air academy ASSOCIATES

Introduction to Design for Six Sigma (DFSS)

Continuous Process Improvement (CPI) Technical Session

Test & Evaluation in a Multi-Domain Operational Environment
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Agenda

- The motivation for DFSS
- How DFSS differs from Lean Six Sigma
- The DFSS roadmap/methodology
- Key players and roles in DFSS
- DFSS projects and studies
- DFSS Certification

True or False?

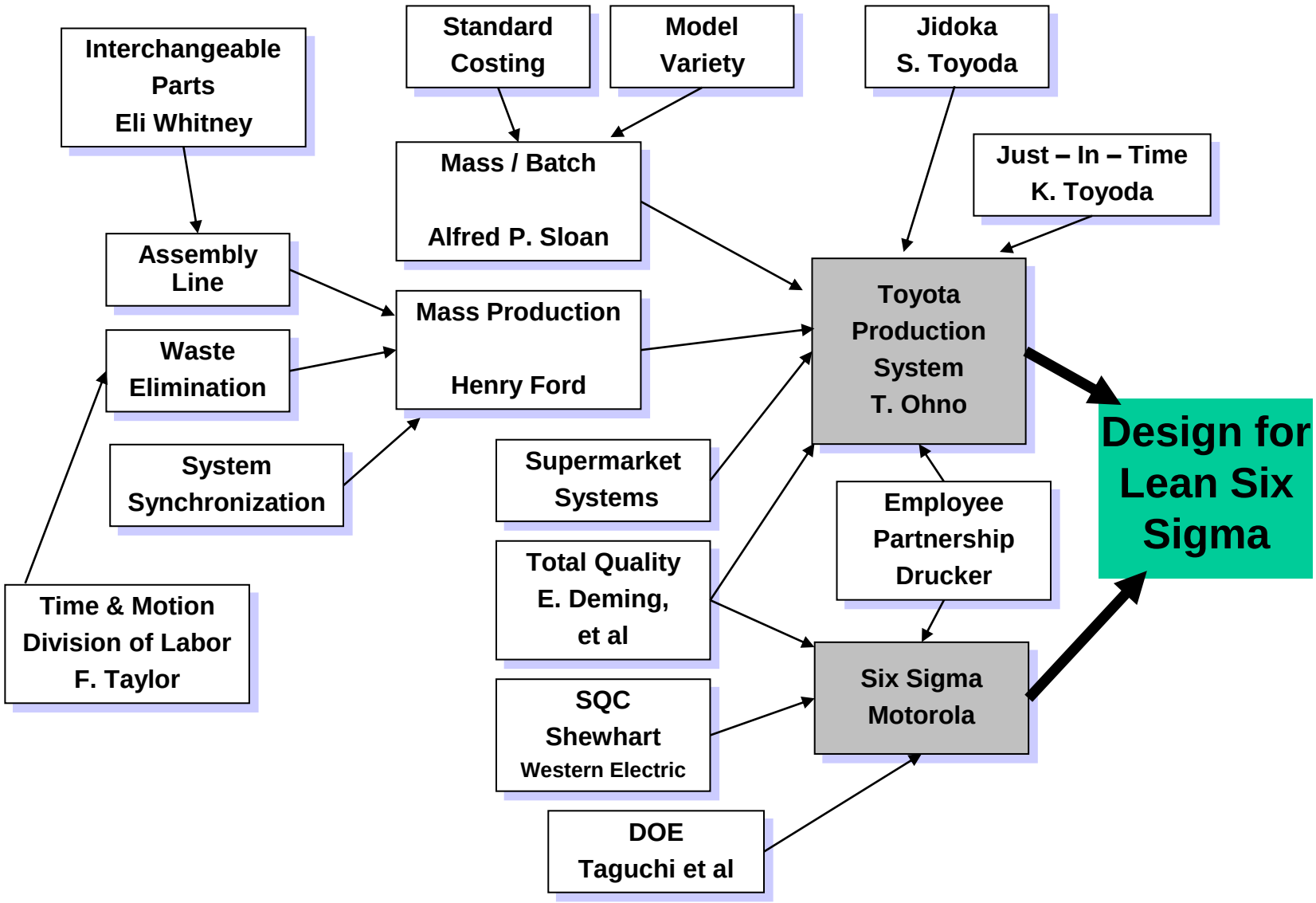
The systems and products that deliver value to our customers are perfectly designed to achieve the results we are getting today.

What is Design for Six Sigma (DFSS)

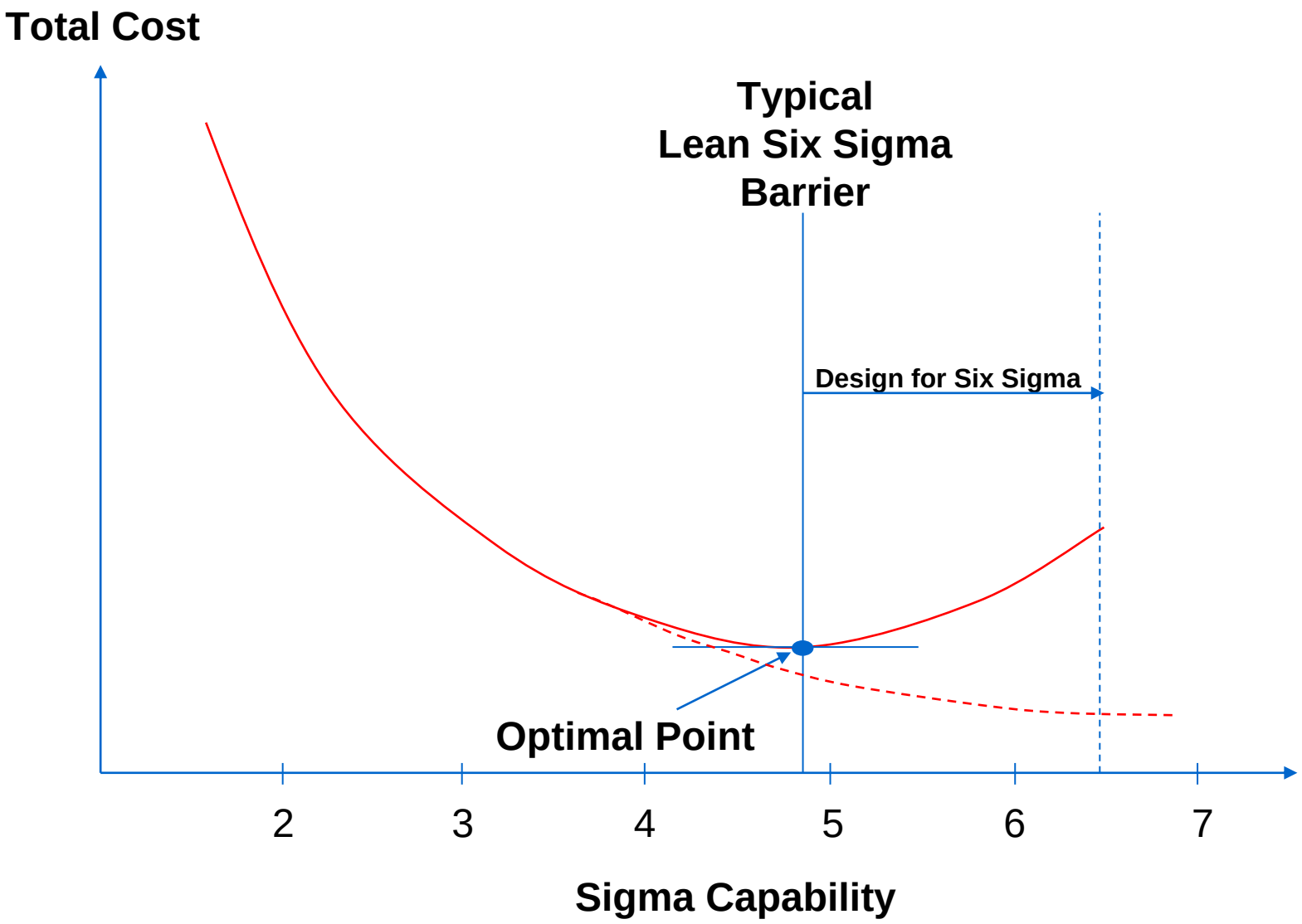
- Also known as Designing for Successful Systems
- It is the natural evolution of Lean Six Sigma (LSS)
- It is a methodology with a distinct roadmap called IDOV
- It has some unique tools that extend the LSS repertoire of tools
- Leverage talent and
- Develops systematic innovation
- Deliver **greater value to the customer** and **the business**

- **Better** products and services
- Produced **Faster** at **Lower cost**
- **Earlier market entry and faster market growth**
- **Lower total lifecycle costs**

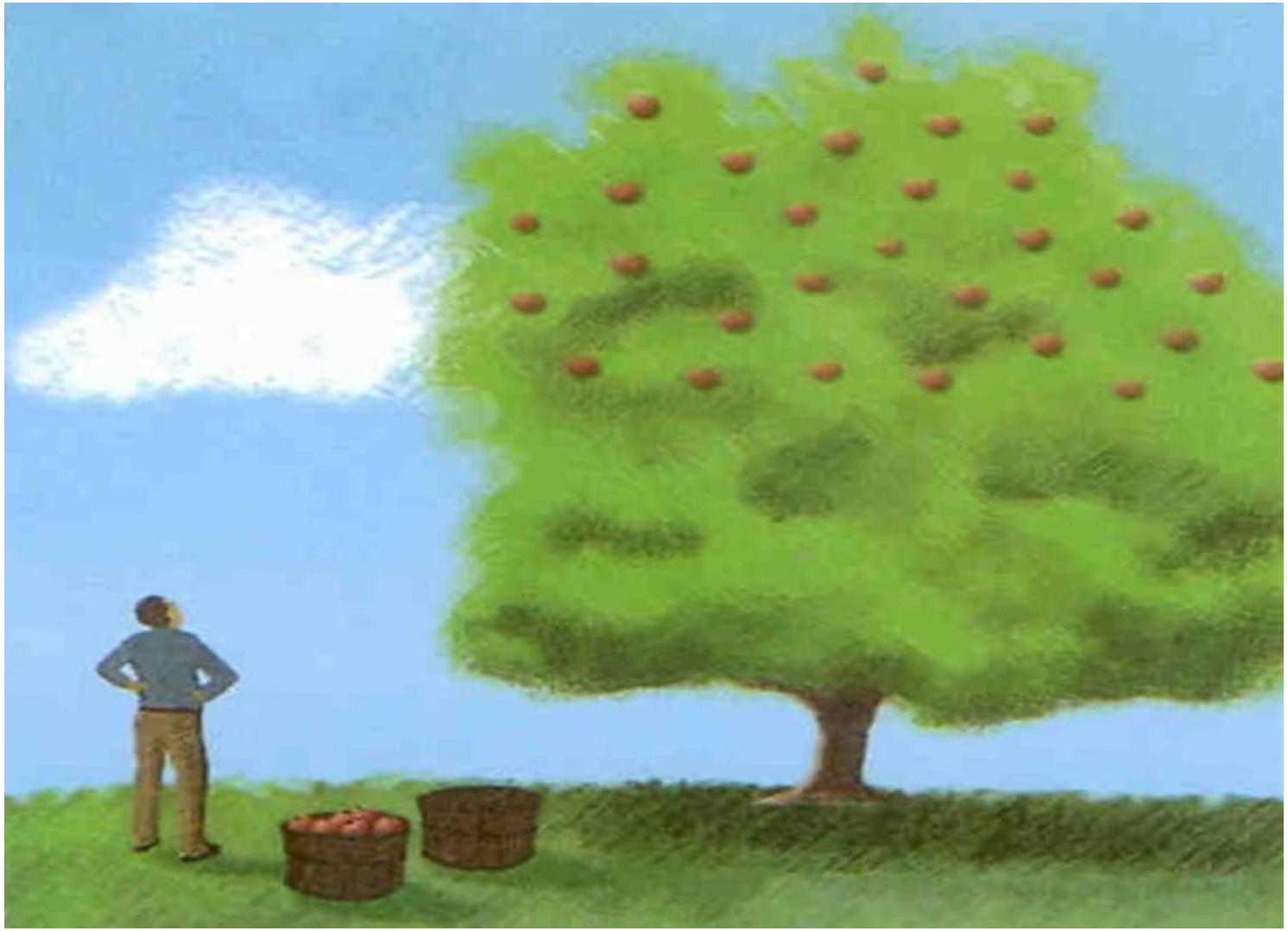
Where Did It Come From?



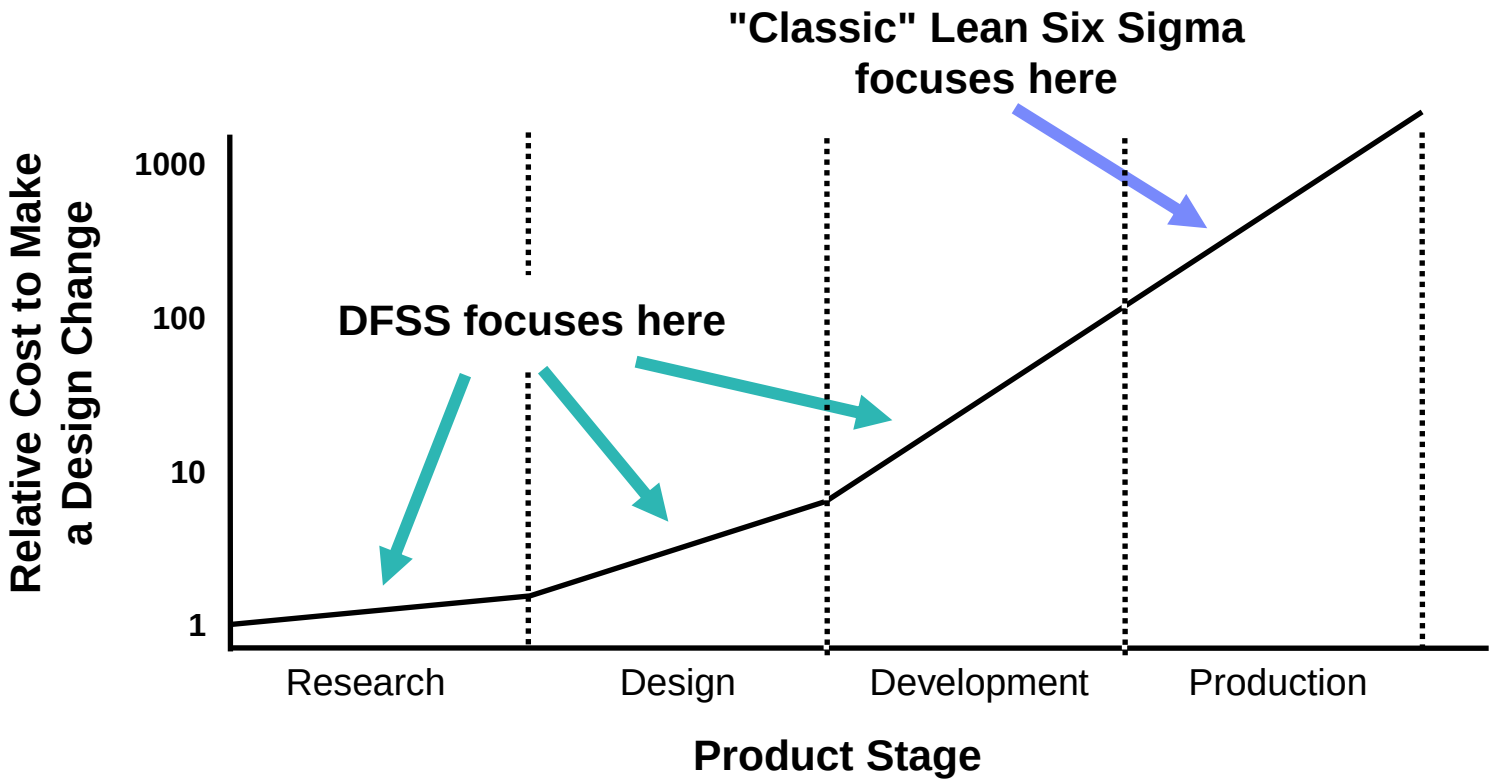
What Have We Learned from LSS?



DFSS: Getting to the Next Level



Why DFSS

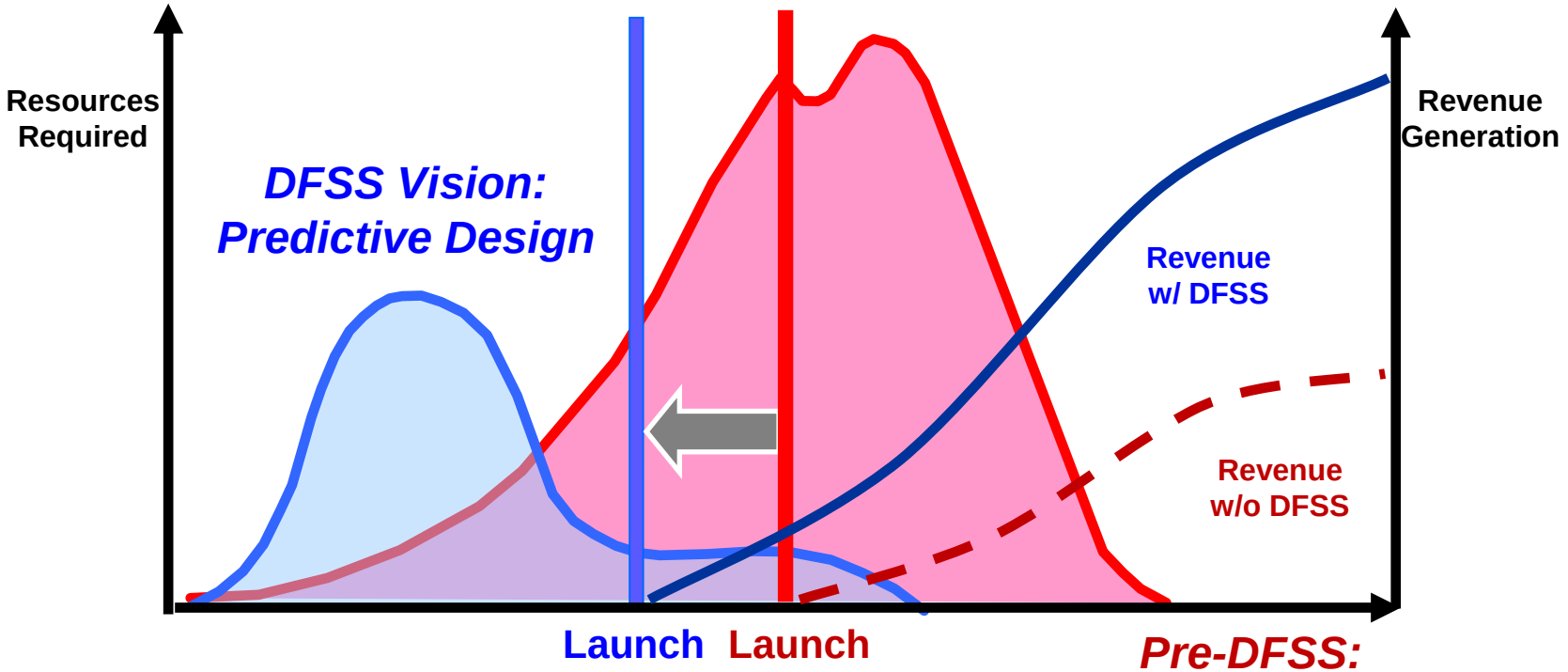


- **Gain knowledge when costs are lowest**
- **Design in quality right from the start**

The Goals of DFSS

- Reduce Cycle Time in the Design and Development Process
- Reduce the Time to Money (TTM)
- Reduce the Cost of Poor Quality
- Improve Predictability of QCD (Quality, Cost, Delivery)

The Benefits of DFSS



- Early problem identification; solution when costs low
- Faster market entry: earlier revenue stream, longer patent coverage
- Lower total development cost
- Robust product at market entry: delighted customers
- Resources available for <u>next</u> game-changer

Pre-DFSS:
Reactive Design

- Unhappy customers and employees
- Unplanned resource drain
- Skyrocketing costs
- Next product compromised

- **Upfront investment is most effective and efficient**
- **Show customers high quality products right from the start**

General Electric Testimonial
(Dr. Norm Kuchar*, GECRD, Oct 2003)

- Quality increases of at least +1σ at launch over previous designs
- Time to Market decrease by at least 25% over previous launches
- Cost savings due to total resources utilized in the 20-40% range

* Norm was responsible for the worldwide deployment of GE's DFSS initiative.

Xerox Testimonial
(Jeff Koff, DFLSS Global Deployment Leader)

- “We have multiple products that we would have been absolutely unable to commercialize without DfLSS.”
- “We have multiple products that have been developed faster than previously.”
- “We have multiple products that have been launched with better and more predictable reliability and performance than previously.”

Intuit Testimonial
(Scott Cook, CEO, January 2015, HBR)

- "We developed D4D (Design for Delight) which clearly articulated Intuit's approach to design thinking, based on deep customer empathy, idea generation, and experimentation."

- "D4D is vital because it provides the entire company with a common framework for building great products."

- "Today we are really a customer-focused, design-driven technology company. And by 2020 we'll be even better."

The Vision of DFSS

From

- Evolving design requirements
- Extensive design rework
- Product performance assessed by "build and test"
- Performance and producibility problems fixed <u>after</u> product in use
- Quality "tested in"

To

- Disciplined CTC flowdown
- Controlled design parameters
- Product performance modeled and simulated
- <u>Designed</u> for robust performance and producibility
- Quality "designed in"

- Lean Six Sigma (DMAIC) fixes known problems.
- ***DFSS prevents unknown problems from occurring.***

Sigma Ratings Measure Process Capability

Sigma (σ Capability is a measure of quality. It compares the Voice of the Process with the Voice of the Customer and is correlated to the defect rate. It is computed from DPMO.

Yield is the probability that whatever we are producing (manufactured part, PO, shipped part, etc.) will pass through the entire process without rework and without defects.

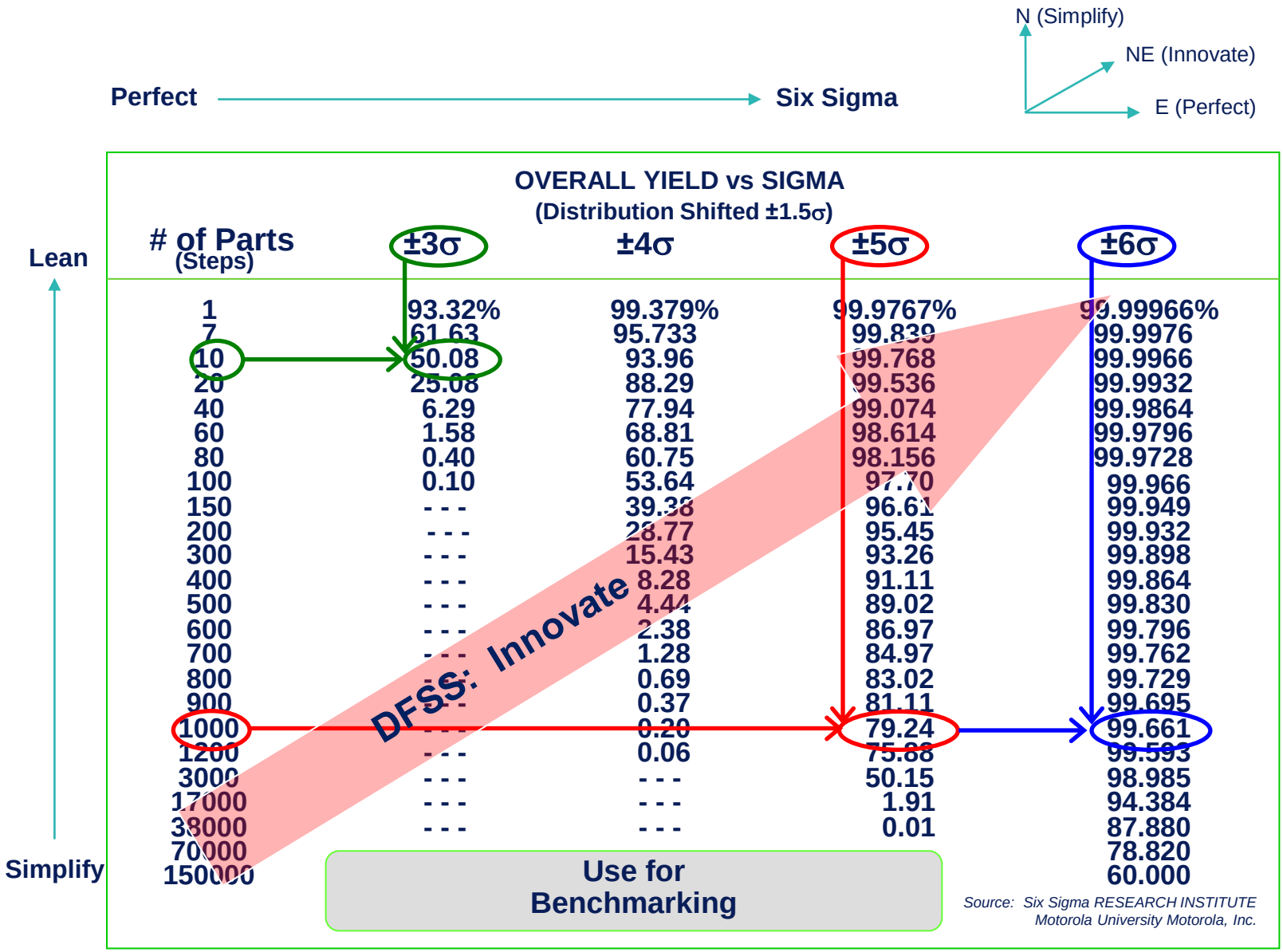
σ Capability*	DPMO*	RTY
2	308,537	69.1%
3	66,807	93.3%
4	6,210	99.4%
5	233	99.97%
6	3.4	99.99966%

Process Capability	Defects per Million Opportunities	Rolled Throughput Yield

Six Sigma is a standard of Excellence.
It means less than 4 Defects per Million Opportunities.

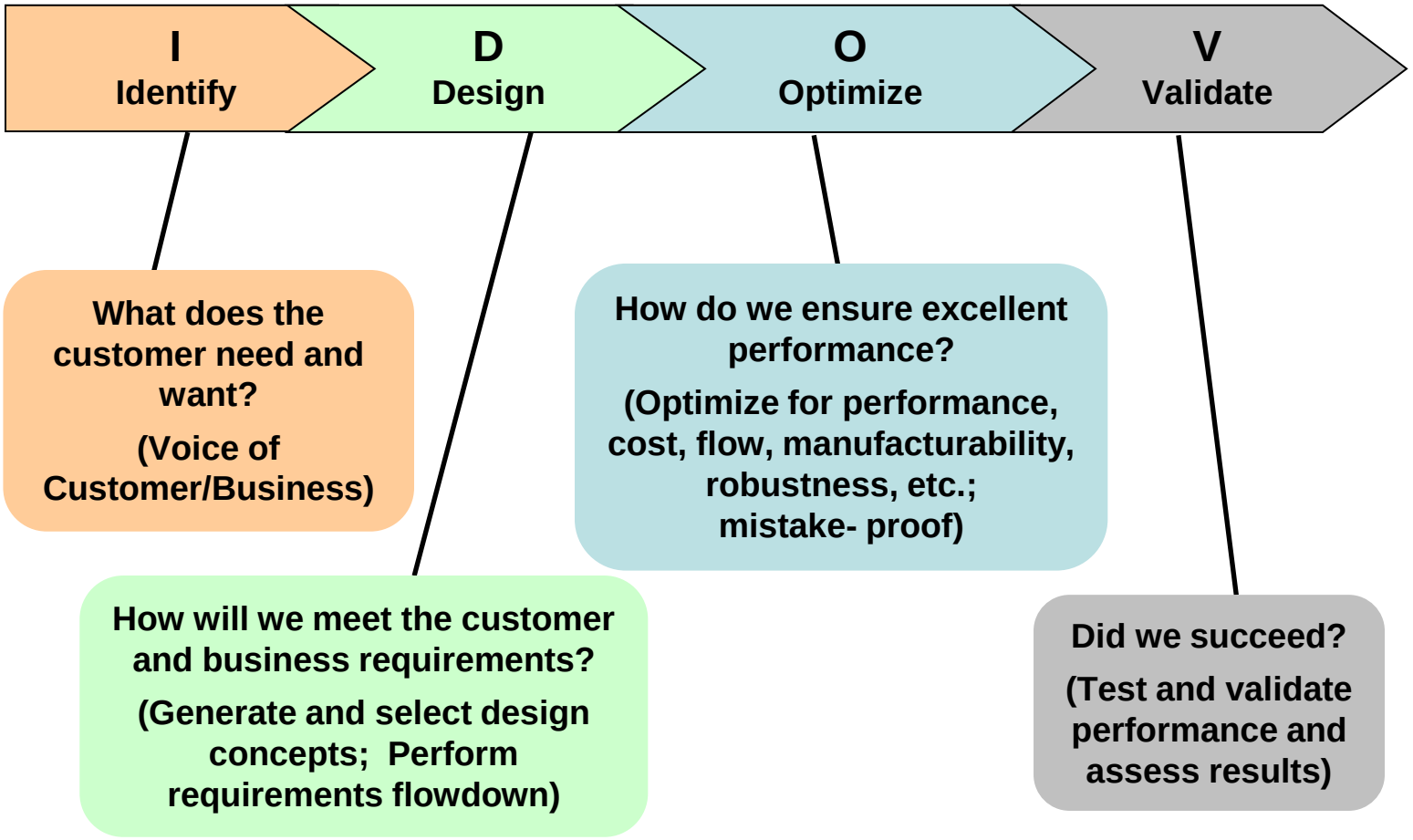
* Assumes a 1.5 sigma shift in average if the performance measure is normally distributed

Relationship Between Lean, Six Sigma, and DFSS



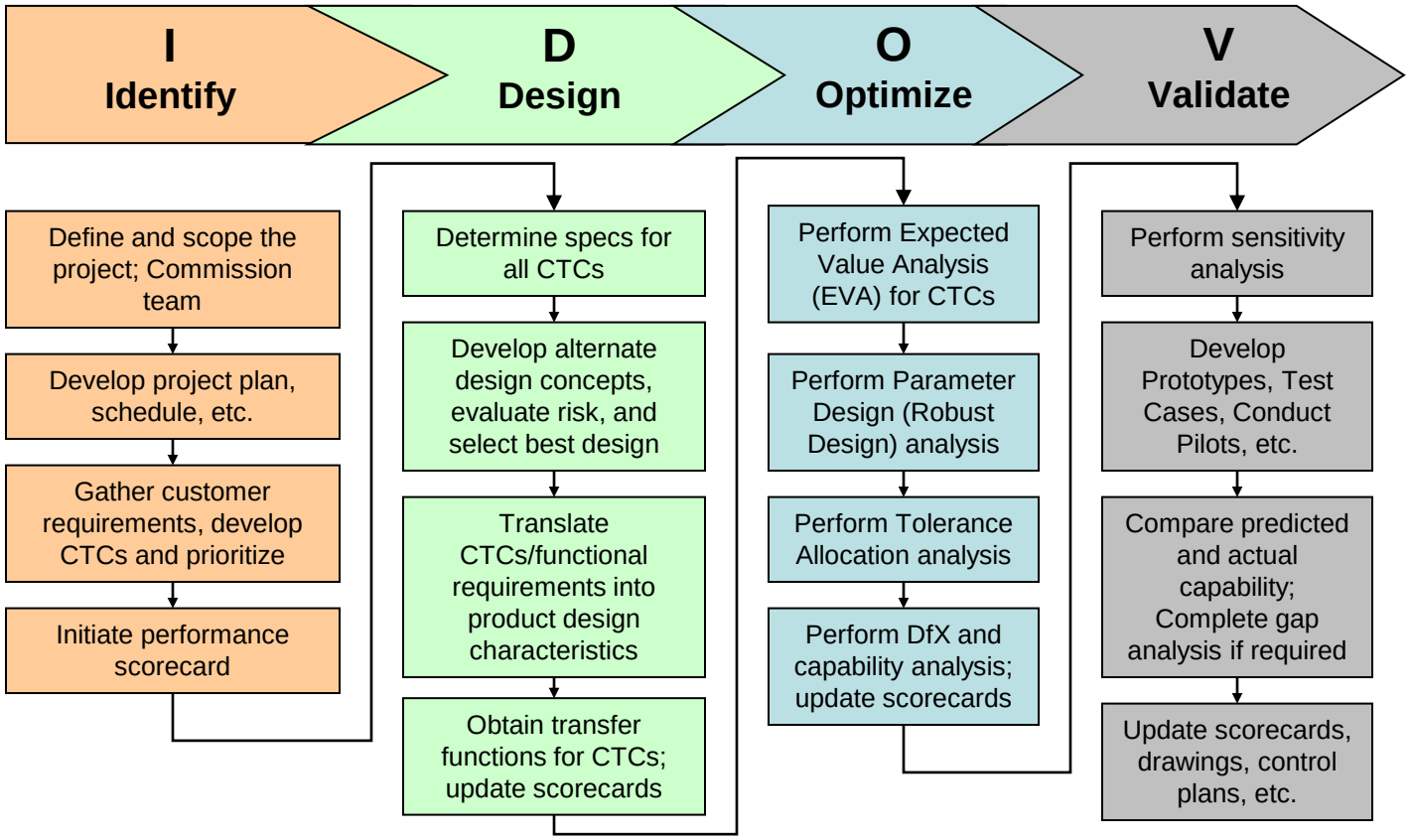
Ref: Animal Planet

The DFSS Roadmap



** The **IDOV** four-phase DFSS process originated with Dr. Norm Kuchar at GE CRD and is used with permission.*

Break Points in the IDOV Journey



Key Deliverables:

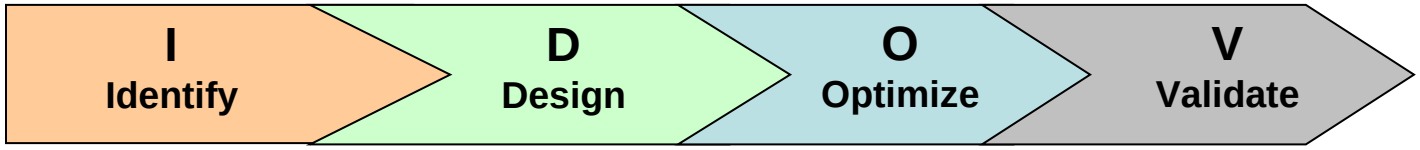
- strategic plan
- benchmarking results
- customer requirements; prioritized, measurable CTCs (HOQ #1)
- Initial performance scorecard

- Design concepts and selection results
- Requirements flowdown
- Prioritized product design characteristics (HOQ #2)
- Design risk assessments
- Transfer functions
- Updated scorecards

- Capability and reliability studies
- X-ability assessment
- Optimized design
- Capability analysis
- Tolerances for key Xs
- Updated scorecards (capability flowup)

- Sensitivity analysis
- Pilots / prototypes and capability analysis
- Validated processes and products
- Updated scorecards
- Control plan

Extending the LSS Tools



Project or Study Charter
Strategic Plan
Cross-Functional Team
Voice of the Customer
Customer Retention Grid
Benchmarking
KANO's Model
Questionnaires
Focus Groups
Interviews
Internet Search
Historical Data Analysis
Design of Experiments
Quality Function Deployment
Pairwise Comparison
Analytical Hierarchy Process
Performance Scorecard
Flow Charts
FMEA
Visualization

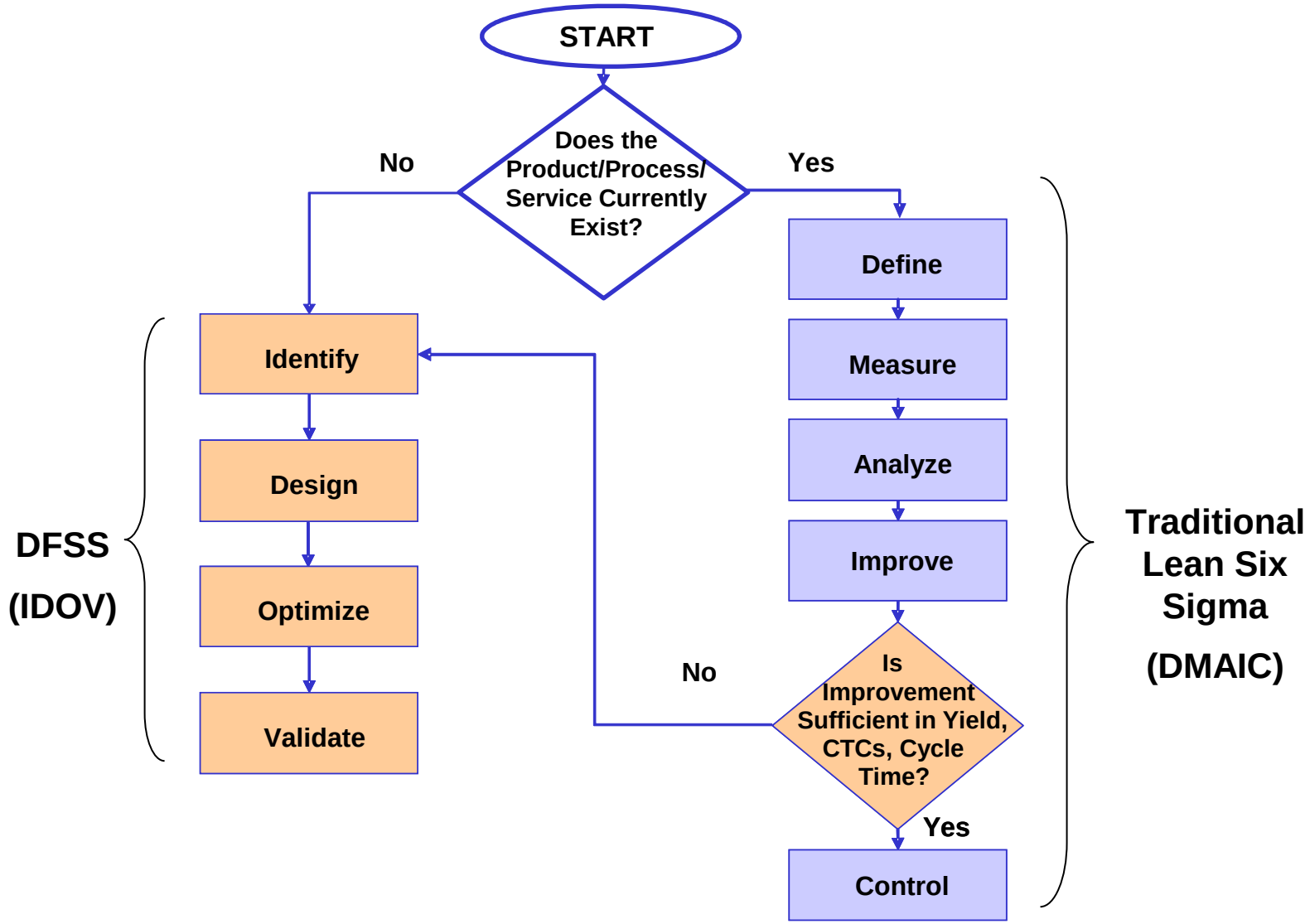
****Unique to DFSS***

Assign Specifications to CTC's
Axiomatic Design
Customer Interviews
Formulate Design Concepts
Pugh Concept Generation
TRIZ
FMEA
Fault Tree Analysis
Brainstorming
QFD
Scorecard
Transfer Function
Design of Experiments
Deterministic Simulators
Discrete Event Simulation
Confidence Intervals
Hypothesis Testing
MSA
Computer Aided Design
Computer Aided Engineering

Histogram
Distributional Analysis
Empirical Data Distribution
Expected Value Analysis (EVA)
Adding Noise to EVA
Non-Normal Output Distributions
Design of Experiments
Multiple Response Optimization
Robust Design Development
Using S-hat Model
Using Interaction Plots
Using Contour Plots
Parameter Design
Tolerance Allocation
Design For Manufacturability and Assembly
Mistake Proofing
Product Capability Prediction
Part, Process, and SW Scorecard
Risk Assessment
Reliability
Multidisciplinary Design Optimization (MDO)

Sensitivity Analysis
Gap Analysis
FMEA
Fault Tree Analysis
Control Plan
PF/CE/CNX/SOP
Run/Control Charts
Mistake Proofing
MSA
Reaction Plan
High Throughput Testing

DFSS (IDOV) vs LSS (DMAIC)



Definition of a “Champion”

- **Champion**: “one that defends, fights for, or supports a cause”
  (source: The American Heritage Dictionary)

- **DFSS Champion**: one who defends, fights for, or supports the cause of DFSS; that is, one who, by his or her actions and behavior, is a strong advocate of DFSS

- **DFSS Deployment Champion**: one who is responsible for deploying and implementing DFSS throughout an organization

- **DFSS Project/Study Champion (a.k.a. DFSS Project/Study Sponsor):** one who is responsible for chartering, sponsoring, and supporting a DFSS project or study, ensuring that it crosses the finish line

Responsibilities of a DFSS Champion

- Know the what and why of DFSS
- Identify and define key projects/studies that can best benefit the organization
- Identify belt candidates and make sure their projects/studies align with their current work
- Provide financial and organizational resources to train and equip belts to accomplish project goals
- Create and maintain project or study momentum
- Ask the right questions and review the answers
- Break down barriers to project completion and push the project across the finish line
- Recognize and reward success
- Propagate success stories to generate cultural change
- Raise the level of effectiveness of new product/process development throughout the entire organization

DFSS GB Competency Areas

- VOC Gathering and Requirements Generation and Analysis
- DFSS Scorecard Generation and Analysis
- Concept Generation and Selection
- Detailed Design Strategy
- Measurement System Analysis (MSA)
- Failure Mode and Effect Analysis (FMEA)—risk analysis
- Statistical Tools and Analysis (hypothesis testing, regression, etc.)
- Design of Experiments (Screening, Modeling, and Validation Designs)
- Analytical Modeling and Simulation
- Robust Design and Optimization Methods
- Tolerancing and Specifications
- Design for X (manufacturability, testability, serviceability, etc.)
- Design and Process Capability

Key Takeaways

- Design for Six Sigma (DFSS) means all of the following:
  - Better products and services produced faster and at lower cost
  - Earlier market entry
  - Faster market growth
  - Reduction in total lifecycle costs
  - A framework for systematic improvement and innovation
  - A vision
- DFSS expands the toolset of LSS to include tools that must be used earlier in the lifecycle of a product or service
- Certification is based on competency

Thank You

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