Learning Based Product Development

Dr. Parviz (Perry) Daneshgari
Motor Consultants of America

Philip E. Nimmo IV
Motor Consultants of America

ABSTRACT

The complex task of Product Development has been a major challenge for product manufacturers and developers since the introduction of complex mechanical systems. The current approach to Product Development planning and execution, for many complex commercial products, is resource based as opposed to learning based. The future competitiveness in the world market is being driven by a need to enlist a new Product Development planning and execution philosophy. This new philosophy is one that is focused on identifying and prioritizing learning requirements on a product specific basis. In this paper, the authors will explain the fundamental philosophical and technical differences between the two approaches and illustrate the advantages of the new approach. This new approach is dependent on the understanding and application of the following key concepts:

1. Zero Based Learning
2. Risk Prioritization and Sequencing
3. Mathematical Models and Problem Solving
4. Rapid Learning Cycles
5. Rapid Engineering Prototyping

This paper will describe the scientific application of Learning Based Product Development. It will provide examples of planning and execution that have been tested and proven through current product development efforts. This will enable the product developing organizations, and the individuals responsible for product development to use all of the available knowledge to reduce risk of uncertainties and improve timing, quality and performance of new products.

INTRODUCTION

As the typical product becomes more and more complex the task of engineering requires the integration of tens of thousands of individual components into a single product. The conventional approach to complex product development has been to develop each part separately (perhaps even at different companies) and then have the product development team integrate all of the individual components into a working system.

This approach works under two conditions:

1. Breakthrough technology; such as NASA satellites or new military technologies
2. Hypothetical unlimited markets and unlimited time-to-market (TTM)

The breakthrough technology approach requires top down identification of system, subsystem and component specification. Practical application of this method is limited to unique scientific projects such as those that commonly occur in the aerospace industry.

Unlimited markets and a long product life-cycle will also enable a product developing company to design and engineer their products part by part, since the product can be improved during each successive year in the market. Unfortunately, the luxury of unlimited markets and long product life cycles are more hypothetical then real, in today's marketplace.

In a multi-year investigation and implementation MCA, working with one of it's clients, has been able to redesign the processes within the area of product development. The redesign resulted in impressive improvements in time, cost and quality of the products. Time and cost savings in excess of 20% were achieved in the area of product performance development. The methodology used to get these results within this company is a specific application of "Learning Based Product Development".

PRODUCTION ENGINEERING AS A SYSTEM

The Value Added Workflow of product engineering is depicted in Figure 1. Product needs are the existing gaps between current product performance and the customer requirements. Application of Quality Function Deployment (QFD) helps to translate the customer needs into technical requirements. At this stage, the design and calibration of the product starts. Development adds value by making sure that the design will satisfy the customer's functional performance requirements. Validation is the phase of product development, which will enable the product's testing, by simulating the customer environment. This process by itself is not very complicated; the complexity is added to this process when the integration of the parts requires a plan, to enable engineering to achieve its goals. Limited resources and time have the highest impact on the company's process of creating the plan. This limitation has forced many product-developing companies to focus their planning on resources rather than the learning that is necessary to reduce the gap. During the busy years of work, engineers and managers focus on resource firefighting and in order to develop products, they rely on templates and requirements driven product development. This process further alienates them from a product-oriented organization and pushes them towards a resource and process-oriented organization. This, in turn, creates bureaucracies hampering the speed needed to get the product to market.

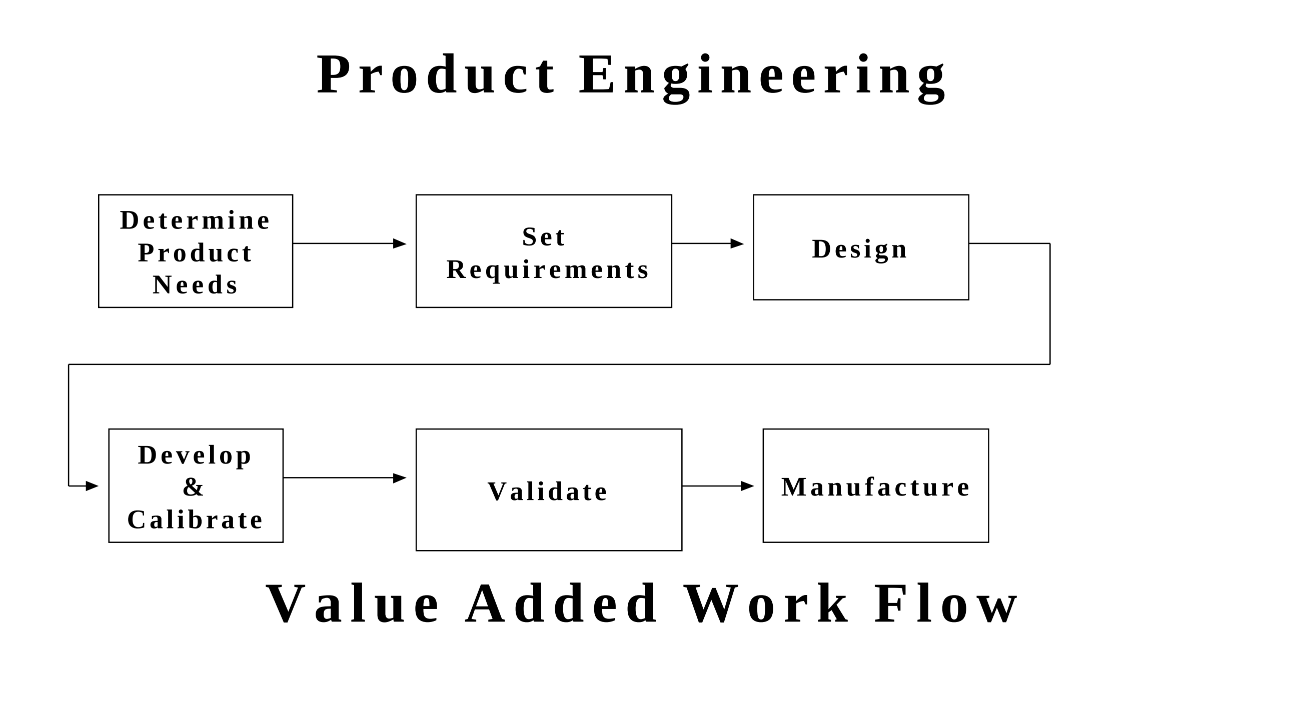

Figure 1; Product Engineering work flow diagram

Several years of research have been conducted to understand the fundamental differences in product development processes that are used by many manufacturers. The final conclusion was that most of the processes of product development look alike. What distinguishes the companies is not their use of tangible tools in the process of product development; it is their ***Management's Philosophy of Operation***.

BUSINESS LEARNING SYSTEM

Not unlike manufacturing, the process of product engineering has a product, which needs to be measured on its merits in regards to time, cost and quality. The product of engineering is ***Information***, which will be delivered in various forms, such as drawings, specifications and assembly documents. To move away from the resource based planning, and produce high quality engineering products; the manufacturer must establish a procedure for worldwide benchmarking. The results of the benchmarking then direct the managers to Learning Based Product Planning. Figure 2 was developed to depict the processes of Learning Based Planning.

This new philosophy is fundamentally different than the traditional resource based process. It starts with identification of the opportunities and gaps to the current market needs. Once the gaps have been identified, they are then divided into:

1. Technological
2. Integration
3. Business

Technological gaps are those opportunities that are created by the introduction of new technology within the market. Integration gaps are defined by the current product's performance opportunities measured by the consumer advocates and other market measures. The business gap is a measure of the opportunity from the gaps in product profitability, warranty costs and product development's allocated portion of the total product cost.

Learning based Product Development starts with management taking an active role in prioritizing the risk and therefore the "Learning Objectives." The steps of management's input to "Learning on Demand" are:

1. Zero Based Learning
2. Prioritization of Learning Objectives (LO)
3. Sequencing of Learning
4. Resource balancing
5. Reduction of Risk

Where most of these steps are self-explanatory, Zero Based Learning requires a more detailed analysis. The fundamental difference between the resource based and learning based product development is best illustrated in this step. In the resource-based process, all of the tests are run for all of the products. There are no reference points to start with. Every program starts with a clean sheet of paper. In contrast, with the learning based process, the historical knowns and unknowns are identified and only the real program risks are investigated. The second difference between the two processes is the prioritization and sequencing of the program risks.

After the real program risks are identified it is practical to begin identifying the necessary learning objectives that must be satisfied to reduce these risks. The learning objectives can be sequenced in order of risk priority (the learning requirements addressing the highest risk areas are the highest priority). Only after the necessary learning requirements have been identified and prioritized can the resources be addressed. Since resources are typically limited they must be balanced in order to ensure that the majority of the resources are available to address the highest priority learning requirements. Last, we identify, plan and perform the work necessary to satisfy the learning objectives of the program.

Common tools and processes are necessary within the world of product development. However, these tools by themselves will not ensure a product's success in the market place. The true measurement of the product's performance is gauged by the market's prevailing forces such as is measured by:

1. JD Power or similar data
2. Time to market
3. Product cost
4. Product quality
5. Process efficiency
6. Development cost
7. Product performance

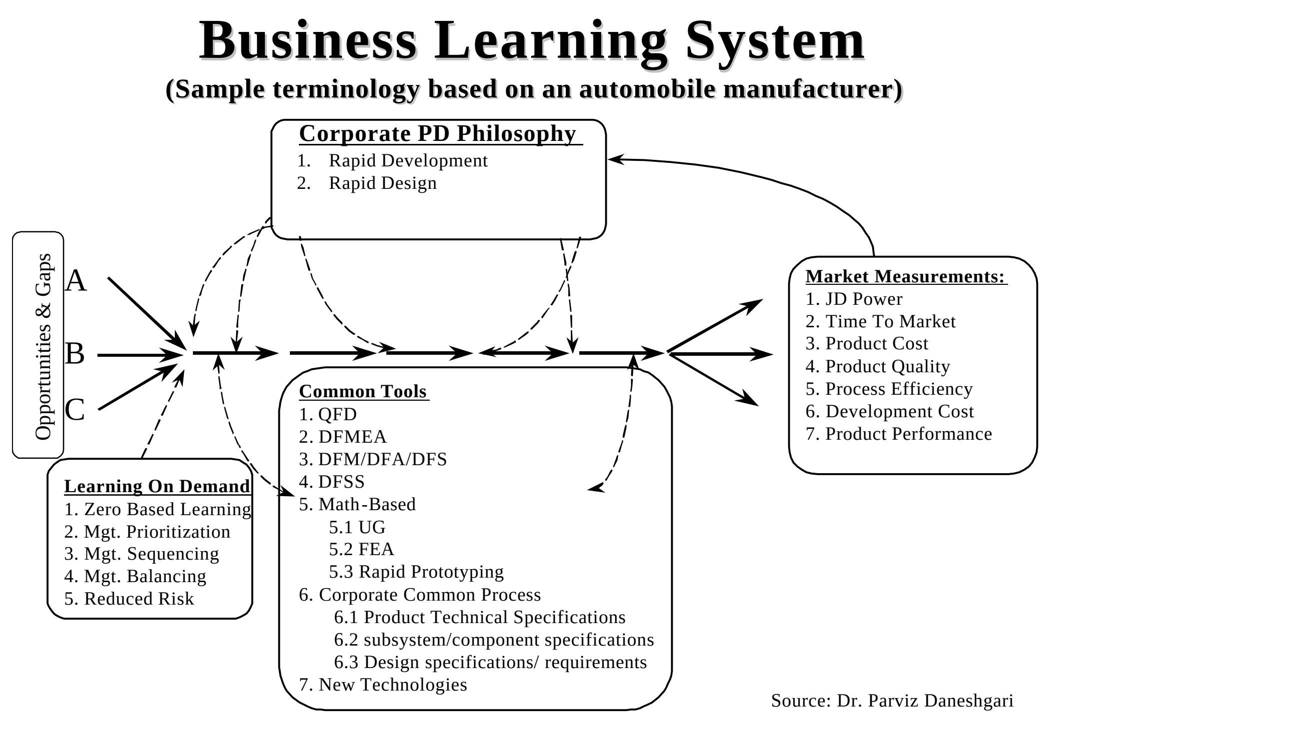

Figure 2; Process map for a typical Business Learning System

The main factor distinguishing various companies is their ability to implement the Rapid Product Development Philosophy, which is enabled **only** by the correct management philosophy. Thus, it is ***Management's Philosophy of Operation*** and not their tools or processes that most influence success.

BASIC ENABLERS

The application of Learning Based Product Development requires some fundamental shifts in the corporate engineering infrastructure. One of the major changes in the infrastructure needs to be in the pre-

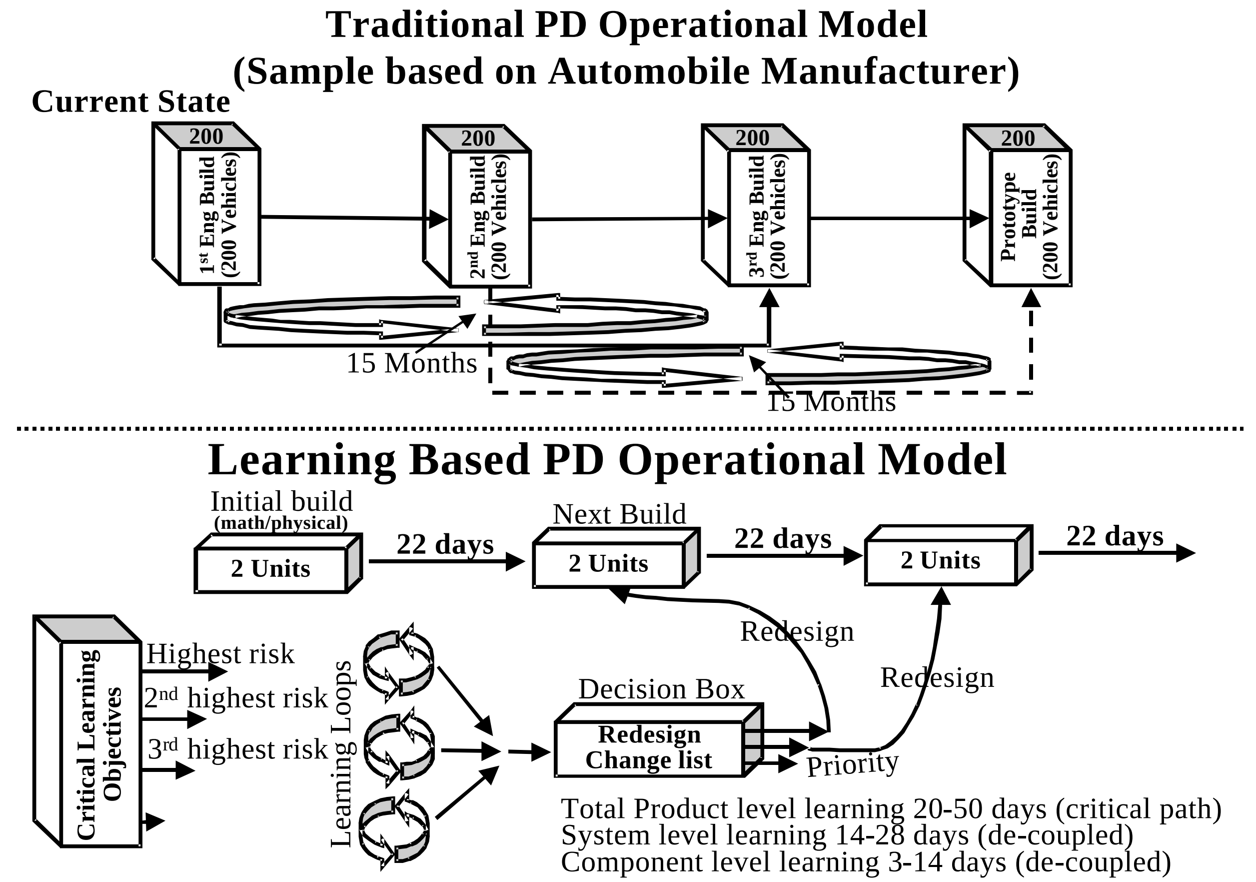

Figure 3; Resource based vs. Learning based operational models

production area. Throughout most industries the traditional approach has been a batch production system. The Learning Based Product Development requires a more nimble process that can support rapid learning loops. In this process, the major engineering build and assembly events are no longer necessary during the early product development phases, although block builds may still be used for some total product integration activities. The learning happens in smaller and more focused development events. Figure 3 shows the differences between these two operations. Based on the learning objective priorities, the allocated test "vehicles" will be used to solve the problems and reduce the risk. Figure 3 is also depicting the typical learning cycle time differences between the two processes.

Other enablers, such as:

1. Creation of "Knowledge Bins"
2. Content reduction
3. De-coupled technology development
4. De-coupled subsystem development
5. Subsystem learning cycle reduction
6. Complete integration of math models into the process of product development.

Most companies have tried one or the other of these enablers. Our sample company had to make all these infrastructure changes to enable rapid product development.

CONCLUSION

By using this philosophy MCA has been able to reduce product development cost by better than 20%, for one of it's client's product performance issues. It is imperative to note that Learning Based Product Development is not a process; rather it is a Philosophy of Operation that must be supported by the highest level of the corporation's management. In summary, "Learning Based Product Development" can be summarized as:

1. It is a Management Philosophy.
2. It consists of multiple quick learning cycles.
3. Managers set and prioritize the "Learning Objectives," and lead the product development.
4. Managers sequence the learning based on risk.
5. Manufacturing variation is part of the early risk assessment.
6. Product technical specifications are simplified and used as a statistical process control tool.
7. Mathematical models and hardware tools are used simultaneously to reduce risk.
8. Infrastructures must support rapid learning and the reduction of risk activities.

REFERENCES

1. Managing New Product & Process Development, Clark & Wheelwright, Free Press 1993.
2. The Chase, Daneshgari, Black Forest Press 1998.
3. The New Economics, Deming, MIT 1993

CONTACT

Dr. Parviz (Perry) Daneshgari
MCA
12765 S. Saginaw St, Ste 401
Grand Blanc, MI 48439
Ph: (810) 953-5500 / Cel: (810) 287-1975

Motor Consultants of America (MCA), Inc. was founded in 1990 by Dr. Parviz (Perry) Daneshgari to assist companies with the identification and reduction of internal waste and inefficiencies. MCA's focus has been and remains on process improvement through the managed application of fundamental business philosophies and principles.

Unlike most process consultants MCA is focused intently on aiding managers to identify inherent waste associated with their intangible processes and systems. Once identified MCA assists managers to redesign their processes and systems allowing them to function more efficiently and better serve their corporate goals.

DEFINITIONS, ACRONYMS, ABBREVIATIONS

LO: Learning Objectives

PD: Product Development

QFD: Quality Function Deployment

DFMEA: Design Failure Mode and Effect Analysis

UG: Unigraphics

FEA: Finite Element Analysis

DFM: Design For Manufacturing

DFSS: Design for Six Sigma

DFS: Design for Service