Tools for Competitive Product Development

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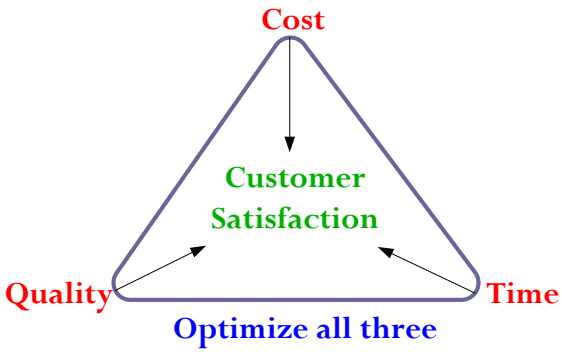
Lebanon

It is all about……



"Customers will go out of their way to buy a superior product, and you can charge them a toll for the trip."

Facts

(Aberdeen Group, 2006,2007)

Best in class **Mechatronics** manufacturer's hit their revenue, cost, launch date, and quality targets for 84% or more of their products; 4/5 resolve integration issues in design; and 7/10 plan on **integrated data management** across disciplines.

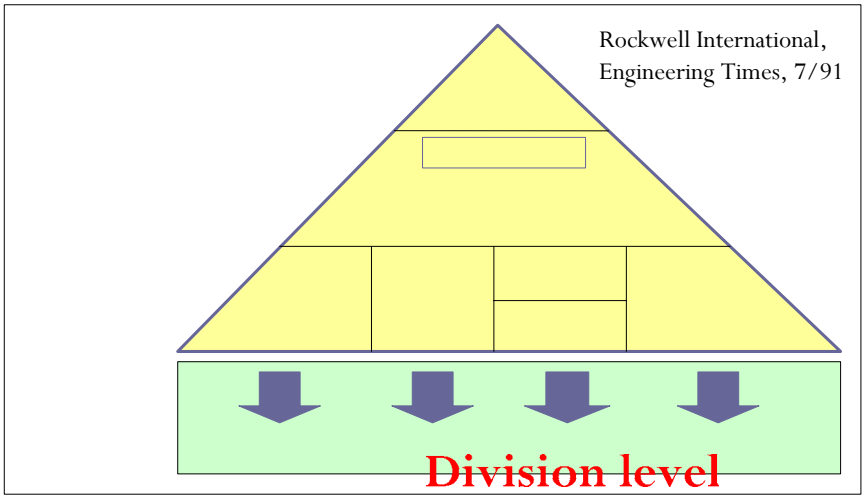
Leveraging a variety of **product lifecycle management (PLM) technologies**, the best-in-class SMEs deliver products to market on average 22% faster than their competition and show superior (twice or better) product performance in hitting Launch date targets, revenue targets, product cost targets, development cost targets, and quality targets.

Using **CAD/CAM/CAE tools, best–in-class SMEs** are:

- More likely to execute formalized design processes with the support of the data management lifecycle state and workflow technology
- More likely to provide combined CAD/CAE tools to engineers and combined CAD/CAM tool to machinists
- More likely to capture and reuse design, simulation, and manufacturing knowledge in CAD, CAM, and CAE templates and wizards.

4

Concurrent engineering culture



Robust design (or *parameter design*): the product development activity aimed at improving the desired performance of the product while minimizing the effect of noise.

5

Organization

Colloc

Keys to building quality

Begin with the assessment of the current state!

- ***Philosophy of continuous improvement*** (CI) – strong leadership that understands the CI concept is essential to implement this philosophy. Methods include TQM, lean manufacturing, 6-sigma, etc.
- ***Consistency in everything you do*** – standardization (written procedures for all operations) is necessary but without inhibiting innovation. Confirm that all operators understand the "how and why" and follow the established procedures.
- ***Team work*** should be engrained in the culture - involves every individual in the firm. Participation take many forms: quality circles, cross-functional groups, problem solving teams, project teams, etc.
- ***Routine measure and analysis*** to ensure more consistent products and services.
- ***Training and education***– most significant building block of quality. All must be educated in the concept of CI and statistical tools needed to maintain the stability of the process. This is what glues all keys together.

6

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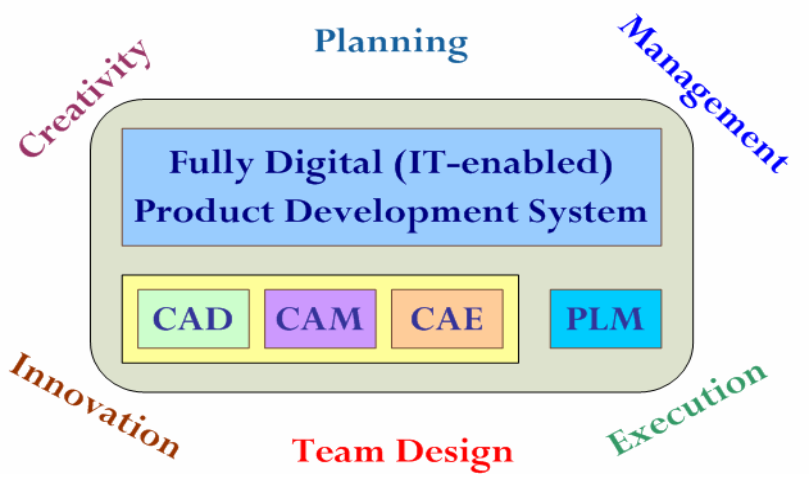
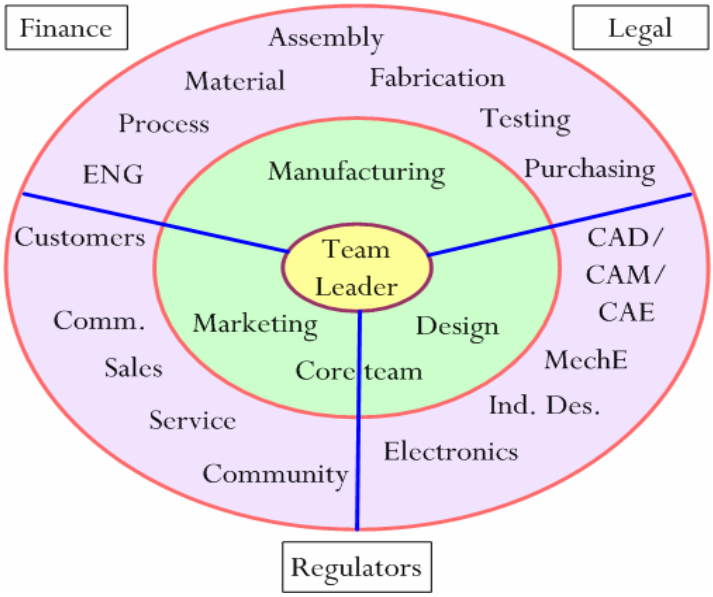
Tangible attributes for successful product realization



7

Project team



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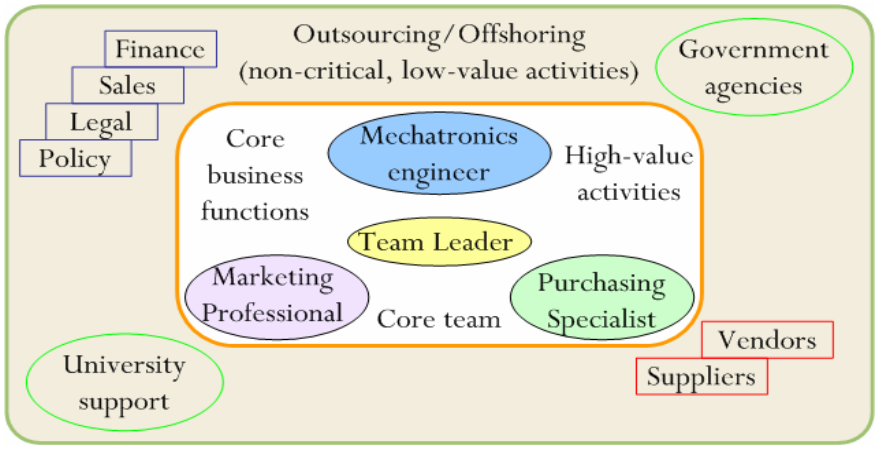
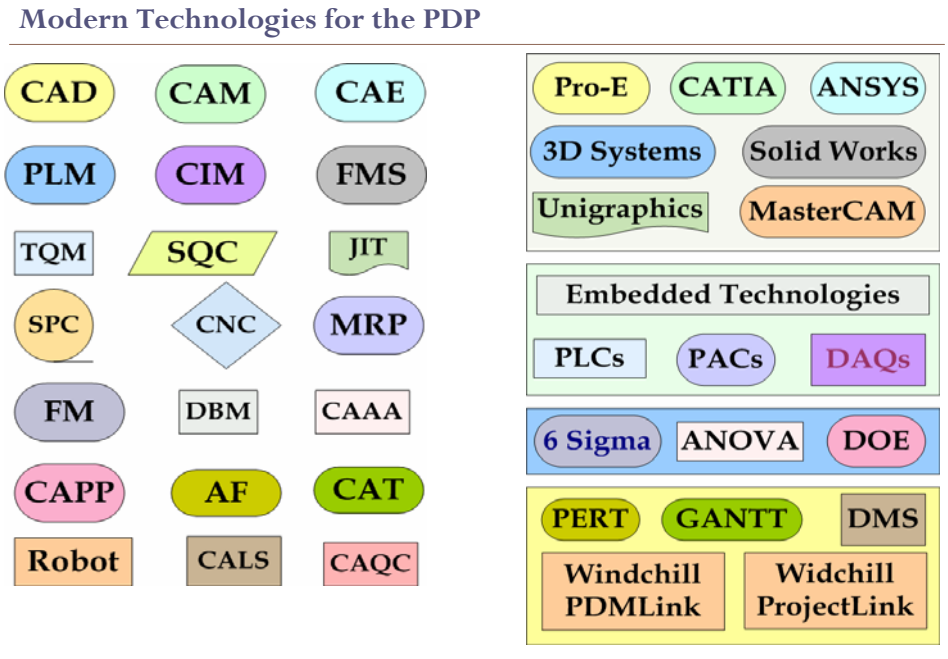
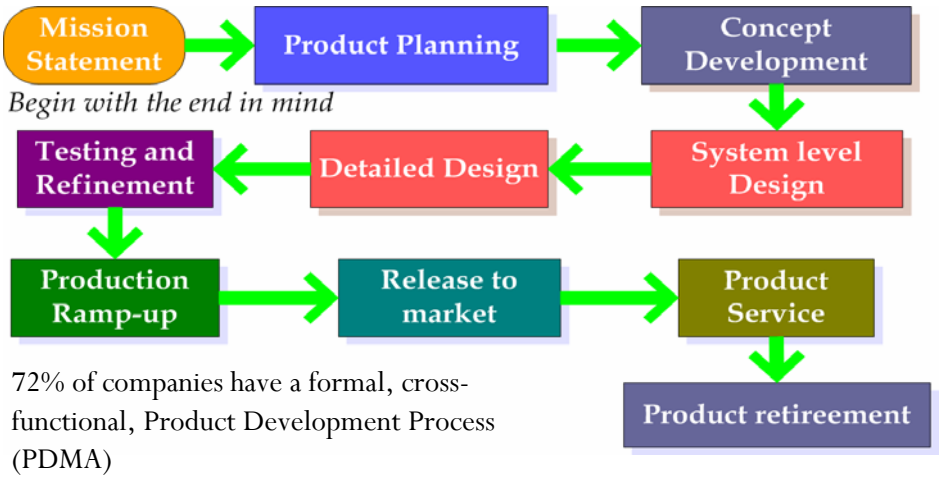

Outsourcing/Offshoring
(non-critical, low-value activities)
Finance
Sales
Legal
Policy
Government agencies
Core business functions
Mechatronics engineer
High-value activities
Team Leader
Marketing Professional
Core team
Purchasing Specialist
University support
Vendors
Suppliers


Modern Technologies for the PDP
CAD
CAM
CAE
PLM
CIM
FMS
TQM
SQC
JIT
SPC
CNC
MRP
FM
DBM
CAAA
CAPP
AF
CAT
Robot
CALS
CAQC
Pro-E
CATIA
ANSYS
3D Systems
Solid Works
Unigraphics
MasterCAM
Embedded Technologies
PLCs
PACs
DAQs
6 Sigma
ANOVA
DOE
PERT
GANTT
DMS
Windchill PDMLink
Widchill ProjectLink
10

Generic Product Development Process

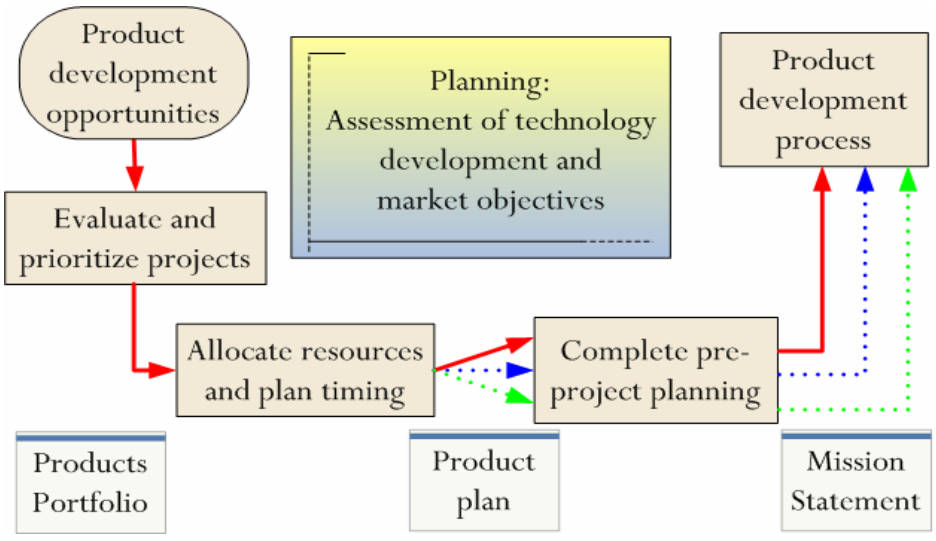


72% of companies have a formal, cross-functional, Product Development Process (PDMA)

The **process** to conceive, design, produce, bring to market, and support new and improved products. It includes: QFD, design of the product, its production and support processes, and operating the processes.

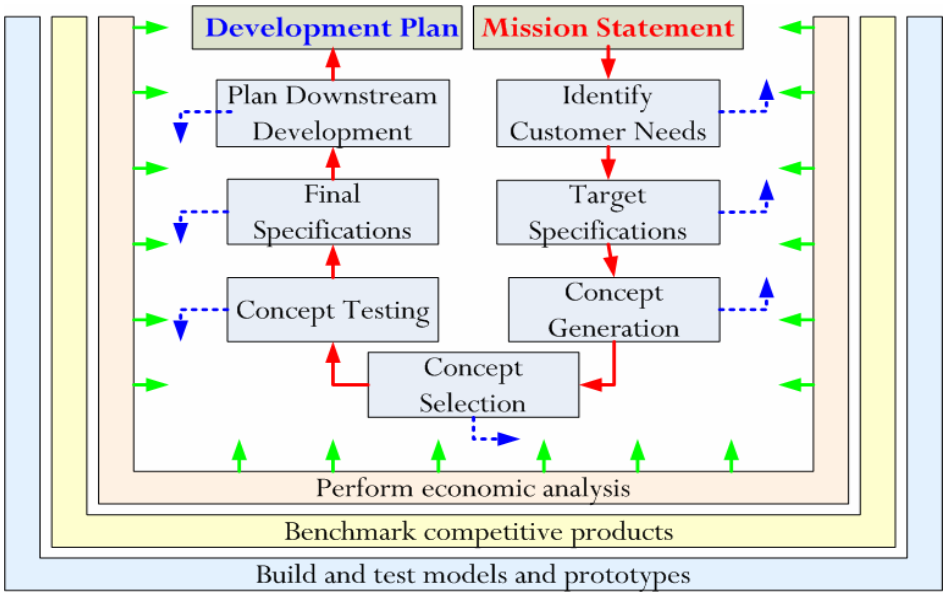
11

Product planning



12

Concept Development Process- front end process



13

Identify customer needs

Interviews, focus groups, actual use environment

Express needs in terms of product function and attributes

Primary & secondary needs, subgroups of 2 to 5 groups

Gather raw data from customers → Interpret data in terms of customer needs → Organize the needs into hierarchy

Establish the relative importance of customer needs → Reflect on the results and the process

Process Goals

- Ensure product focused on customer needs
- Identify latent and explicity needs
- Establish a facy base for justifying soecs
- Create an archival record of the needs activity
- Ensure no critical customer needs are missed
- Develop a common understanding of customer needs

Product specifications

Product specifications

The process in which customer needs stated in the language of the customer are translated into a set of specifications which are measurable detail what the product has to do

A specification consists of a metric (e.g. average time to assemble) and a value (e.g. less than 75 seconds)

Product specifications are the set of individual specifications

Needs-metrics matrix relates needs and metrics. It is a key element in the *house of quality*, a graphical technique used in *quality function deployment*, or QFD.

Metrics should be complete, dependent variables, practical, and should include a popular criteria for comparison in the marketplace (e.g. SNR, MTBF, etc.)

Target specifications

- Prepare the list metrics
- Collect competitive benchamrking information
- Set ideal and marginally acceptable target values
- Reflect on the results and the process

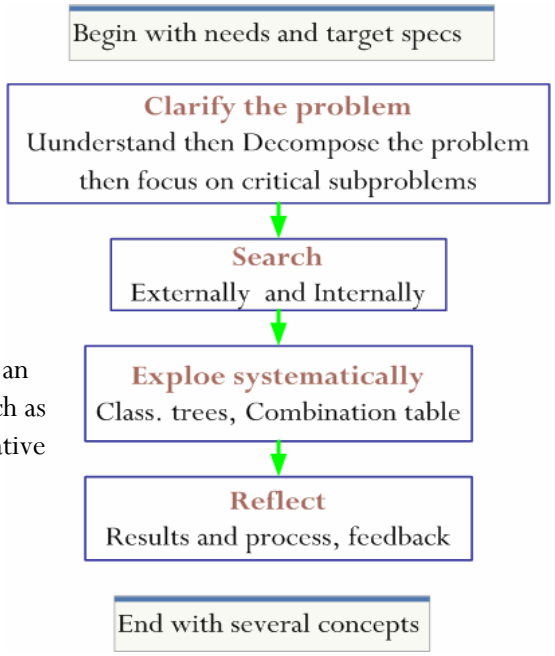
Final specifications

- Develop technical model to assess technical feasability
- Develop cost model for target costing
- Refine specs, make trade-offs as necessary – competitive map
- Flow down specs to specs of each subsystem (as appropriate)
- Reflect on results & process: competitiveness, uncertainty, concept, technical model, etc.

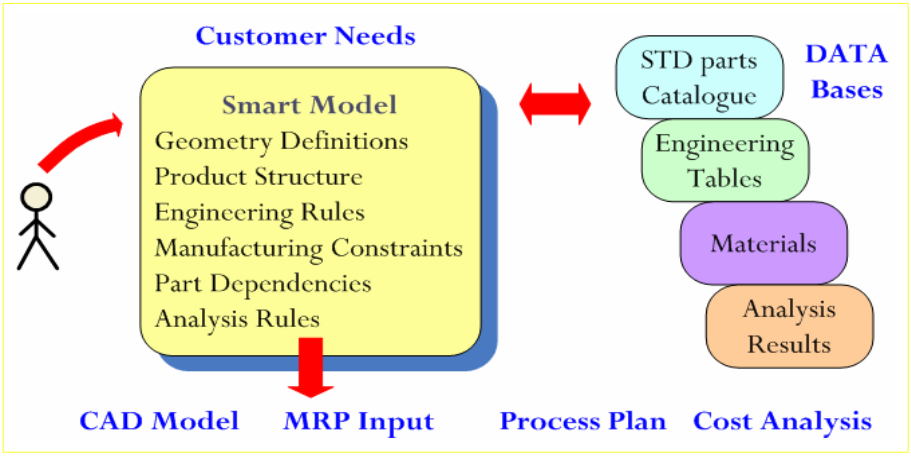
Concept Generation and Selection

product concept is an approximate description of technology, working principles, and form of the product expressed as a sketch or a rough 3D model accompanied with a brief description.

Concept selection is the process of evaluating concepts with respect to an established performance criteria such as customer needs, comparing the relative strengths and weaknesses of the concepts, and selecting the best concept(s) for further design, refinement, and production.



Design: Knowledge-based engineering



Cost of the product is **committed early** in the design process

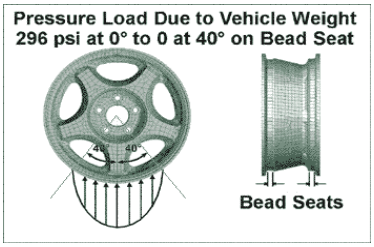
18

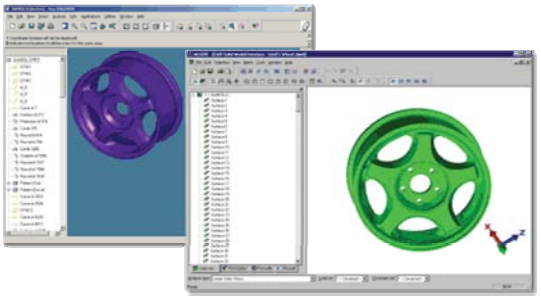
CAD/CAM/CAE

CAD/CAM/CAE refer to the integration of computer into design and manufacturing by means of computation, analysis, testing, and simulation process to improve the accuracy, and production process to improve productivity. Advantages:

- Reduced cost
- Short product design cycle
- Improved quality
- Display and analytical capabilities reduce number of test articles and mock-ups
- Enhanced communications between design and manufacturing improves design and production methods
- Fewer engineering change orders

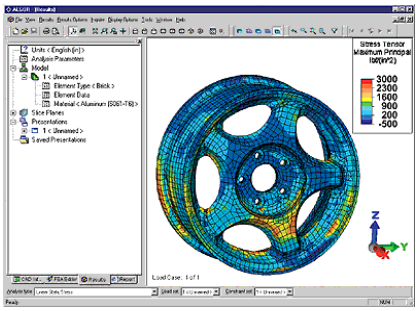
19



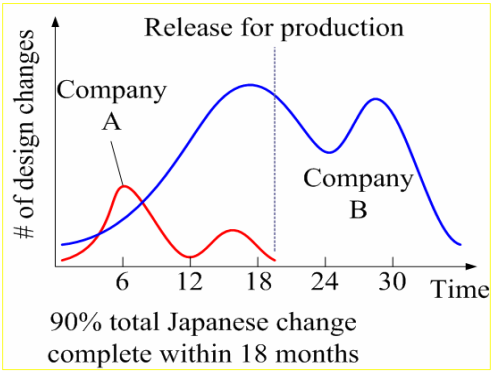


CAD: ProE solid model

Measurement Tools: Strain gauge experiment



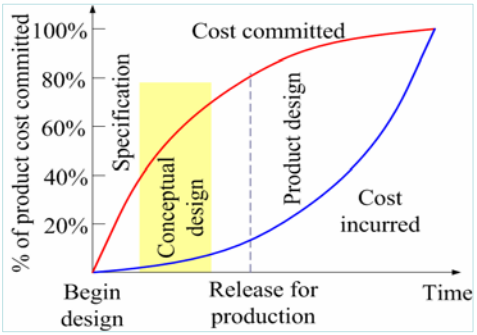
CAE: FEA Solution



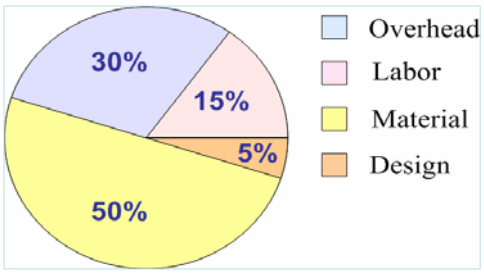
90% total Japanese change complete within 18 months

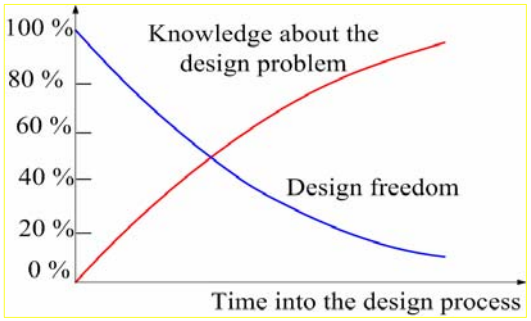
The more design changes early on saves time

Decisions made during the design process have a great effect on the cost of a product

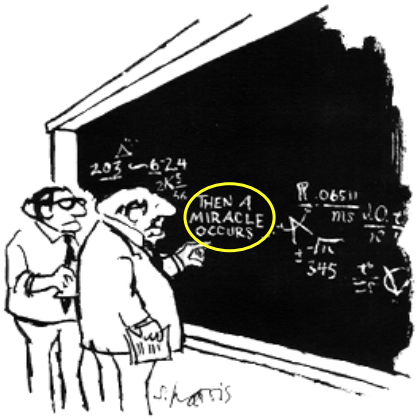


The actual cost of design is usually a small fraction of the manufacturing cost of a product.

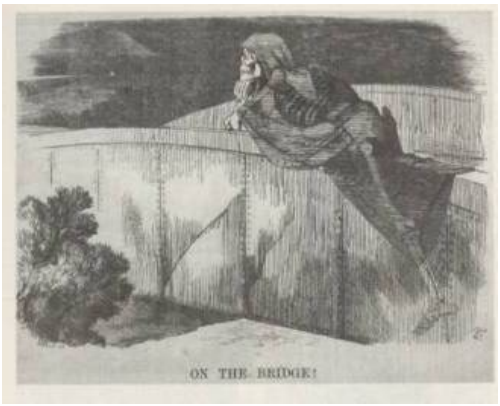




Design process paradox: The more knowledge you acquire about a product the less freedom you have



"I think you should be more explicit here in step two."



So much at stake to be complacent

Supporting Materials

Innovation

Market place is placing immense pressure to make innovative, quality, more complex, smart, cost effective, and sustainable products.

Although innovation is difficult, challenging, and carries immense financial risks.

Why companies engage in innovation? The potential returns are worth the gamble.

The pressures of creating new quality and cost effective products, assessing risks, and introducing the product to market first are immense.

72% of companies put innovation in their top three priorities yet only 48% are dissatisfied with financial returns from the innovation investment. *Boston Consulting Group,* 2006

Reason: "in the end it is clear that the biggest challenge in innovation remains ***execution***, not invention" (*Invention 2005*)

25

Creativity vs. innovation

".....creativity, by individuals and teams *is a starting point for innovation;* the first is necessary *but not sufficient* condition for the second".

Creativity blossoms in a culture that celebrates teamwork and entrepreneurial spirit

"Groups in cross-functional teams can achieve creative solutions that are often beyond the scope of individuals"

Dysfunctional teams can often trace their lack of innovation back to corporate culture"

Holding creativity workshops during product development could reap results if

- Support of top management
- Focused on customer needs
- Execution - expectation to when technology work could be done.

ME Magazine, September 2007 26

Team design drives innovation

Forming *Cross-functional teams* bring together multiple perspectives to solve problems and share specialized insights across a range of products.

Team design

- Collaborative in nature to effectively exchange ideas online and in person to move the process toward the best.
- Requires the right technology, the right processes, and the appropriate encouragement to practice.
- Involved engineers rarely have full-time commitment; they interact on other projects concurrently avoids narrow perspectives on any solution.
- Share ideas and information and have open communication forum
- Engineers in a team must be empowered, provided with the right tools to investigate new thoughts, to drive innovation.

(ME, Sep. 2007) 27

Enabled team design practices yield the following outcomes:

- Drive much higher levels of performance
- Speed up development by eliminate resource bottlenecks,
- Improve the quality and creativity

Better design is possible if the team members overcome three inhibitors:

Prisoner's dilemma – everyone involved must give a little, the earlier they do leads to better design several steps later (negotiations theory)

Cycle of influence – To stop endless loop of design changes and revisions, all engineers should have roughly even influence on each other

Liar's club – when engineers work in parallel on separate of a design of a complex system, each holding off reporting problems until someone blinks and all problems are revealed at once!

(ME, June 2007)

Product Development - Overview

Metrics of PD effort relating to profit (product Success)

Product Quality

Measured by its satisfaction to stated needs, robustness, and reliability.

Product cost

Manufacturing cost ultimately determines profit

Development time

How quickly the team completed the PD effort.

Development cost

Money spent during the PDP

Development capabilities

Ability to develop future products as a result of developing the current one.

29

Functions central to PD

Marketing function

Identify product opportunities, define market segment, identify customer needs, communication link between firm and customer, set target prices, launch and promote product.

Design function

Define physical form of the product. Include engineering design (ME, EE, ..) and industrial design (aesthetics, ergonomics, user interface)

Manufacturing function

Supply chain. Design and operate production system, purchasing, distribution, installations

Intrinsic attributes of PD

Intensely creative process

Satisfaction of societal and individual needs

Team diversity

Teams spirit

Duration and cost of PD

Cost is roughly proportional to the number of people on the project and duration of the project.

Expenses of the development effort

Investment in tooling and equipment for production (fixed costs)

Structured methods to PD activities (not to be applied blindly)

Make decision process explicitly

Make sure that important activities are not forgotten

Self-documenting

Starting point for continuous improvement

Product development organization

A well defined process is important for:

- Quality assurance, phases and checkpoints
- Coordination – blueprint in which roles are defined
- Planning – natural milestones to completing each phase
- Management – benchmark for continuous assessment of performance of the development effort
- Improvement - documentation

Organization's environment conducive to success

- Empower team
- Functional allegiances should not transcend product goals
- Provide adequate resources
- Cross-functional representation on the project team

Challenges to Product Development

Trade offs

For example airplane can be made lighter but at a higher manufacturing cost.

Dynamics

Technology improves, customer preferences evolve, competition introduce new products, macroeconomic environment shifts, etc.

Details

Economic implications of choices made, example use of screw rather than snap-fits on computer's enclosures

Time press

PD must be done quickly without complete information

Economics

Development (3B, 50 M, 750K), production (3B, 25 M, 1 M), and marketing of new products (Boeing 777; HP deskjet printer, roller-blades in-line skate); require large investment.

33

Variants of the generic PDP

- Generic (Market-pull) products – sporting goods, furniture, tools
- Technology push products – new proprietary technology (Gore-Tex rain wear, Tyvek envelopes)
- Platform products – products built around an established technology (consumer electronics, computers, printers)
- Process intensive products – Highly constrained by the production process (Snack foods, cereals, chemicals, semiconductors)
- Customized products – slight variation of existing products (motors, batteries, containers)

34