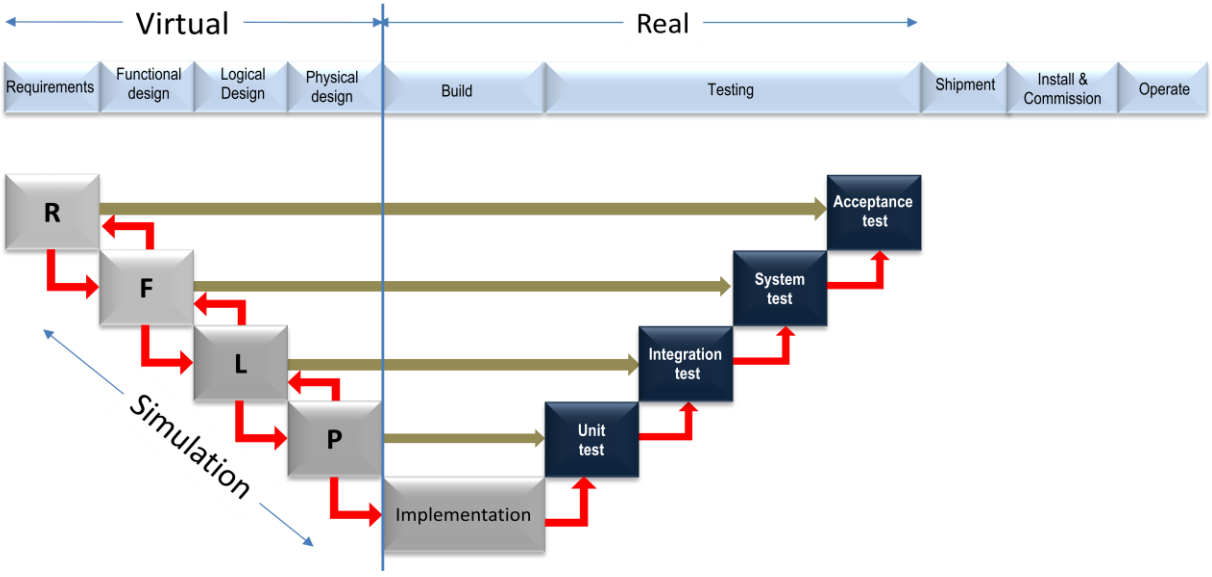

Figure 4: V-Process for industrial machinery development. (R - Requirements; F - Functional design; L - Logical design; P - Physical design).

Trends and Challenges

IF WE meet the challenges facing industrial equipment manufacturers, we can evolve our business model to be more stable and profitable

The global industrial equipment market continues to display intense competition with less profit in the pure equipment sale. There is little room for manufacturers to manoeuvre in satisfying increasing customer demands without making fundamental changes to the design. At the same time, customers expect products to be delivered right first time, on time and operate with exceptional quality and reliability, whilst being offered at a competitive price and supporting an attractive life cycle investment. The equipment must comply with the ever-growing legislative requirements and safety standards. These factors are no longer differentiators in winning, but are essential in being able to compete effectively.

The emphasis has recently since shifted to greater machinery innovation. The more complex machines provide greater operational flexibility with increased cost effectiveness. At a later stage in the life of the equipment, customers expect the possibility to field upgrade so they can enhance the performance of their existing machinery over an extended life.

Various surveys have shown that recent attempts by manufacturers to successfully deliver industrial equipment have not produced the desired results for its customers:

- Up to 50% of equipment has been delivered late *(source: INCOSE, VDC Analysis)*
- More than 40% of projects have failed due to a lack of good requirements management and traceability *(source : VDC Analysis).*

Increasing combinations of mechanics, hydraulics, electronics, and software are being used to extend the overall performance and flexibility. Although good development progress had been made elsewhere, internal systems which incorporate a mixture of mechanical, electrical and software components had been limited by the capabilities of commercial development software. As a result, each discipline had to be separately developed and tested. When completed, they could be made and assembled to form a single physical system for prototype testing. This would be the first time that the system could be end-to-end tested and would frequently result in numerous re-works followed by repeated system testing and validation.

With each re-work cycle, increasingly less time would be available to complete the remaining actions in order to meet the agreed delivery date. With this pressure, testing would frequently be limited to standard use cases. If a specific set of circumstances occurred which resulted in failure, even though infrequent, then under these circumstances, it was highly likely that the problem would remain hidden until after the delivery of the equipment.

Another problem involves user requirements. The cause may have resulted from poor tracking through the development process, compounded by possible customer changes to the original requirements after development work had already started. Unless tightly managed, the delivered equipment may not reflect the requirements of the contract.

Given these challenges, this paper suggests a way forward for these manufacturers to achieve positive and repeatable business results.

Market Analysis

The current worldwide industrial machinery market sizing for systems engineering IT software spend has been estimated by Cambashi Limited to be $636M. Figure 5 below shows the separation of spend for the main application areas within systems engineering. The height of each bubble indicates the total number of employees that use the IT within the listed task.

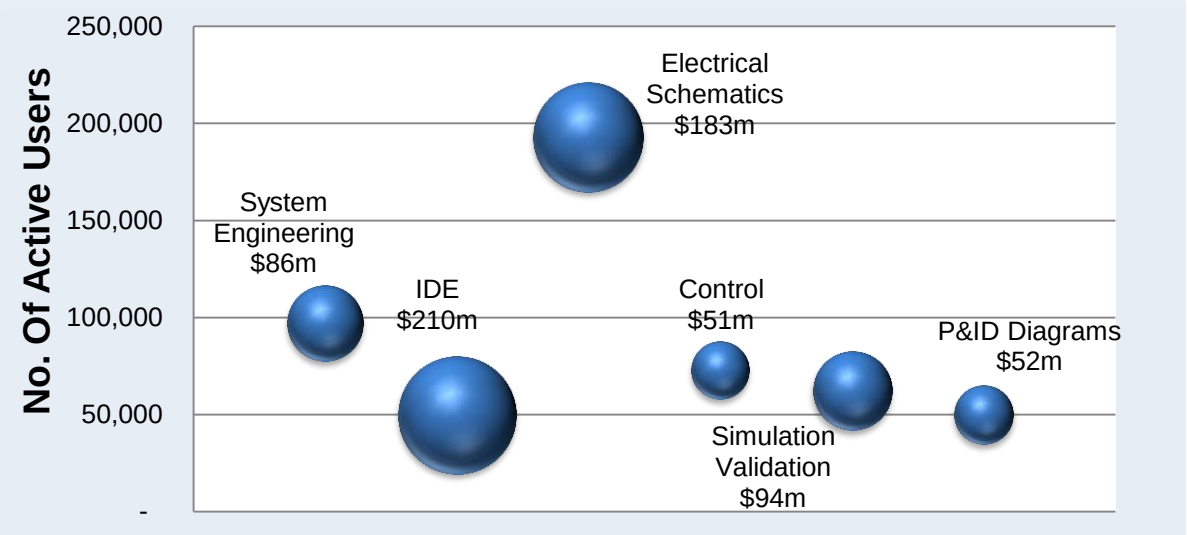

Figure 5 : Number of active users and IT spend within each of the main industrial machinery tasks

Figure 6 shows the same revenue totals per main application task. The difference being that each bar has been separated into those companies which have more than 500 employees (representing approx. 60% by revenue) and those companies which have less than 500 employees (making up the remaining 40% of the total revenues). Estimated growth rates are shown in Figure 7.

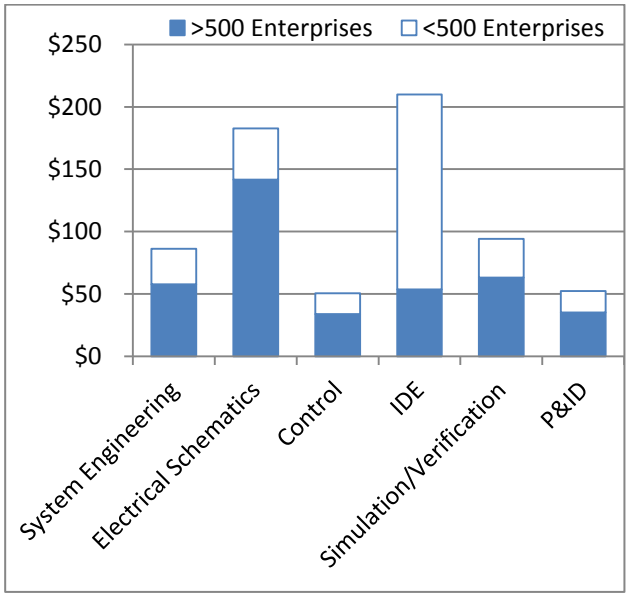

Figure 6 : IT spend ($M split by Industrial Machinery tasks

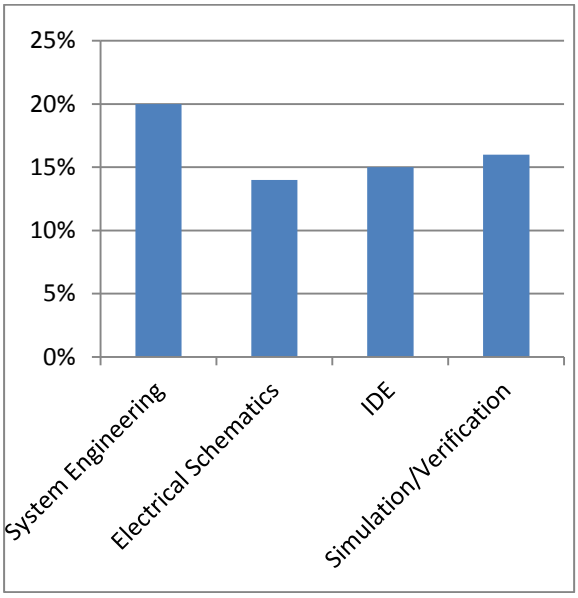

Figure 7: Estimated growth rates from 2012 to 2013

Evolving the development approach

The process of developing industrial equipment has advanced over time, from a serial approach to one based on concurrent engineering. The transition has often resulted in less total development cost and shorter cycle times. Further improvements are possible by adopting a smart and synchronized development approach. This progression is explained further below.

Serial development process

Historically, companies operated a serial development process in which individual disciplines progressed the design activity in isolation of other disciplines. Once completed, the design would be passed on for further advancement. Work could not proceed without adjustments being made to accommodate further progress. This could occur often and create a stream of reworks to earlier design content. Sometimes this related to manufacturing planning and rework at this late point could be extremely expensive and time consuming.

Concurrent development process

Many companies have since adopted concurrent engineering. Multi-disciplined teams work in parallel to advance the design so that each step is considered for capability, manufacturability, sourcing of parts and servicing. By doing so, much of the rework emanating from a serial approach is avoided. This reduction can lead to fewer test cycle times, lower man-hours and reduced costs are often achieved (Figure 8).

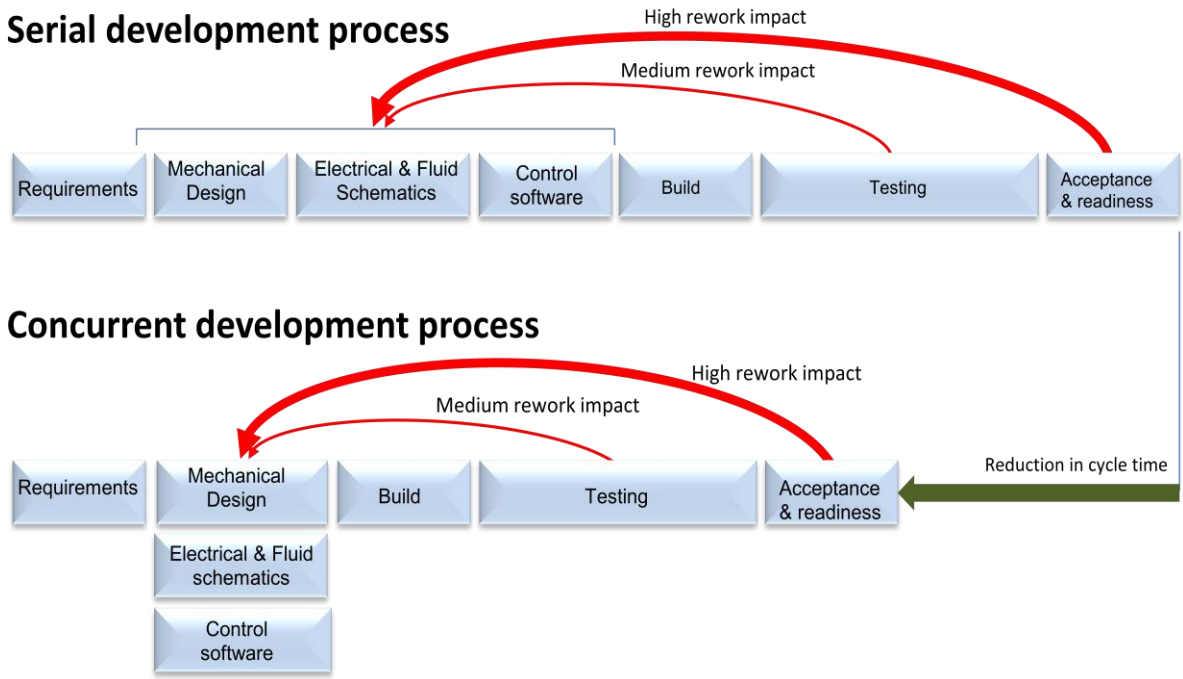

Figure 8: Time reduction in moving to a concurrent engineering process

The concurrent engineering approach was a positive step forward. However, customer demands continued to increase which lead to greater design complexity of the equipment. Manufacturers responded by increasing the amount of electronics and software into the equipment. By combining these disciplines into single systems, increased flexibility, more compactness, and a further lowering of costs would be achieved.

Despite the benefits of these multi-disciplined systems, problems continued to occur in them. It was not possible to test the full system capabilities until late in the development process when a full prototype could be made available. Any indentified problems had to be reworked, sometimes causing long loop-backs in the process in order to modify specific parts of the design, re-build the system and re-test it until

the manufacturer was satisfied with the design. Each time this happened, it gradually eroded the benefits that had been gained from a concurrent engineering approach.

Smart and Synchronized process

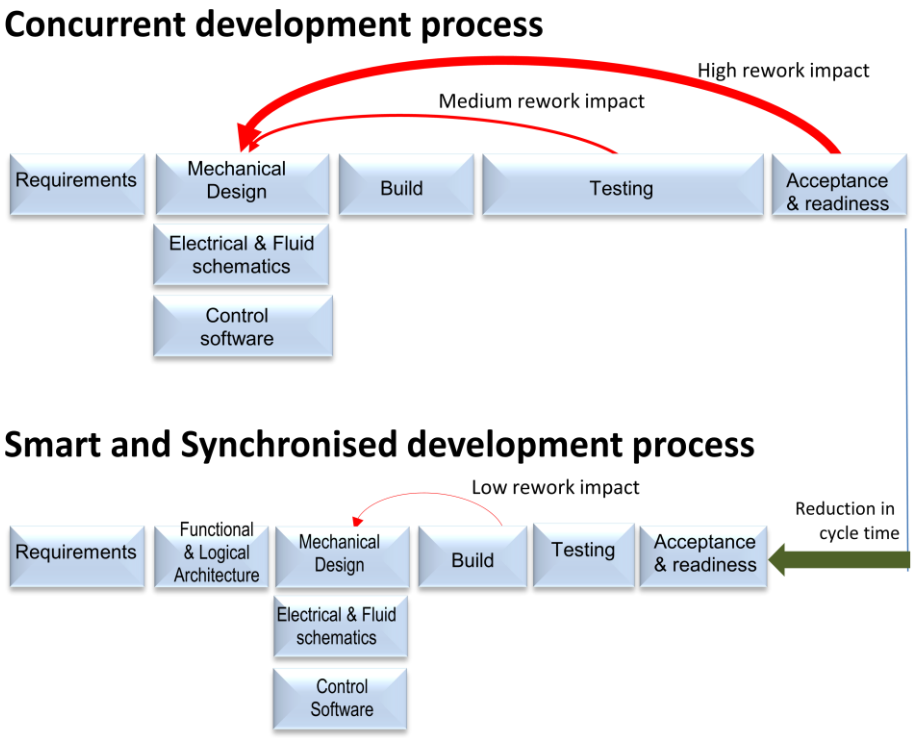

Figure 9 Further performance improvement by moving to Smart and Synchronised process

With the recent advancement of design application software, manufacturers can now address these multi-discipline systems in a way that reduces the unpredictability of results before physical prototyping. By doing so,the level of re-work would be reduced, resulting in a further shortening of time to delivery and the lowering of development costs (Figure 9).

Figure 10 shows the relative costs for each type of development approach.

Serial development is characterised by a lower cost in the early stages. As the design is advanced, the number of re-works grows and the costs increase.

Costs for a concurrent engineering approach are front-loaded. Most disciplines are involved in the team from the development kick-off and enabling earlier design convergence, with fewer late changes and providing lower overall cost. The main weakness with a concurrent approach relates to the limitation of the application software in being able to design even more complex equipment. Without this capability, it will not be possible to avoid re-work.

A smart and synchronised approach goes further and introduces application software that can design and validate multi-discipline systems. In this way, many of the late re-works would be avoided at a much lower development cost.

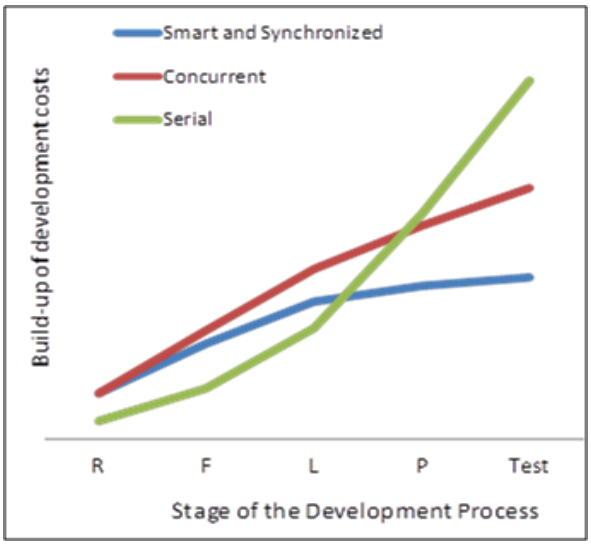

Figure 10: Cost comparison of the different development approaches

A case for Smart and Synchronized

A smart and synchronized approach has the potential of generating business results in excess of the concurrent engineering approach for increasingly more complex equipment. For the manufacturer, the overall development cost will be less and requiring fewer man-days to complete in less time.

A smart and synchronized approach to equipment development can positively affect the business case for both manufacturer and the customer.

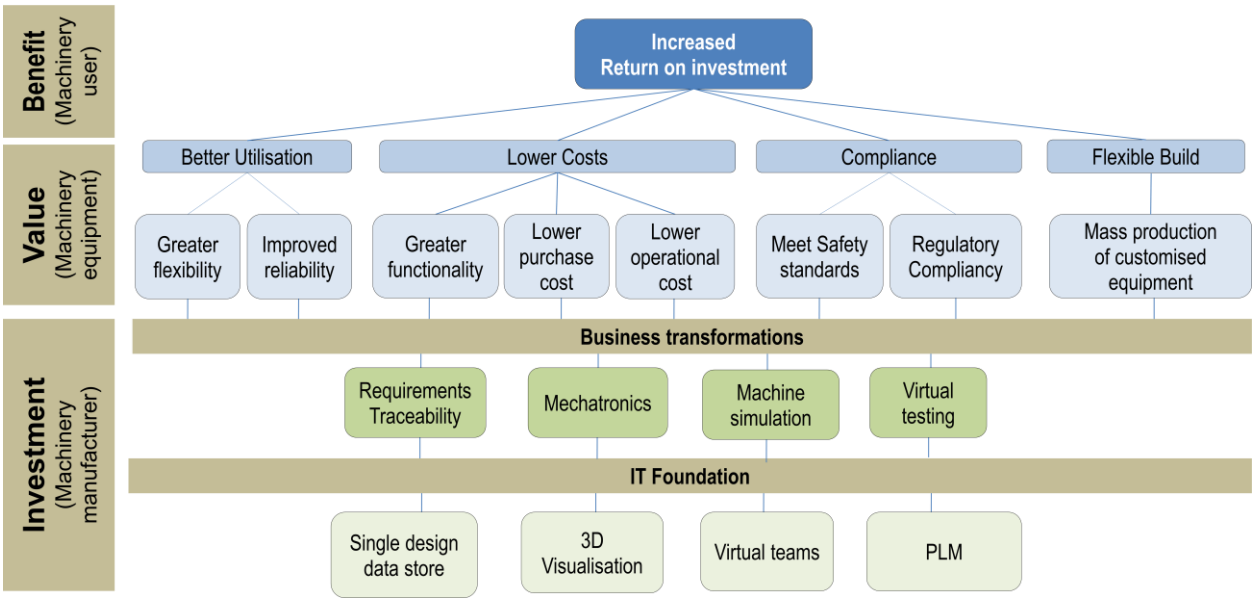

Figure 11: Return on Investment model for Industrial Machinery

Benefit to the machinery operator

The illustration above shows the benefits to the end user of the equipment, including the financial gains that they will experience by using industrial machinery developed in this way. The primary commercial benefit presented here is an increase in return on investment.

Create increased Product Value

Customers normally buy value that fits their needs. By designing industrial machinery that provides value from which the user can benefit, increases the chance of selling it.

Today, users expect better utilisation whilst they can purchase it at a competitive price and it provides excellent economy of operation. The machinery needs to be able to take on a wider range of jobs so that it can remain fully loaded. This helps the business case and provides a better return on investment.

The ability to configure each customer order from standard modules and options, whilst providing greater options through software options provides a swing from heavily customised engineered machinery to predominantly configured-to-order projects. In doing so, costs and timescales whilst reliability will increase through greater reuse of proven design for each order.

Investment for the manufacturer

Being successful in the industrial equipment market today means that manufacturers have to develop machinery with more value to the end user, deliver it on time within the agreed requirements, and provide quality support throughout its product lifecycle. It is likely to require an investment to transform the development business process to a smart and synchronized approach and to have it supported by an appropriate IT platform and applications.

Benefits

This white paper focuses on how industrial equipment manufacturers can meet their current business performance by applying selected key business transformations enabled by appropriate IT capabilities.

With this smart and synchronized approach, industrial equipment designers will be able to offer their customers compliant products with better utilisation at fewer costs.

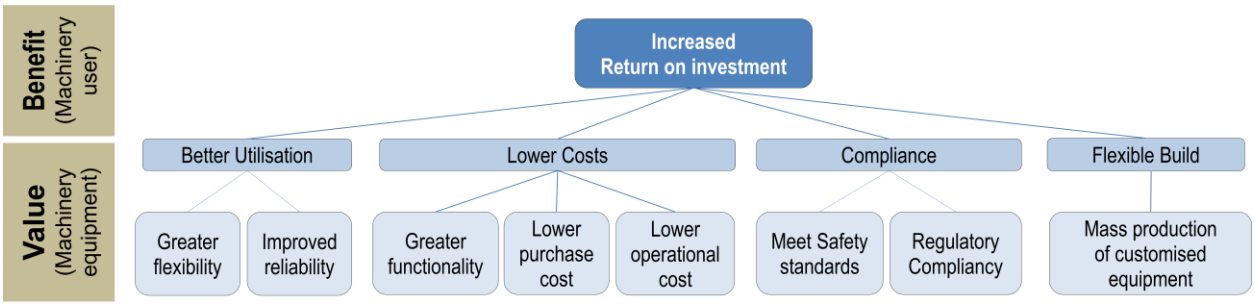

Figure 12: Potential benefits

Achieving greater equipment value through a smart and synchronised approach will also provide the following:

- A single design data store that holds all details and relationships which link to the functional definition, manufacturability, configuration simulation results
- Virtual team members able to explore, simulate, analyse and inject better ideas and innovation through this digital environment
- Compliance can be examined to ensure that the development maintains its focus on these issues and continues throughout the development process, ensuring that each decision from any team member remains compliant
- Simulation of the full operational cycles for equipment to verify that it functions correctly and no points of failure exist.
- Requirements that are traceable throughout the process so that every feature ultimately meets customer needs and the final acceptance process is completed 100% first time.

Recent advances in application software can assist industrial machinery manufacturers to get their products right through design. As part of its Smart and Synchronized 3DExperience, Dassault Systèmes has recently launched the necessary application to enable multiple disciplines to be combined into systems, virtually validated, and built so that they will be right first time. In doing so, industrial equipment manufacturers will now be able to address the increasing complexities and deliver reliable projects on time and to cost.

Call to Action

Industrial equipment manufactures need to be at the forefront of their markets in developing highly competitive products that have high value and meet customer demands. Smart and synchronized provides a path to achievement of this and delivers greater commercial results.

To find out how you can benefit from smart and synchronised development, contact your local Dassault Systèmes representative, or call the contact below directly to evaluate how they can help your business. You can also visit the Smart and Synchronized dedicated web page:
http://www.3ds.com/industries/industrial-equipment/smart-and-synchronized/

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