Lean Upstream Fastbreak!

Durward Sobek & Jim Morgan

5 March 2014

Introductions

Durward Sobek

- Professor of Industrial Engineering, Montana State University
- Researcher in Lean PD for over 15 years

Jim Morgan

- "Senior Advisor" @ LEI
- 30 Years PD experience, the last 10 as Global Engineering Director at Ford.
- Researcher/Co-Author of TPDS with Jeff Liker

Where is the greatest opportunity to create value for your customers?

- On the factory floor?
- Through sales, marketing, or service?
- In streamlining accounting and business functions?

The greatest opportunity to create value for your customer is upstream.

90% of costs and

100% of benefit to customer

are defined in the design phase.

The greatest opportunity to create value for your business is also upstream.

Profit = Revenue - Cost

Capped by amount of benefit to customer

Design decisions fix minimum

Would you like to…

- Earn a profit every year for the past 4 decades?

SCANIA

Would you like to…

- Earn a profit every year for the past 4 decades?
- Set industry benchmarks for quality while improving productivity?

Ford Go Further

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Would you like to…

- Earn a profit every year for the past 4 decades?
- Set industry benchmarks for quality while improving productivity?
- Increase innovation by 5x without additional resources?

PING

9

Would you like to…

- Earn a profit every year for the past 4 decades?
- Set industry benchmarks for quality while improving productivity?
- Increase innovation by 5x without additional resources?
- Achieve a 70% reduction in time-to-market with a 3x improvement in on-time delivery?

10

Would you like to…

- Do all of that **and** create an innovative, joyful workplace?

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How?

By applying lean upstream from the factory!

We call it:

Lean Product and Process Development

Goal for the Session

That you will realize:

- Lean applied upstream is transformative.
- The transformation requires:
  - *A focus on actionable knowledge,*
  - *Internalization of new principles, and*
  - *A systems approach.*
- And, it produces results.

Agenda

1. What is Lean Product and Process Development?
2. Foundation: Actionable Knowledge
3. Transformational Principles
4. Principles in Action:
   Lean Development at Ford Motor Company

Why Lean Product ***and Process*** Development?

The Development Value Stream Creates Operational Value Streams.

Product Features

The Development Value Stream Creates Operational Value Streams.

Manufacturing

Customer

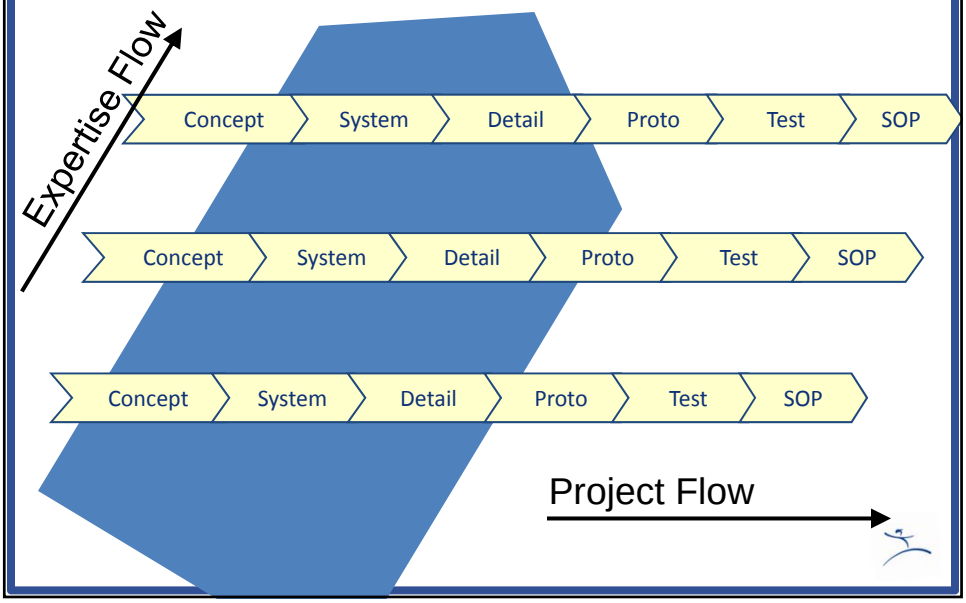
Suppliers

Product Features

Lean Product and Process Development is:

A system that consistently produces profitable operational value streams while avoiding waste.

Two Knowledge Flows



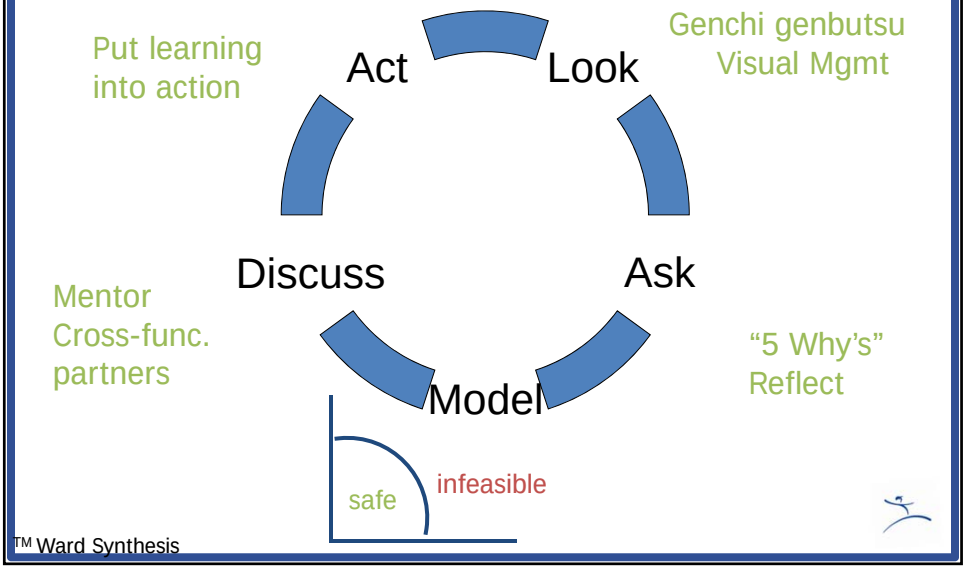
Key Points

- World-class development organizations must manage **both** knowledge flows simultaneously.
- To do so effectively, and to continually improve, requires **useable knowledge**.

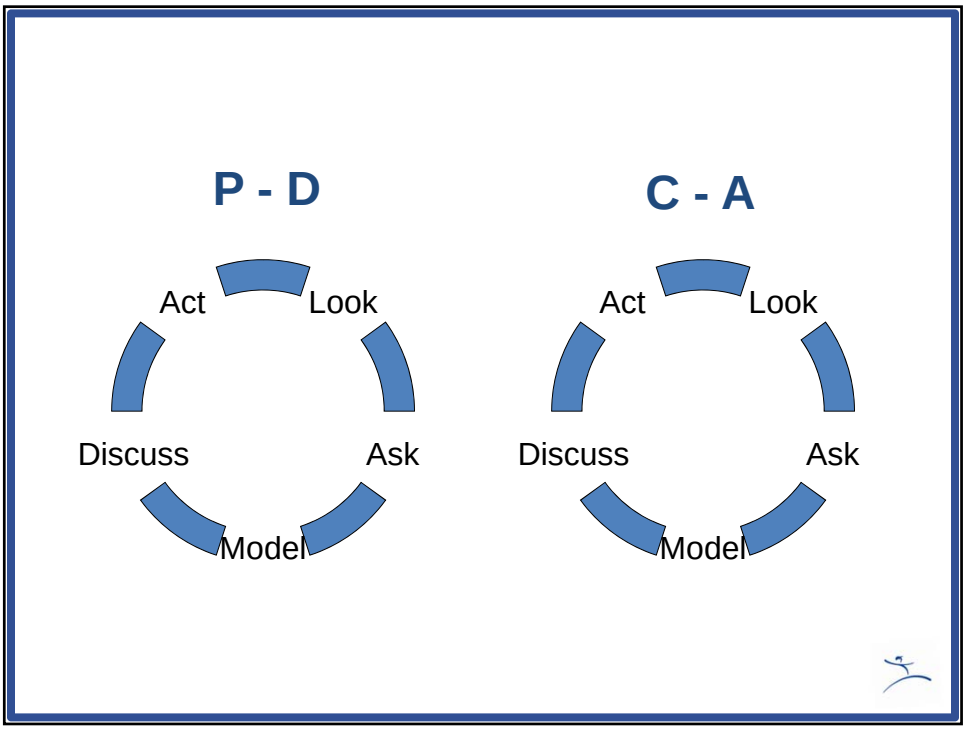
Five Transformational Principles

1. Rapid Learning Cycles
2. Teams of Experts
3. Entrepreneur System Designer
4. Flow, Pull and Cadence
5. Set-based Innovation

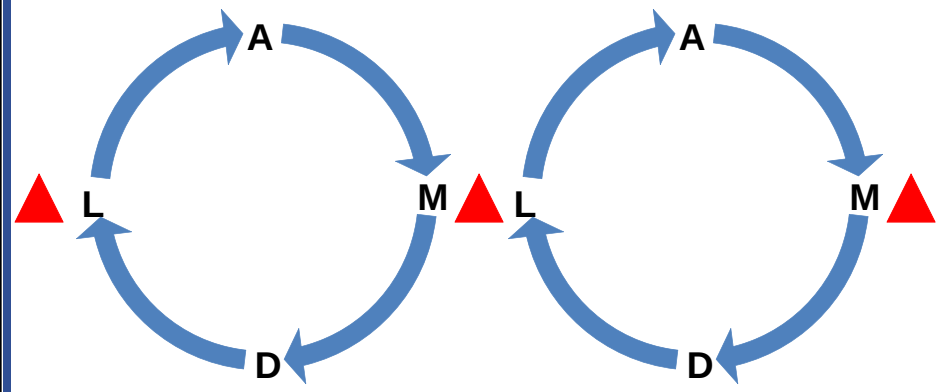
LAMDA™: Basic Learning Cycle for Developers



™ Ward Synthesis



Design the PD System Around Rapid Learning Cycles



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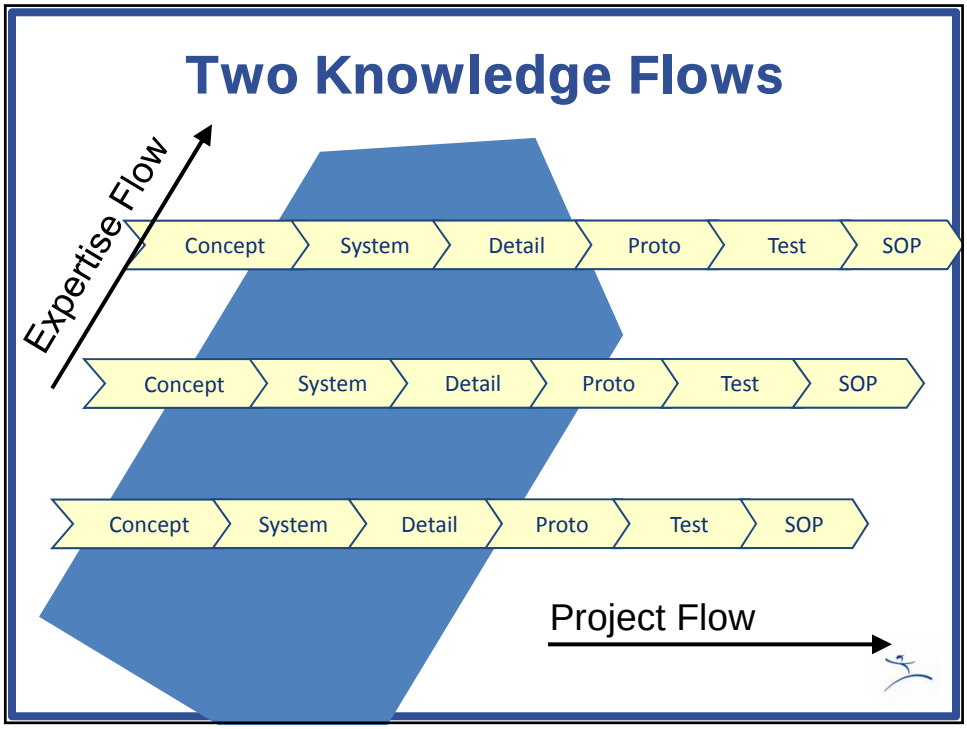
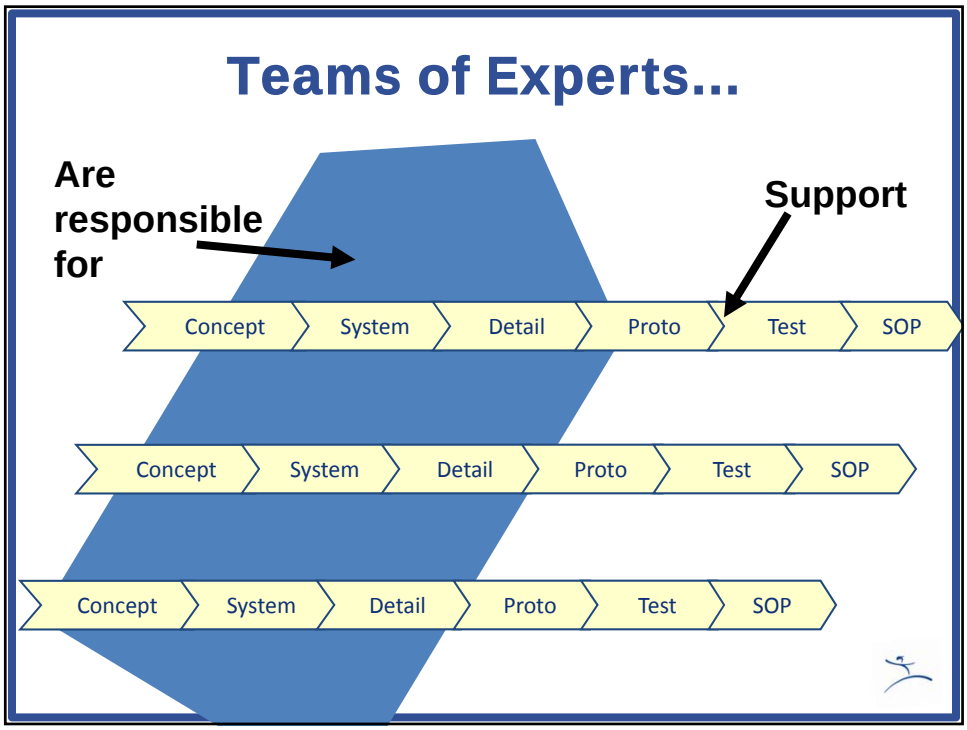
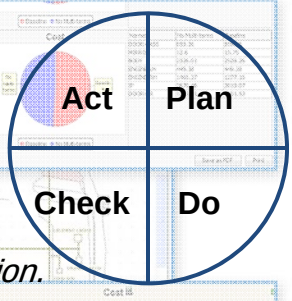




Caretakers of Knowledge

- **Generate** useful knowledge
  - *Through rapid learning cycles.*
- **Capture** useable knowledge
  - *Through reflection and documentation.*
- Make the knowledge **actionable**
  - *Through check sheets, design guides, etc.*



People Development

- Knowledge generation must be **expected** at every level.
- Knowledge capture must **planned for** and rewarded by leadership.
- Creating actionable knowledge must be **mentored** by a coach... and valued by the organization.

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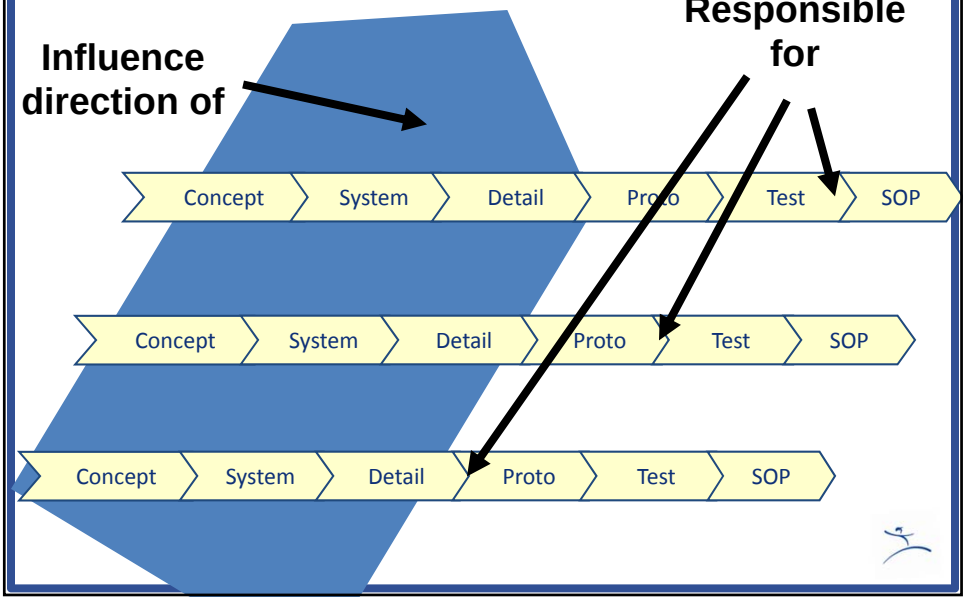
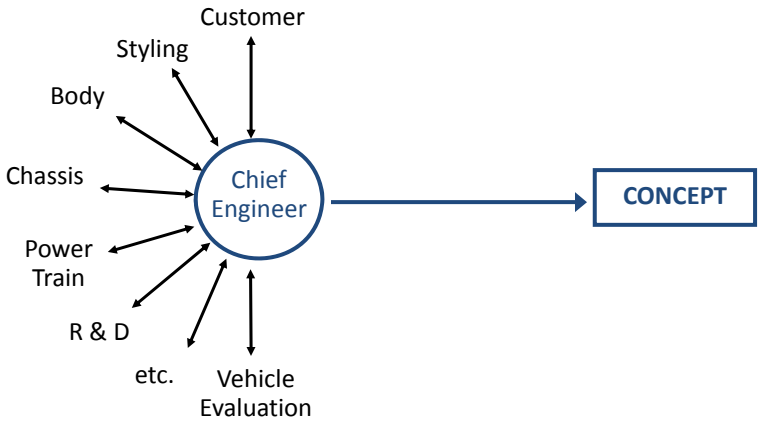
ESD's…

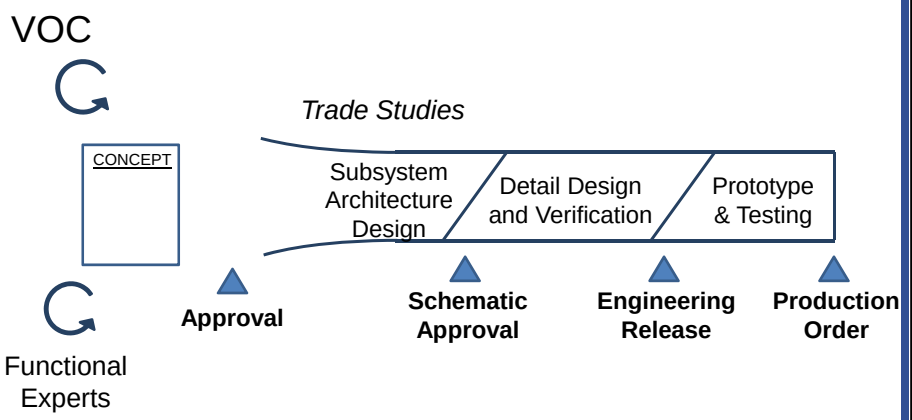


ESD's Acquire Knowledge of True Customer Interests

ESD's Create the Product Vision



ESD's Lead and Integrate



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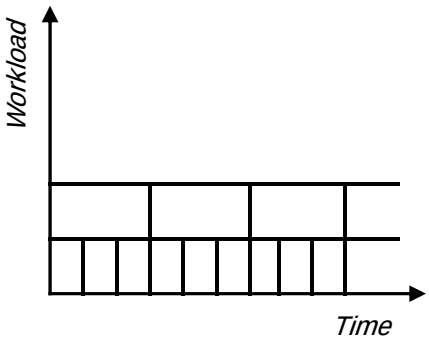
Workload Leveling



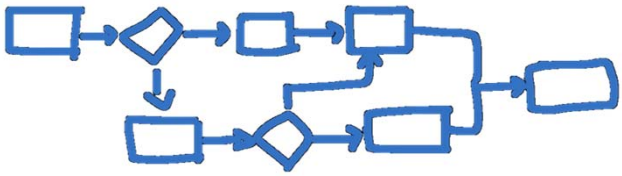
Map “cadence” to market innovation rate

Match product plans and org. capacity

Release work at regular intervals

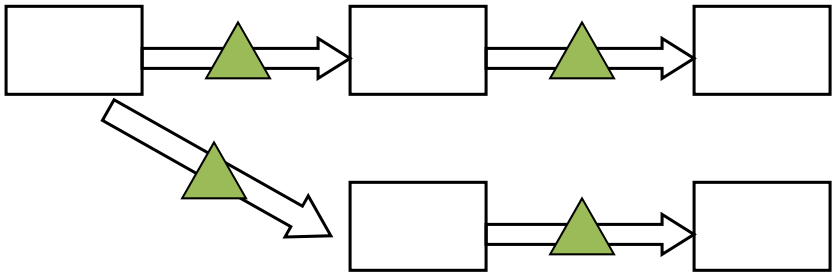
Standard Processes

- Routine tasks/processes are standardized.
- Processes specified only to the detail that they are useful
  - *i.e., simple & easy to follow.*
  - *Example: CE’s project plan fits on an A3.*
- Departments create and maintain their own procedures.



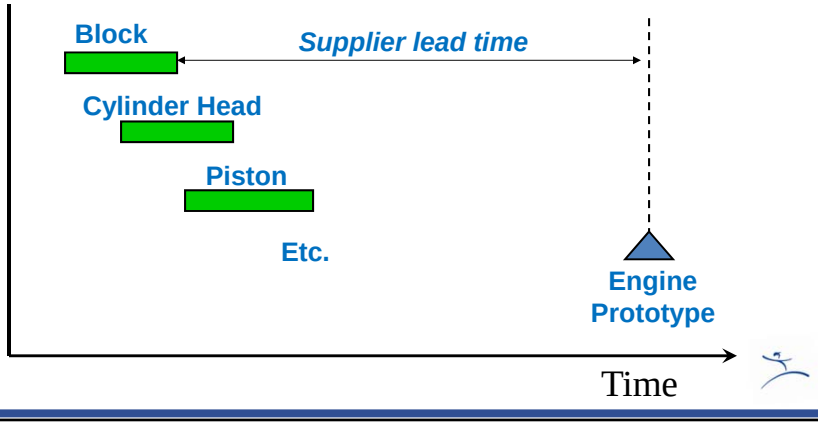
Map the PD Value Stream

to identify wastes of waiting, useless information, and lost knowledge



Pull the Work

Work groups plan their own work to meet integration event deadlines.



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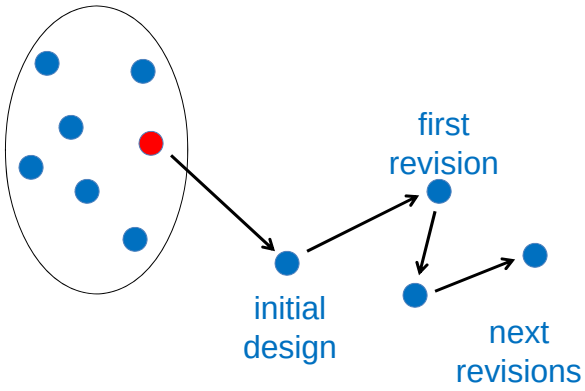
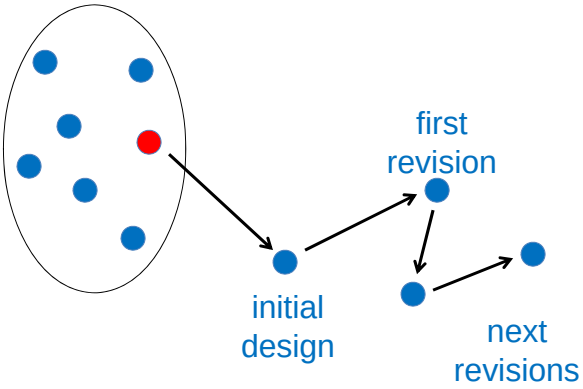
Iteration on a "Point" Solution

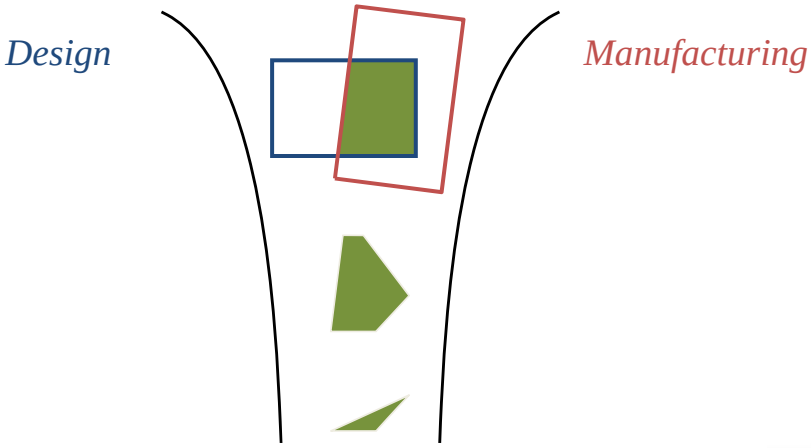


Problems with Iteration



- When will you find a design that works?
- Where to go next?
- How far are you from a “cliff”?
- Have you produced any reusable knowledge?
- How can teams work concurrently?

Set-Based Approach



Set-based Innovation

1. Trade-off curves
2. Design standards
3. Design to accommodate sets
4. Gradual convergence of alternatives
5. Feasibility before commitment

Trade-off Curves

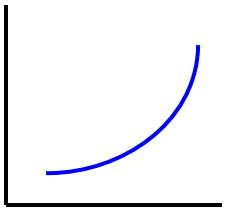
Design, Then Test

Test 1	P
Test 2	P
Test 3	F
…	

Does not generate useful knowledge

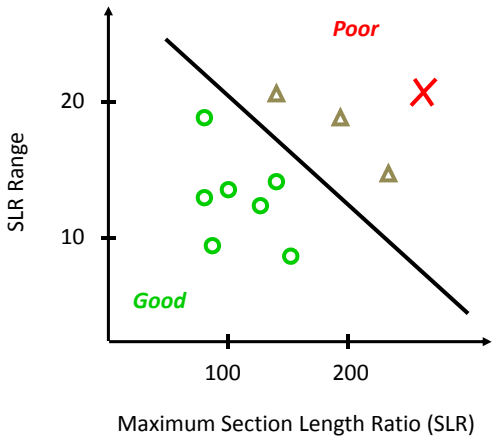
Vs.

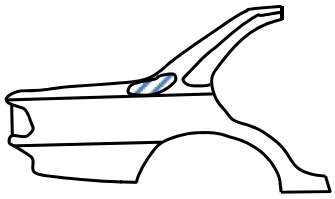
Test, Then Design



Creates knowledge useful now and in the future

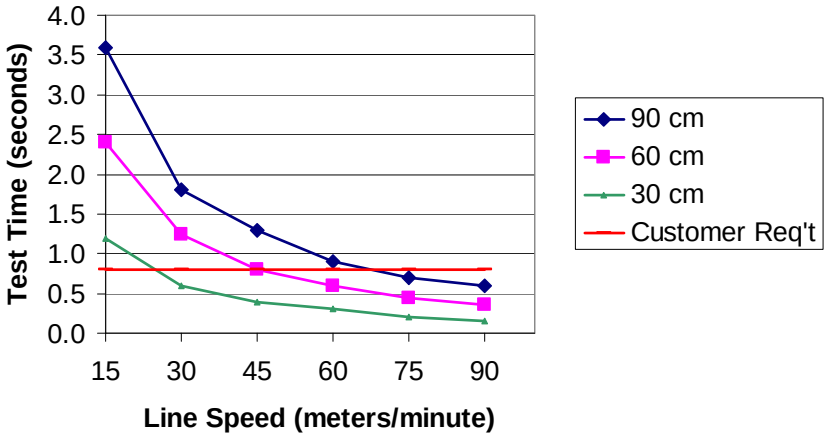
Example Manufacturing Curve





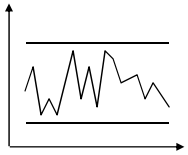
Tryout Hours
500
900
1200

Design Standards: Where do you need to be on this curve?

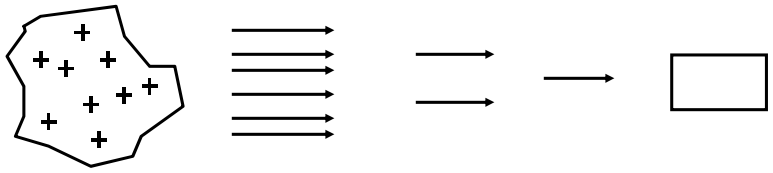


Design to accommodate sets

- Physical variations.
  - *e.g., wear, manufacturing variation.*
  - *solutions: quality, Taguchi methods.*
- Marketing variations.
  - *e.g., volume uncertainty, styling innovations.*
  - *solutions: development speed, manufacturing flexibility.*
- Design uncertainty.
  - *what will the rest of the design team do?*
  - *solutions: designs that will work regardless, modular design.*



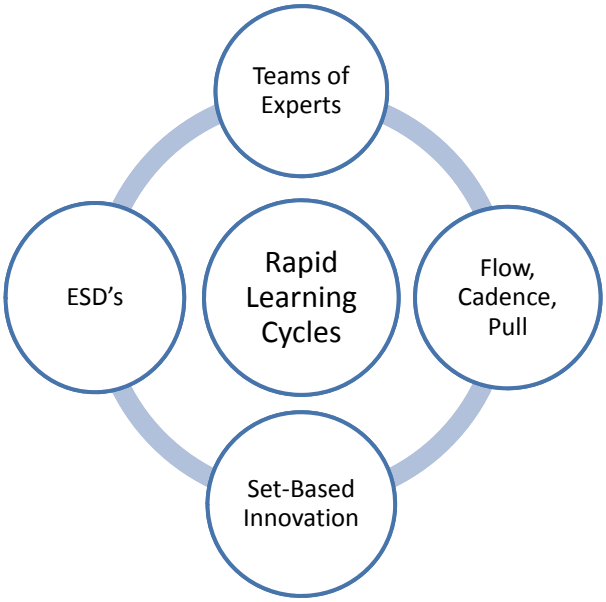
Gradual Convergence



Find robust solutions by:

- *Aggressively trying to kill alternatives*
- *Eliminating inferior ideas in stages*
- *Making sure set has a known feasible*
- *Allowing specs to emerge from learning*

The Principles work as a system



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Principles in Action

Lean Development at Ford Motor Company

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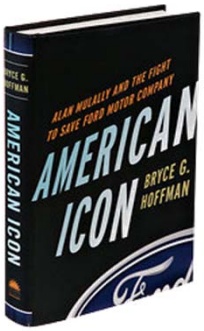
Transforming An American Icon

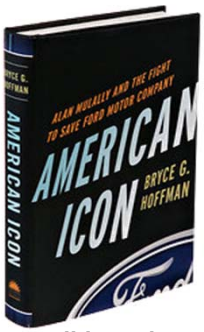


It's nearly impossible to describe…

- ($17B) in losses
- 20yr market share decline
- $1.90 stock price
- Sudden supplier bankruptcies
- Difficult culture
- Massive layoffs
- Betting the company on a $23B loan

"I was right – Ford's problems weren't as bad as Boeing's. They were much, much worse" - Alan Mulally

Transforming An American Icon



It's nearly impossible to describe…

- $8.5B Profit
- 2 year market share increase
- $17 stock price
- Strong supply base
- "ONE FORD"
- Hiring thousands

"I was right – Ford's problems weren't as bad as Boeing's. They were much, much worse" - Alan Mulally

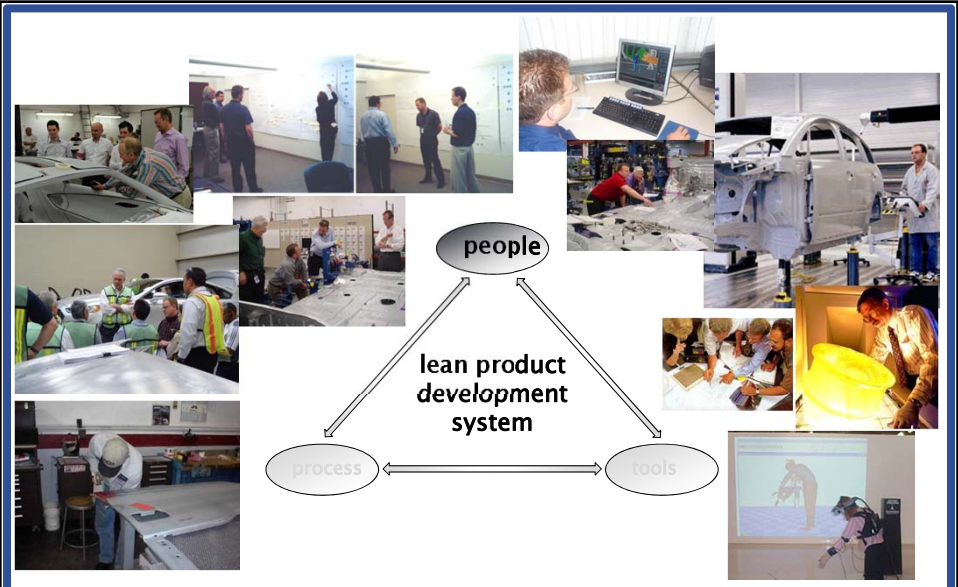
Product Led Revolution




- "All in for product" Completely new process and portfolio
- Global Body, Safety and Stamping Engineering
- Dramatically reduced lead time, investment, improved quality and performance attributes




"Create products our customers will value and buy." - Alan Mulally



The best people create the best products

So we develop people & products simultaneously

Create Towering Technical Competence

Honor technical excellence and value creation

Developing Engineers as a <u>Priority</u>

- TMM
- ITDP
- Mentoring & targeted assignments
- Design reviews – for developing people and products
- Technical mastery

Strong Functional Organizations

- Foster deep technical knowledge – continually advance your product
- Provide an infrastructure for learning & continuous improvement
- Organize around the value stream
- Create a true competitive advantage

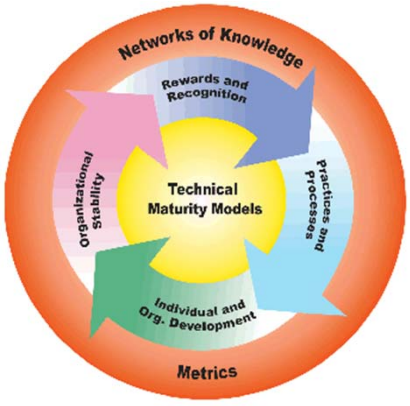
Skilled People

How do you transform
A brand new college graduate
into a Technically Mature, Highly Skilled and Efficient Employee?

SLIDE 50

Technical Maturity Model @Ford

- Technical Maturity Models (TMM) around Critical Functions



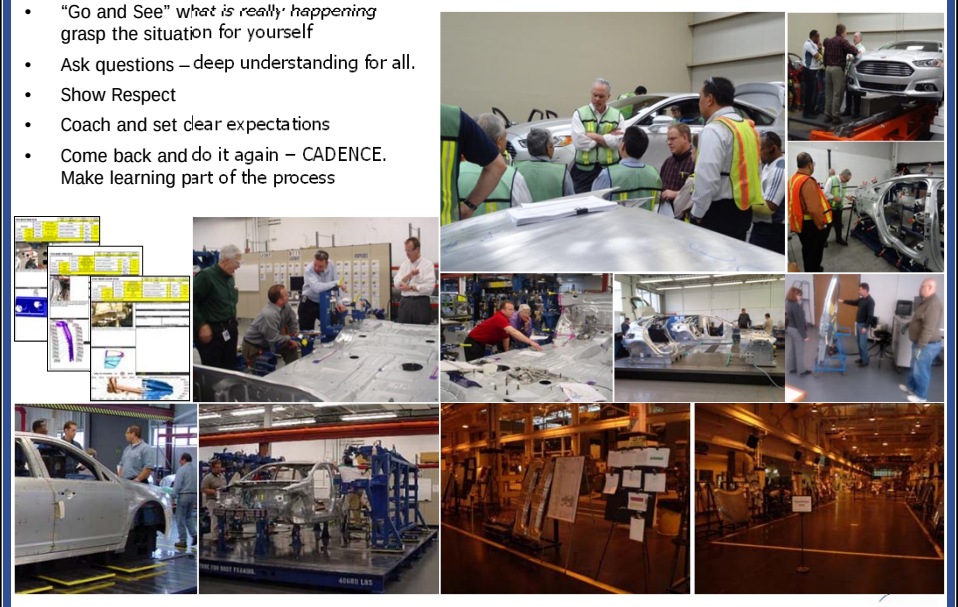
- Skills required for Every Phase of PD mapped to the Function
- Mixture of Industry/Specialized Training/On-Job Experiences Defined to meet requirements of "Novice", "User", "Expert"
- System must teach Employees what they do not learn in school. "Body Structures 101"
- Mentoring role of Functional leaders

Design Reviews

- Great for developing products and people
- Cross-functional participation
- Rigorous, candid…and difficult
- Prep work for review critical for learning
- Critical questions…Did you consider?…..How did you arrive at that?…What's the data say?…..Have you thought of?….What are your benchmarks?
- Scientific Method: Go and see, develop a hypothesis, execute tests, analyze, action plan
- Bring it back to foundation documents – capture knowledge
- Global and cross-functional alignment

Learning At The "GEMBA"

- "Go and See" *what is really happening* grasp the situation for yourself
- Ask questions – deep understanding for all.
- Show Respect
- Coach and set clear expectations
- Come back and do it again – CADENCE. Make learning part of the process



Include The Extended Enterprise

Bloomberg Businessweek

Ford Boosts Supplier Standing in Placing Among Top 3

May 10, 2010, 4:31 PM EDT

(Updates closing share prices in the eighth paragraph.)

By Doron Levin

May 10 (Bloomberg) -- Ford Motor Co., following its first annual profit since 2005, became the only non-Japanese autom in a survey of suppliers.

The Detroit News

Wednesday, May 17, 2006 detnews.com Metro Edition

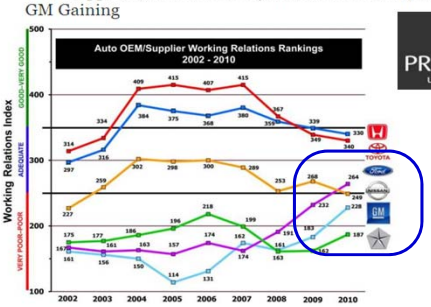
Ford, UAW retooling work rules

Changes at Dearborn plant may serve as model for more efficient factories in the future.

By Brent G. Bierman
The Detroit News

DEARBORN — Ford Motor Co. is sending a message to its remaining North American factories: Be competitive or beware.

Study Shows Ford Climbs to #3 Overall in 'Working Relations' With Suppliers; Honda and Toyota Still #1 and #2, but Slipping; GM Gaining



PR Newswire
United Business Media

WARDSAUTO

'One Ford' Plan Making Auto Maker, Suppliers More Competitive

By James M. Amend
WardsAuto.com, Aug 3, 2010 4:52 PM

TRAVERSE CITY, MI – Ford Motor Co. intends to slash its global supplier list to 750 from the 3,000 it employed just a few years ago, one of the auto maker's top purchasing executives says.

The reduction is part of the company's vaunted 'One Ford' strategy,

Special Coverage
MBS CAR Management Briefing Seminars

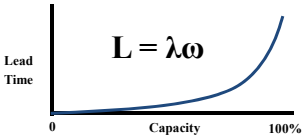
ONE FORD

"Fully integrate suppliers into the system"

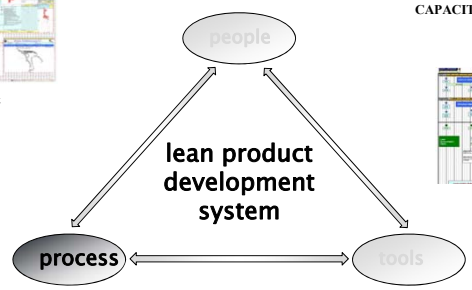
The Matched Pair Process

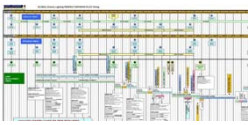
- *"Matched pairs" at Director, Chief & Manager levels in Engineering & Purchasing*
- *Speak with one voice of Ford Motor Company*
- *Align processes, tools & objectives around delivering great products*
- *Improved quality & speed decision making*
- *ABF (Aligned Business Framework) for major suppliers*

STANDARD PROCESS & ARCHITECTURE



CAPACITY UTILIZATION



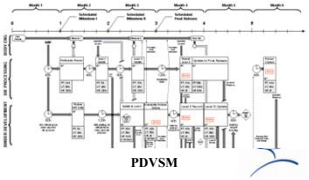


PERFECT DRAWING PLAN

STANDARDIZATION

$$CT_q = \left(\frac{C_a^{\,2} + C_e^{\,2}}{2}\right)\left(\frac{u}{1-u}\right)t_e$$

REDUCE VARIABILITY



PDVSM

PROCESS

STUDY/KENTOU (Front Loaded process to create the right product)

- Product immersion
- Chief engineer concept paper
- Set-based collaboration

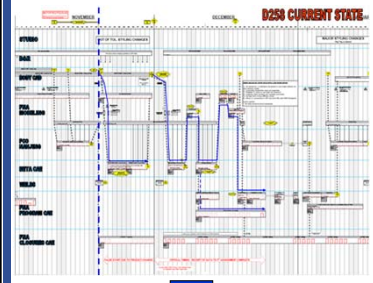
EXECUTION (to deliver the product right)

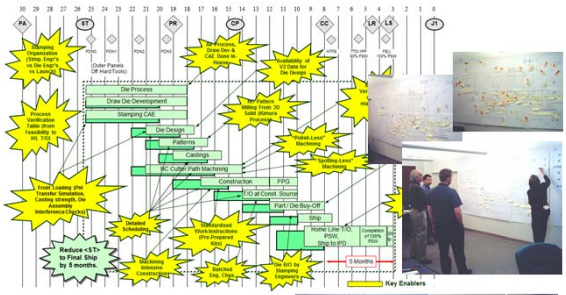
- Capacity/Capability
- Enabling process logic
- Create Flow/Synchronize cross functionally
- Compatibility before completion/minimum feasible maturity
- System of standards (fixed and flexible / C.I.)

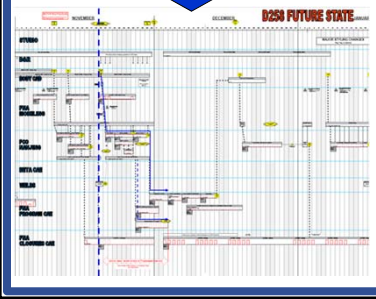
REFLECTION/LEARNING

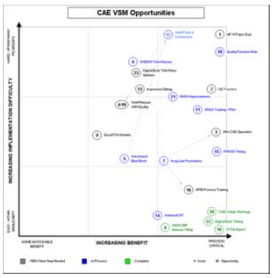
- Learning at GEMBA
- Reflection/Hansei

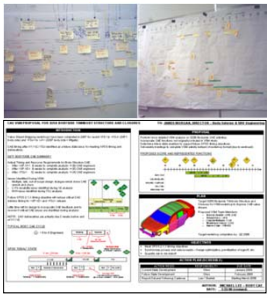
Value Stream Mapping at Ford







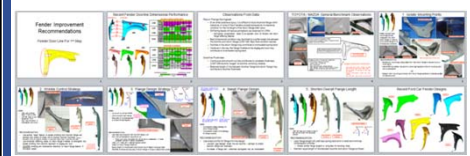




Front Loaded Study / Kentou – tools and methods to increase understanding, alignment and create the right product

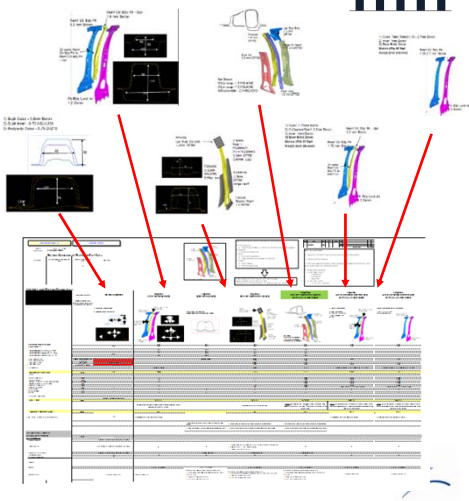
Create mechanisms to align the enterprise around delivering value to the customer

- *Mono-sukuri* – Enterprise Engagement

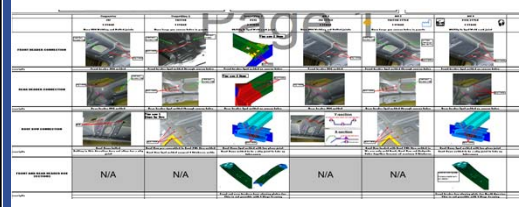


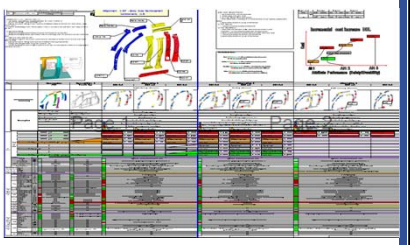
"Set Based" Approaches

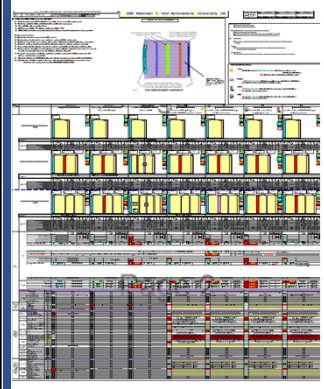
Utilize mechanisms to examine multiple designs/solution sets

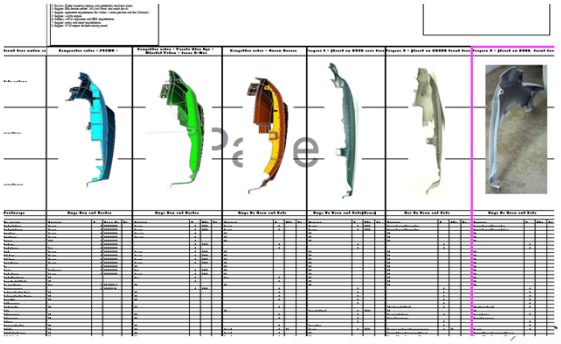


Exploring Alternatives



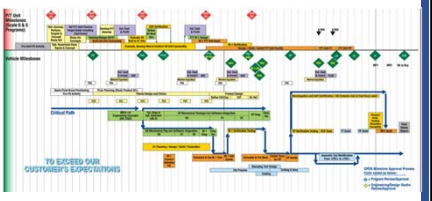






Creating Flow

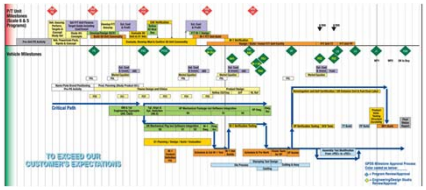
- Capacity/Capability
  - *Linked*
  - *Dynamic*
  - *Capability study*



- Enabling Process Logic
  - *Clear quality of event criteria*
  - *Scalable*
  - *Built in C.I. mechanism*
  - *Synchronize cross-functionally*

- Create Flow
  - *CbC (Compatibility before Completion)*
  - *MFM (Minimum Feasible Maturity)*
  - *Virtual / Physical*

Capability & Capacity



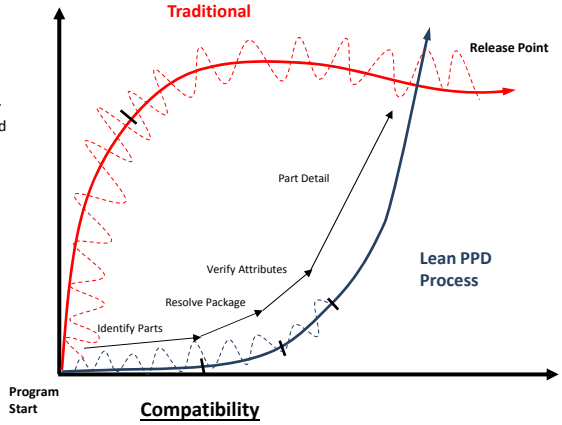
- Tough to know one without really understanding the other
- Task and inter-arrival variability and system capacity effects
- Numerous dynamic contributing variables to consider
- Process capability studies
- Create flexible capacity where possible
- Understand and monitor critical milestones

Compatibility Before Completion

Completeness
Engineering thoroughness of given design including design analysis for failure mode avoidance, testing and verification

CONCLUSION
Early focus on completion creates more CAD work for each change required

LPPD synchronizes the processes of compatibility and completeness minimizing rework workload

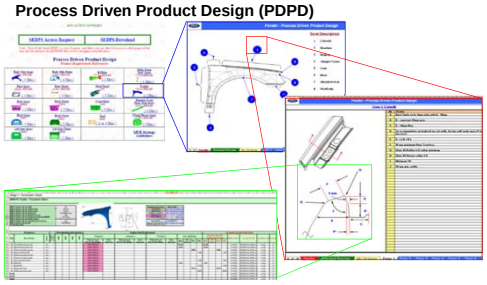


Compatibility
Should be a subset of completeness, virtual (CAD/CAD) checks done prior to CAD freeze for robust release. DPA work streams ensure critical interdependencies are checked.

Synchronization
Sequencing value-added work across Functions to eliminate rework loops (gives and gets)

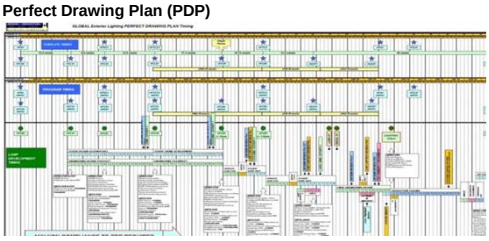
Powerful Global Standards

Process Driven Product Design (PDPD)



Standard Architecture

Perfect Drawing Plan (PDP)



Global Standard Press Equipment

"Today's standardization is the necessary foundation on which tomorrow's improvements will be based.. the best you know today… to be improved tomorrow. But if you think of standards as confining, then progress stops" **Henry Ford**

Standard Architectures

	Prior to 2006 MY		2007 MY to 2010 MY		2010 MY and Beyond		
B - Car	B256 (2005) Eu - Fiesta	BE146 (2005) SA - Ka	B299 (8A61) 2nd FoE Honeycomb Eu - Fiesta		B299N (AE83) 2nd FNA Honeycomb NA - Fiesta	B232 (AV11) Europe	
CD - Car	CD132 (2005) Eu - Mondeo	CD338 (6E53) NA-Fusion	CD338 (9E53) NA - Fusion	CD345 (7S71) 1st FoE Honeycomb Eu - Mondeo	CD391 (Future) Eu - Mondeo	CD391 (2013) NA - Fusion	CD524 (Future) NA
C - Car	C307 (2005) Eu - Focus	C170 (6S43) NA - Focus	C170 (8S43) NA - Focus	C394 (8V41) Eu - Kuga	C344 (AM51) Europe	C346 (BM51) Eu - Focus	C346N (____) NA - Focus
D - Car	S197 (4R33) NA - Mustang	D258 (4G13) NA - Five Hundred	D471 (RAR3) NA - Flex	D258 (8G13) NA - Taurus	D258 (AG13) 1st FNA Honeycomb NA - Taurus	D471 (2014) NA - Flex	S197 (2015) NA - Mustang
P / U	P150 (4L54) NA - Ranger	U251 (6L54) NA - Explorer	U387 (7T43) NA - Edge	P415 (9L34) NA - F150	U387 (BT43) NA - Edge	U502 (BB53) NA - Explorer	U22x / P525 NA - Expedition

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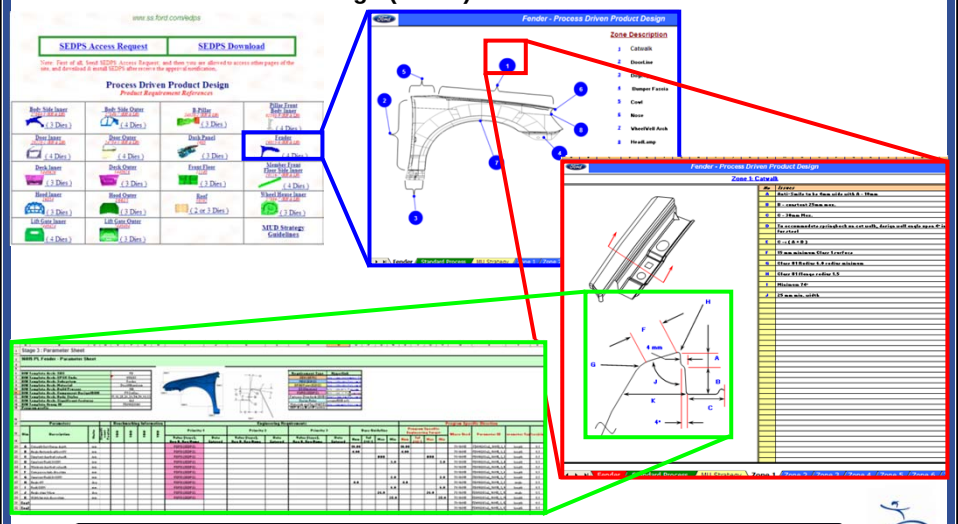
Standard Mfg Processes

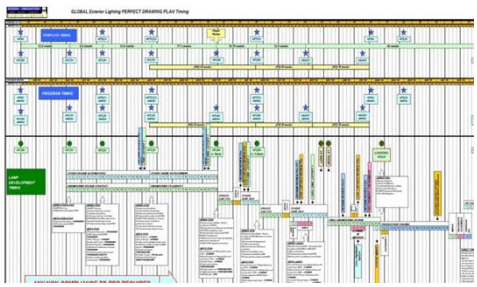
Process Driven Product Design (PDPD)



Standard Process "Hows" enablers to meet Efficient Process

A Plan for Every Part

PDP Overview – "Recipe for Success"



- Commodity Specific Development Timing
- Defines Engineering Needs and Deliverables By Milestone To Enable Success – Clear Quality of Event Criteria and linked to high level process
- Highlights Any Disconnects Between Program Timing, and Commodity Timing
- Consistent Program to Program
- Template for Engineers and basis for CI

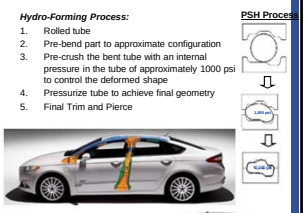
Commodity Business Plan

- Medium range plan for platform architecture and materials
- Supplier strategy development
- Manufacturing footprint development
- Value chain analysis

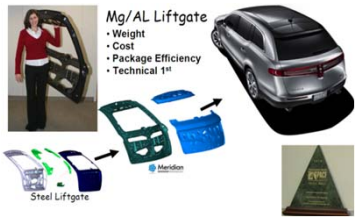
Enabling Standards & Innovation

- Enabling standards and strong foundational knowledge allow innovation in complex systems
- A challenging environment
- Skilled, creative, motivated people working collaboratively. An enabling process. And drive – often stressful
- Effective design reviews
- Response to complex and conflicting market/regulatory demands ("mother of invention"). Front end challenge: design leadership/pedpro/LSD/variable regional crash req/aero & CO2 emissions
- "Adjacent innovation" to change an industry…

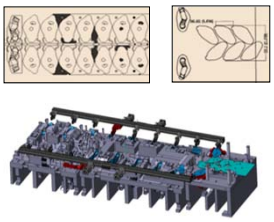
Hydroforming



Magnesium Liftgate



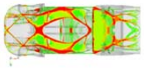
Prog Die vs. In-Die Automation

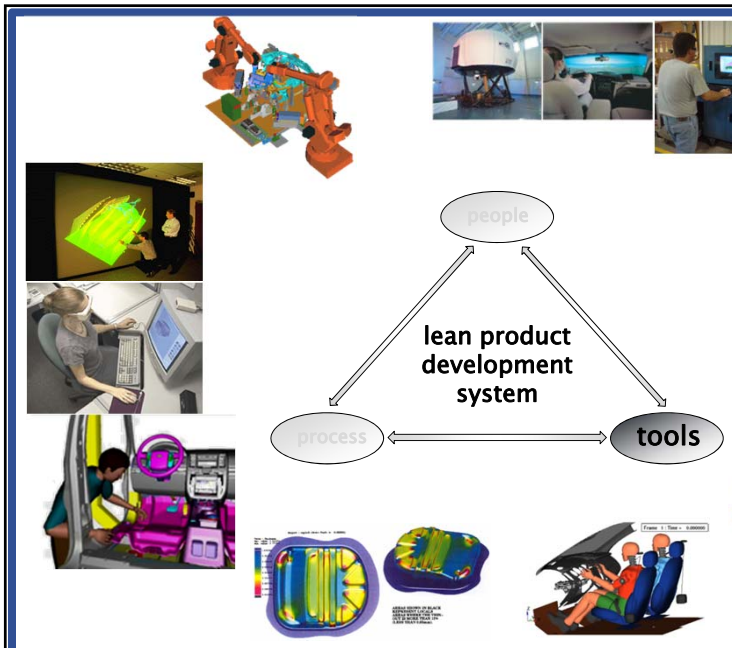


Scallop Blanks

Laser Welding

BIW Topology Optimization





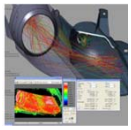
Tools That Enable People & Processes

The Digital Value Stream

"Communicating digitally" across the value stream and around the globe

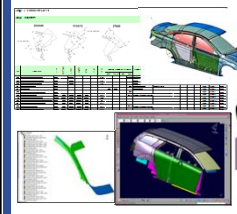
- Common language from studio to shop floor
- Eliminate data conversion steps, errors & other waste
- Same data globally
- Enabler for global PD strategy and re-usability

Analytical Prototypes

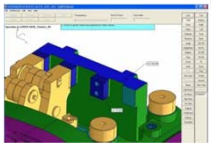


Lighting Simulation

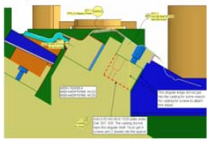
CAD/Engineering Templates



Virtual Manufacturing

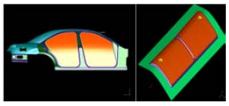


Shop Floor Die Design Viewing, Measurement, & Markup

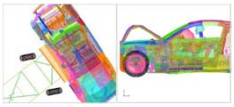


Digital Design Verification

Studio Stamping Feasibility



Virtual Crash Simulation



VIRTUAL ENGINEERING — From Beginning... to End — DIGITAL SHOP FLOOR

Compatibility DPA Checklist

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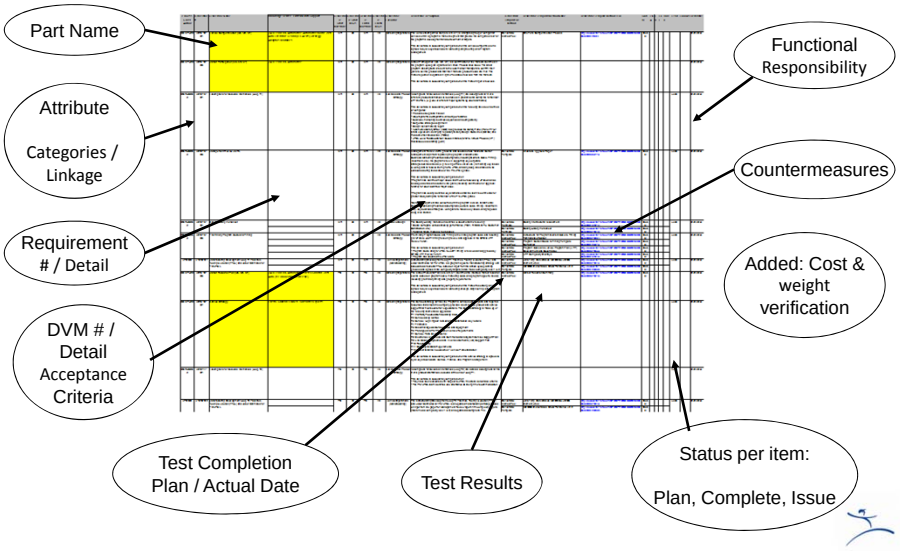
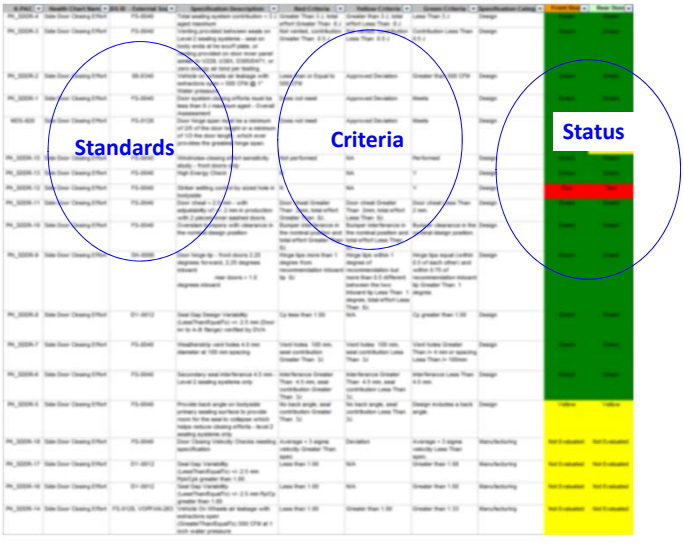
Completeness

Component Verification Matrix



Make Quality Visible: Health Charts

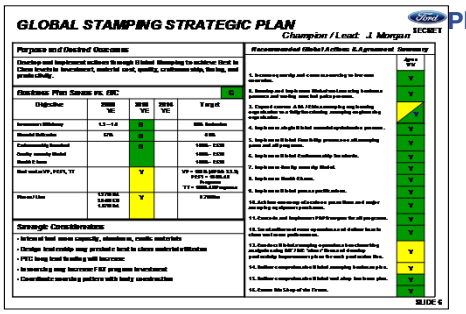


PD Development Process Early HC Assessments

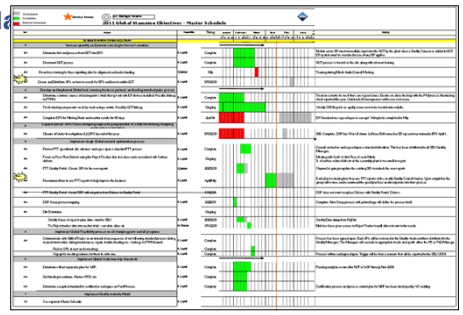
Quality Panel Milestone Requirement
PS
PSC
PTCC
PTC
PA
FDJ

- Created Health Chart of Performance/Design Rules to Meet Customer "HOW"
- Evaluate Health Chart Early in the Program to Drive Decision Up-Stream

Tools To Align and Stretch Your Team



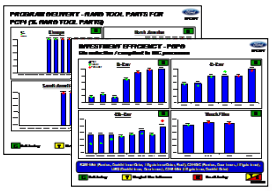
STRATEGIC PLAN A3 DOCUMENT



MASTER SCHEDULE

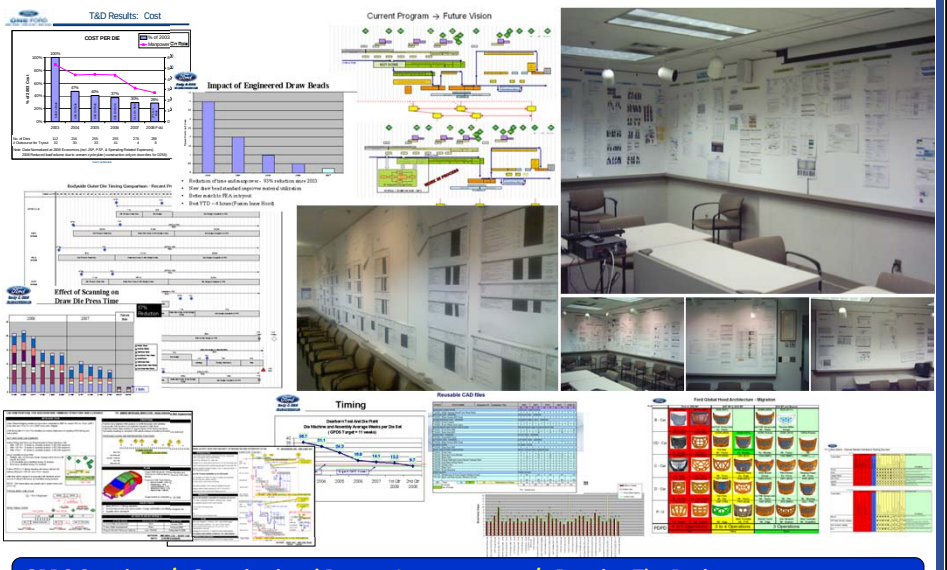
Business Planning Process

1. *Global BPR Process*
2. *A3 Hierarchy / Clear Objectives*
3. *Master Schedules*
4. *B.P.R. Metrics*
5. *Global Leadership Week*
6. *All Hands Meeting*



B.P.R. METRICS

Obeya System



GPDS Creation / Organizational Process Improvement / Running The Business

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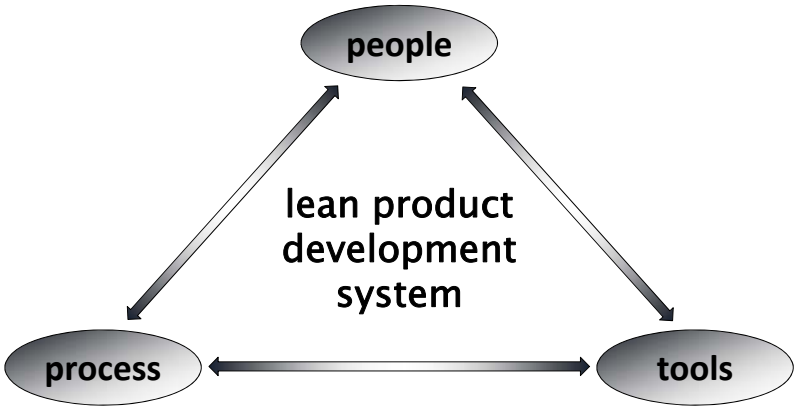
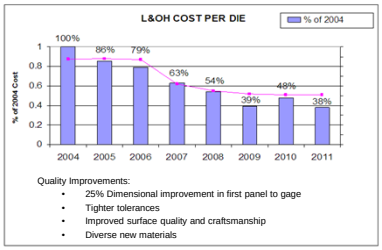
A Systems Approach

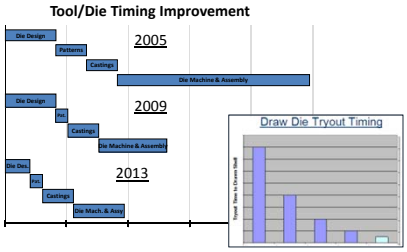


Results

Revolutionized Dearborn Tool & Die

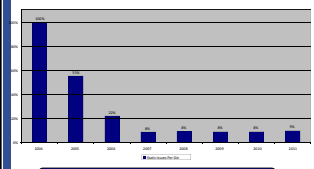


62% Improvement In Hrs Per Die



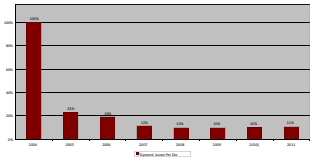
60% Reduction in Lead Time

Static Issues Per Die



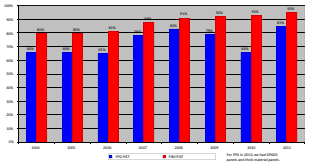
90% Reduction - Static Die Issues

Dynamic Issues Per Die



89% Reduction - Dynamic Die Issues

FPG & PBO PIST%



19pt FPG & 15pt PBO PIST % Improvement

Great New Products

PRODUCT EXCELLENCE

Precision & Design Fidelity

ESCAPE

Precision & Design Fidelity

Prior Escape

2012 Escape

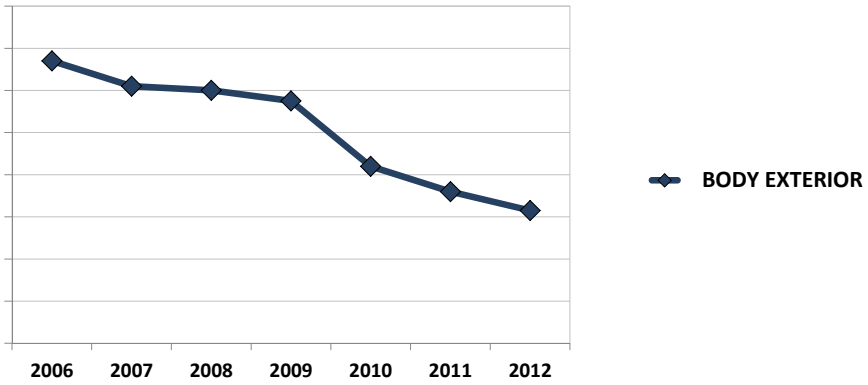
Precision & Design Fidelity

Prior Escape

2012 Escape

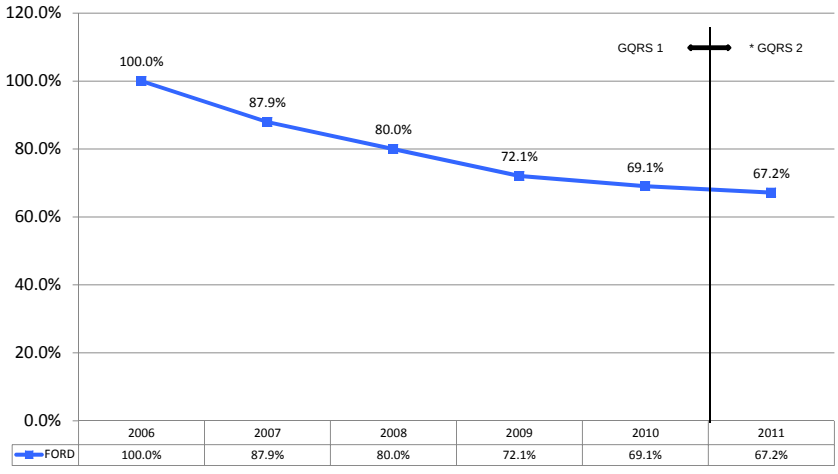
Repairs

R/1000 Trend By Function 06-12MY



53% Improvement

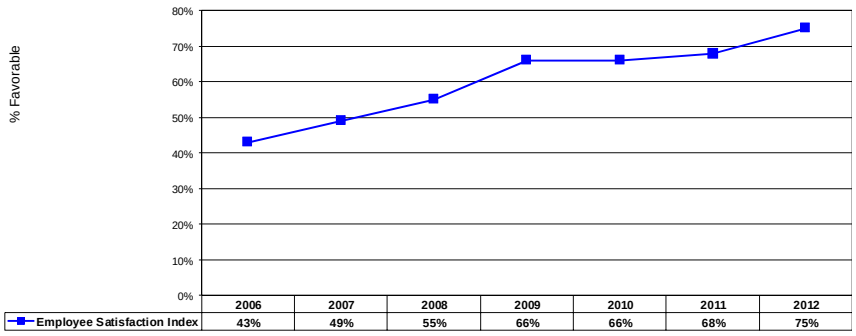
TGWs



* GQRS 2 added new questions

33% Improvement

A better place to work

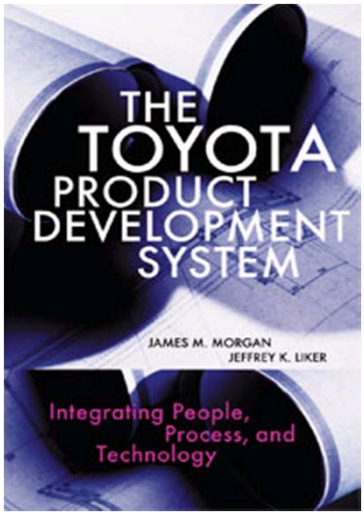


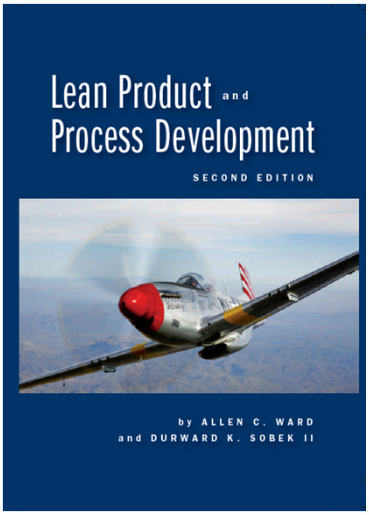
32 Point Improvement

Summary

- Lean applied upstream is transformative.
- The transformation requires:
  - *A focus on actionable knowledge,*
  - *Internalization of new principles, and*
  - *A systems approach.*
- And, it produces results.

To Learn More.....





And More!

LEAN PRODUCT & PROCESS DEVELOPMENT EXCHANGE INC.

Copenhagen, June 2-4
NA, September xx-xx

www.lppde.org

Thank you!

dsobek@ie.montana.edu
jmor990@aol.com

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