Implementing PLM For Heavy Machine Development Using Teamcenter Systems Engineering (TcSE)

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Agenda

- Overview
- Background and Business Drivers
- Opportunities and Challenges
- TcSE as Part of an Integrated Solution
- Lessons Learned
- Future Plans and Opportunities

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Overview

- Background – Heavy Machine Manufacturers
  - Typical challenges, business drivers
  - Opportunities
- Teamcenter 2005 for Systems Engineering (TcSE)
  - Meeting those challenges and opportunities with TcSE as part of an overall PLM solution
- Lessons Learned
  - Based on deployments to date
  - General applicability

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Background

- Large International Companies
  - John Deere, Caterpillar, Komatsu, etc.
- Extended Enterprises
  - Overseas facilities, Suppliers, Dealers, etc.
- Commercial, Competitive
- Support Multiple Industries
  - Construction, Mining, Forestry, Oil & Gas, etc.
- Configurable Machines for Multiple Applications
  - Augers, Hammers, Buckets, Forks, etc.

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Background (cont.)

- Multiple Product Lines
  - Different industries
  - Different applications
  - Multiple sizes
  - OEM for certain Systems (e.g., engines)
- Typically Lots of Legacy
  - Products/machines tend to evolve
  - Legacy business processes, engineering processes, tools, etc.

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Business Drivers/Goals

- Increase Market share
- Improve customer satisfaction/retention
- Improve product quality (all product lines)
- Reduce Time to Market
- Compliance (e.g., emissions)
- Streamline Product Development processes
  - Manage Requirements
  - Maximize Reuse
  - Manage Change

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Challenges

- Development processes not well defined and/or not well followed
- Requirements not complete at program start, and subsequent changes not well managed
- Downstream changes made with little or no understanding of impacts
  - Relative to requirements, other systems, scale/cost of change, etc.
- Information static and not well shared across business units
- Business Units tend to operate autonomously
  - Silos
  - THWADI

THWADI – That's How We've Always Done It

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Opportunities - General

- Maximize commonality and reuse across product lines
- Incorporate Best Practices (Requirements Engineering, 6 Sigma Methods, Change Management)
- Enable Use of the Right, Current Information at the Right Time to Make the Right Decision
- Manage Interfaces and Dependencies
  - Work Tools, Between Subsystems, Between product lines, etc.
- Improve Communication
  - More people involved (even if not directly using TcSE)
  - Information available earlier in the process

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Opportunities - Systems Engineering/ Requirements Management

- Manage plethora of customer needs and wants
  - Collect, Manage and Correlate an Integrated Set of Voices
  - Voice of the Customer (VOC), Voice of the Business (VOB), Voice of Regulation (VOR), Etc.
- Improve the visibility and reuse of requirements across multiple product lines
- Manage requirements changes and improve impact assessment for those changes
- Allocate requirements to specific machine models and lower level systems (hydraulics, engines, etc.)
- Create end-to-end traceability from initial inputs to detailed requirements to design, development, test and production
- Integration throughout the enterprise

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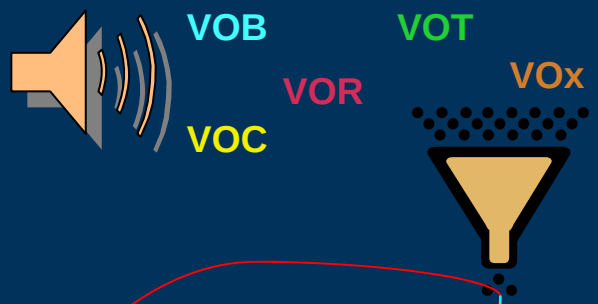
Dimensions of Machine Development



VOC – Voice of the Customer
VOB – Voice of the Business
VOR – Voice of Regulation
VOT – Voice of Technology

Product Line A1 (Excavators – Med)

Product Line A2 (Excavators – Large)

Model A

Model B

Model C

Model D

Model E

Model F

System

System

System

Assembly

Assembly

Component

Component

Component

Product Lines/Models

Common Systems/Components

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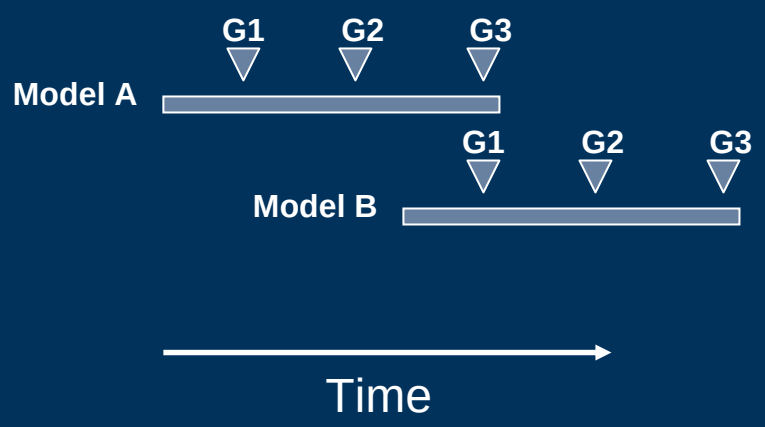
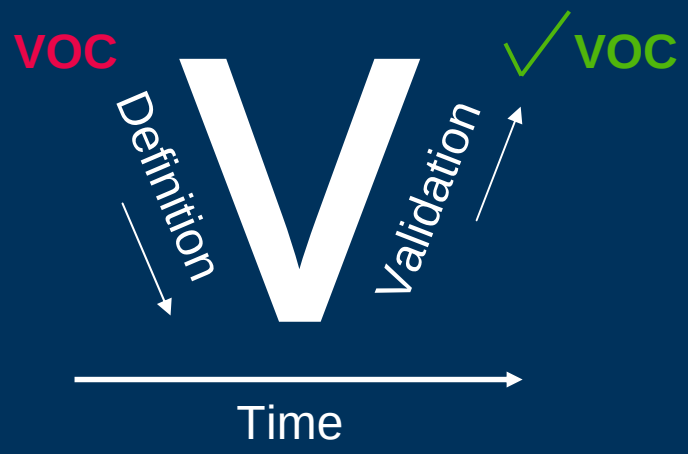
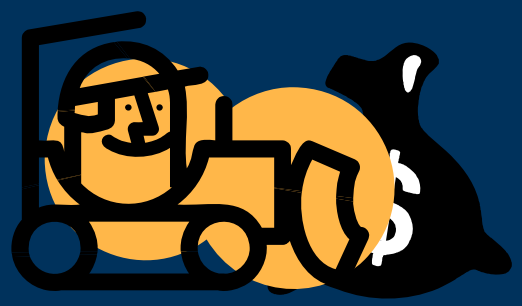
Dimensions of Machine Development

Product Lifecycles/Gates



Validation of Voice





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TcSE as Part of an Integrated Solution

Process Context (What)

- Collect and Analyze Information
  - Trip reports, market surveys, trade shows, dealer surveys, field engineers, warranty info, etc.
- Create Requirements
- Analyze and Validate Requirements
  - Clear, Concise, Non-Conflicting, Consistent, Complete
- Requirements Decomposition
  - Lower-level, more detailed requirements
- Requirements Allocation
  - Allocate/cascade to functional hierarchy
  - Allocate/cascade to physical elements - product lines, machines, systems, subsystems, components
  - Traceability, top-down and bottom-up

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TcSE as Part of an Integrated Solution

Tool Context (How)

Examples:

- Integrate TcSE with Teamcenter Community for collaboration and connection to source information that drives requirements
- Integrate TcSE with Teamcenter Engineering to influence design directly, as it is happening

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TcSE and Teamcenter Community

Ongoing Voice Collection

Operator Environment

Quality, Reliability, Durability

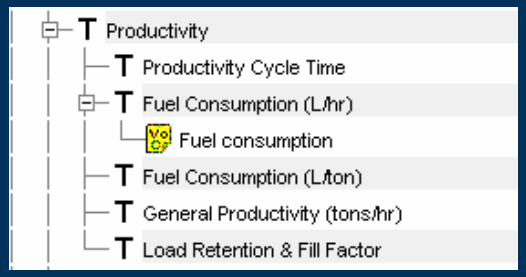
Performance

Requirements Analysis

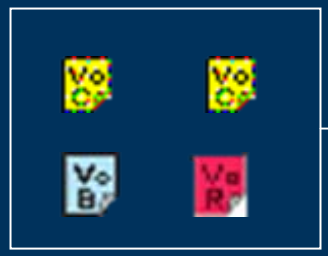
Trip reports, surveys, trade shows, etc.

Teamcenter Community

VOC Template



Decomposition, refinement, allocation



Additional Process Steps in TcSE as Defined

TcSE

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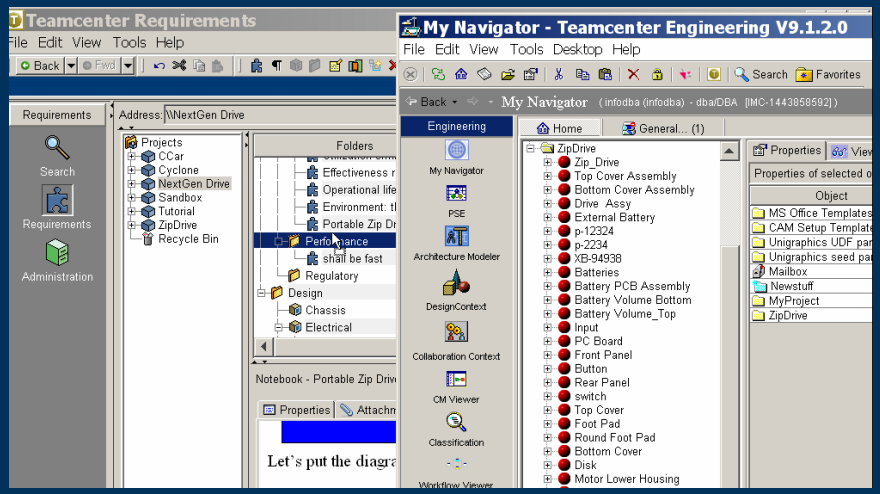
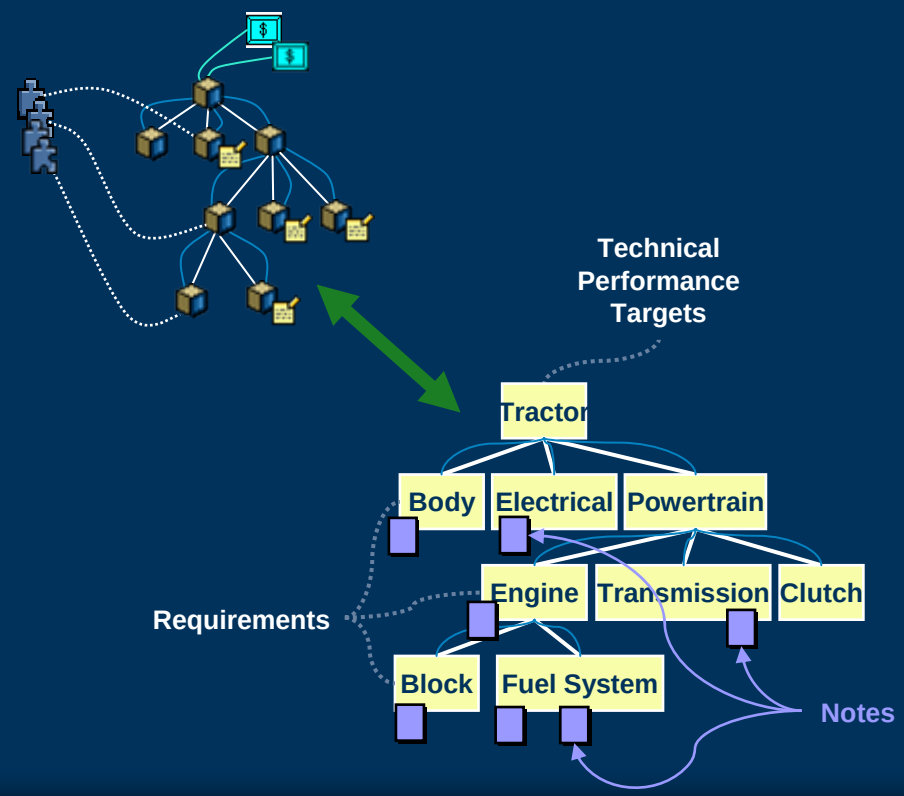
TcSE and Teamcenter Engineering

Connect Requirements to Design, Physical Architecture

- Drag & drop one-to-many/many-to-one linking
- View Requirement properties from Teamcenter Engineering
- Navigate between the applications by following the links
- Synchronization of modifications
- Impact reporting





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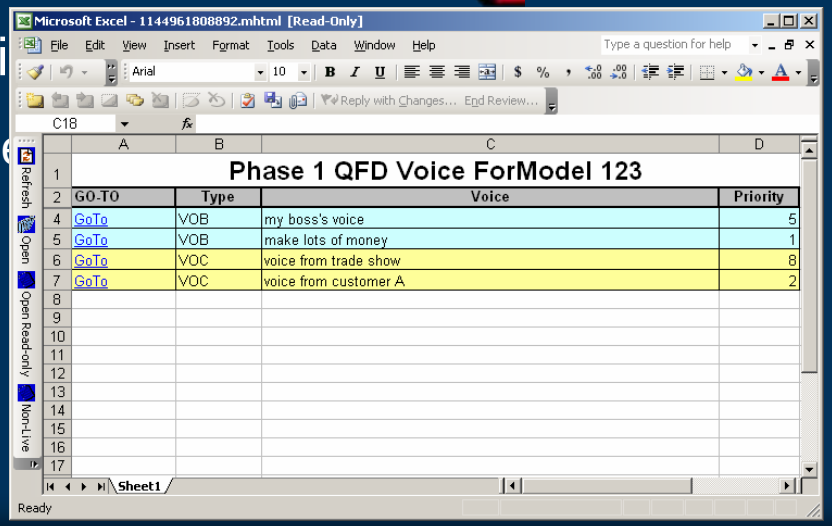
Deploying TcSE - General

- OOTB:
  - Custom subtypes and properties
  - Create template structure for consistency and reuse
  - Custom views, role and process-based
  - Reports to support the process and gate reviews
  - Excel Live
  - Links (including subtype links) for traceability throughout
- Customization (Macros, activators wi
  - Custom menu items for specific proce
  - Streamline certain admin tasks



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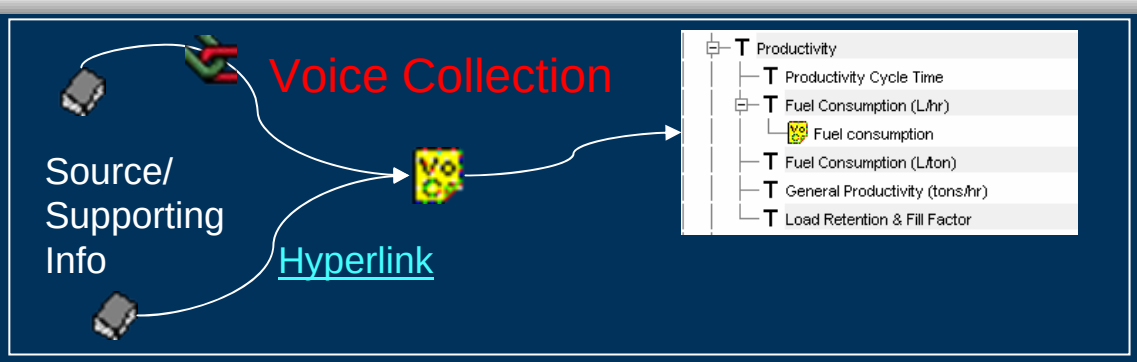
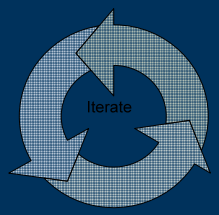
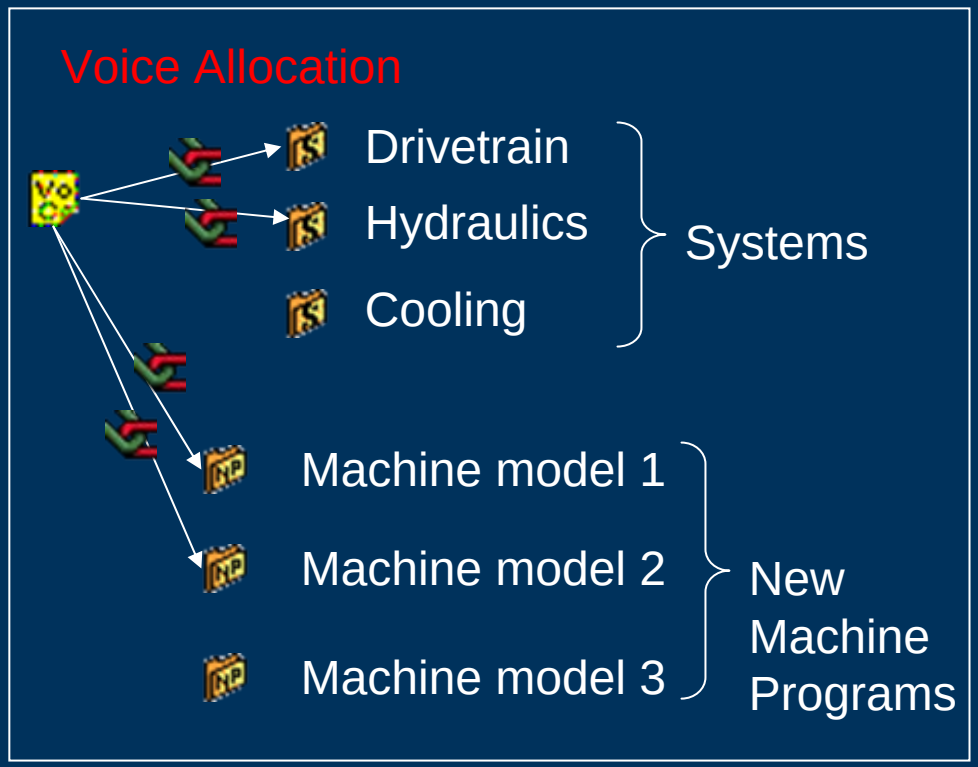
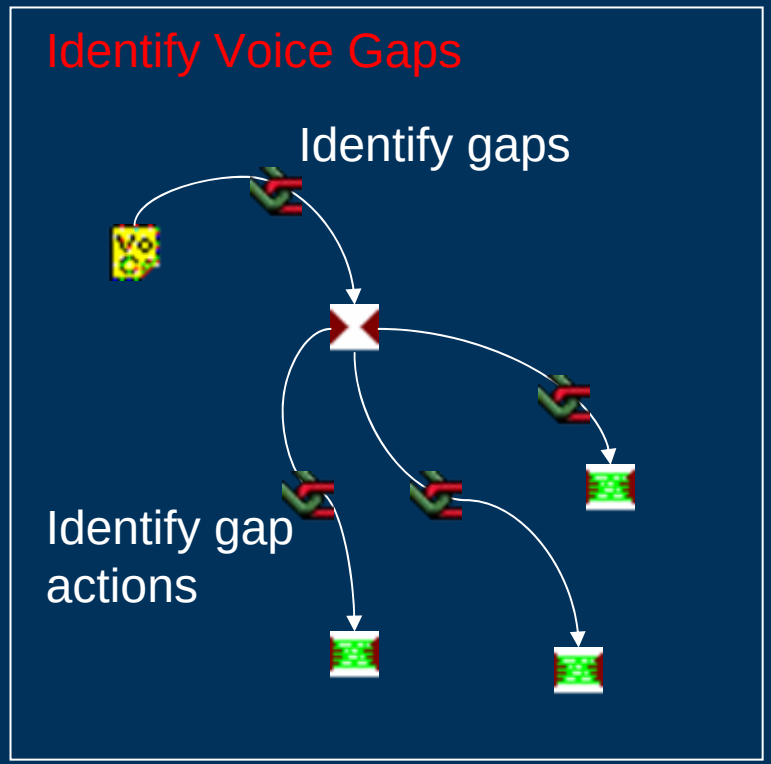
Requirements Collection and Analysis









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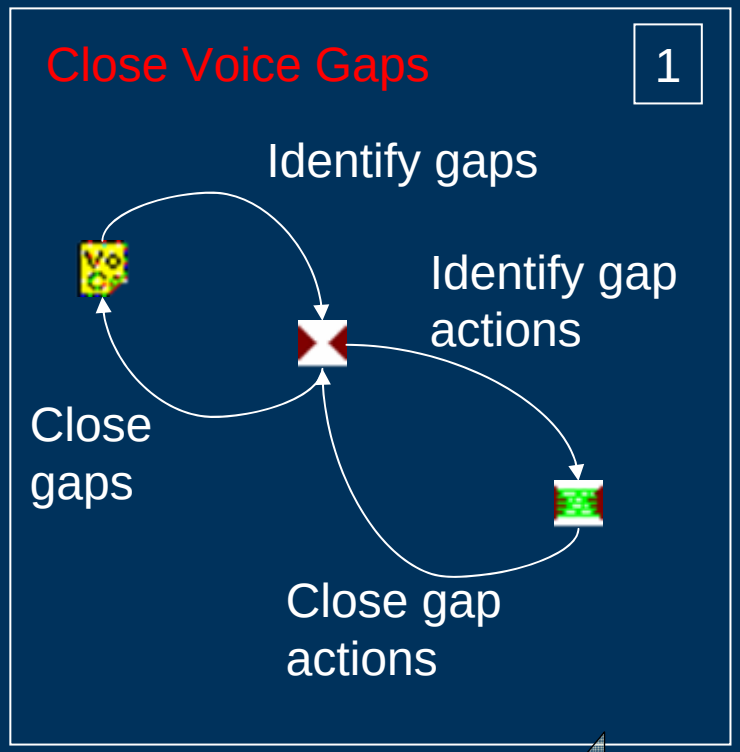
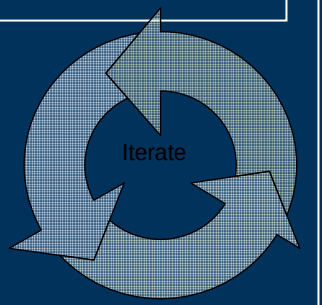
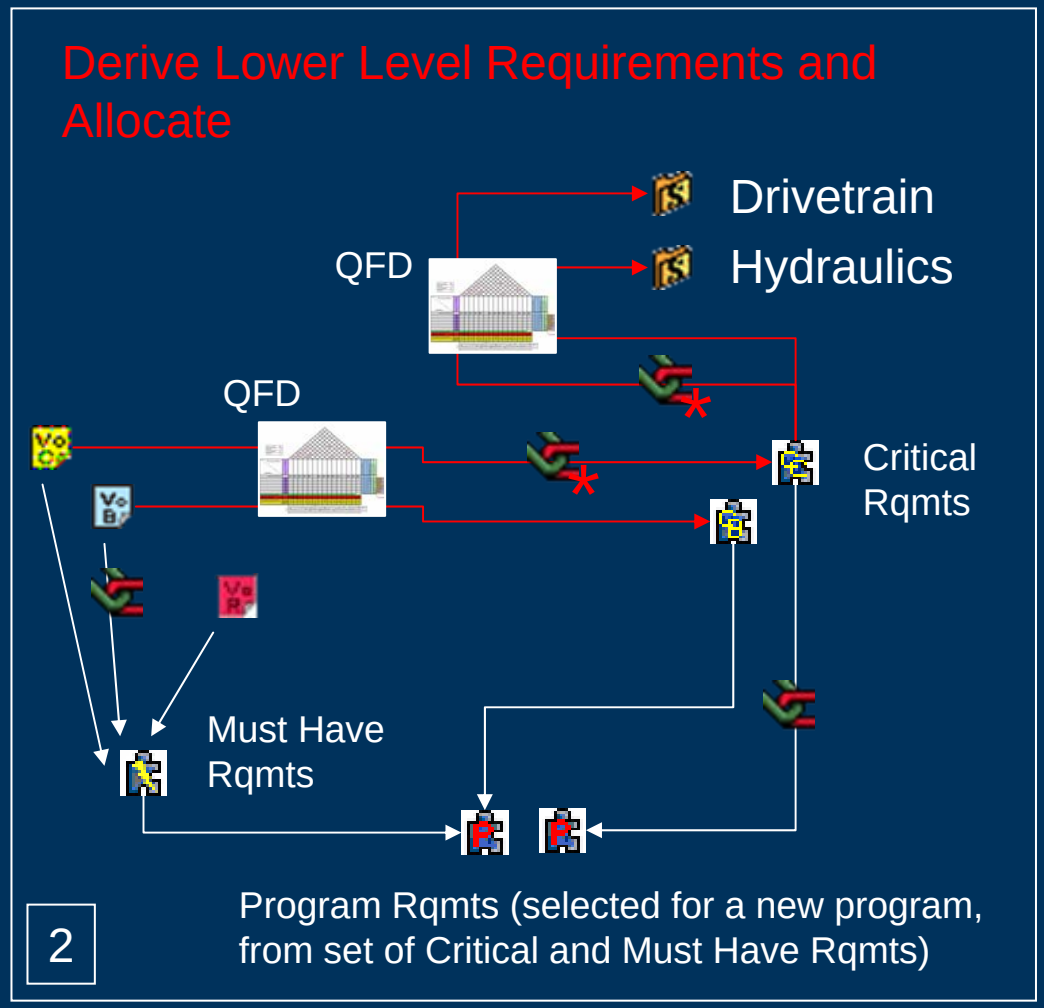
Requirements Derivation and Allocation







DFSS Subtype Link

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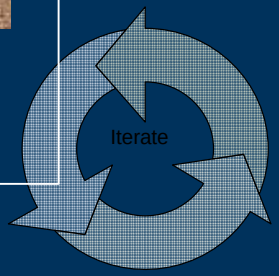
Requirements Derivation and Tradeoffs

Identify concepts

Customer wants & needs (CTQs: Attributes)	Importance of need	Design Baseline	Opt #1	Opt #2	Opt #3	Opt #4	Opt #5	Opt #6	Opt #7	Opt #8	Opt #9	Opt #10	Opt #11	Opt #12	Opt #13
Pc. Cost comparison to existing system	5	0	-	-	-	-	-	-	-	-	-	-	-	-	+
Systems cost impact	8	0	-	-	-	-	-	-	-	-	-	+	-	-	+
Manufacturability	10	0	-	-	-	-	-	-	0	+	0	0	-	-	-
System compatability	10	0	-	-	-	-	0	0	0	0	0	0	0	0	0
Net build at asm.	10	0	-	-	-	-	-	0	0	+	0	0	0	0	-
Thermal range	10	0	0	+	+	+	+	-	+	+	0	0	0	0	0
Air gap	8	0	+	+	+	+	0	0	0	0	0	0	0	0	-
Line speed limit	4	0	+	+	+	+	+	+	+	+	+	0	0	0	+
High speed limit	4	0	0	+	+	+	0	0	0	0	0	0	0	0	-
Resolution capability	9	0	+	+	-	-	+	+	+	+	0	0	0	0	0
Pulse width encoding	5	0	0	+	-	-	0	0	0	0	0	0	0	0	0
Accuracy/ precision	10	0	-	-	-	-	+	+	+	+	0	0	+	0	+
Output signal level	10	0	+	0	0	0	0	0	0	0	0	+	0	0	+
Output waveform	4	0	+	0	0	0	0	0	0	0	0	0	0	0	+
Reliability/ Durability	10	0	-	-	-	-	-	-	-	-	0	0	0	-	-
Serviceability	4	0	-	-	-	+	+	0	0	0	0	0	0	0	0
Materials availability	10	0	0	-	0	0	0	0	0	0	-	0	0	+	-
Package size (mass)	10	0	0	+	-	-	0	0	0	+	+	+	-	0	0
EMI/EMC robustness	10	0	-	-	-	-	+	+	+	0	+	+	-	+	-
SUM	151	0	-42	-37	-75	-75	0	-10	20	30	11	-7	-37	-53	-31

Pugh Matrix

Select concept



Update Program Rqmts Based on Chosen Concept

Technical Specs

System level QFD's based on Previous QFD Allocation

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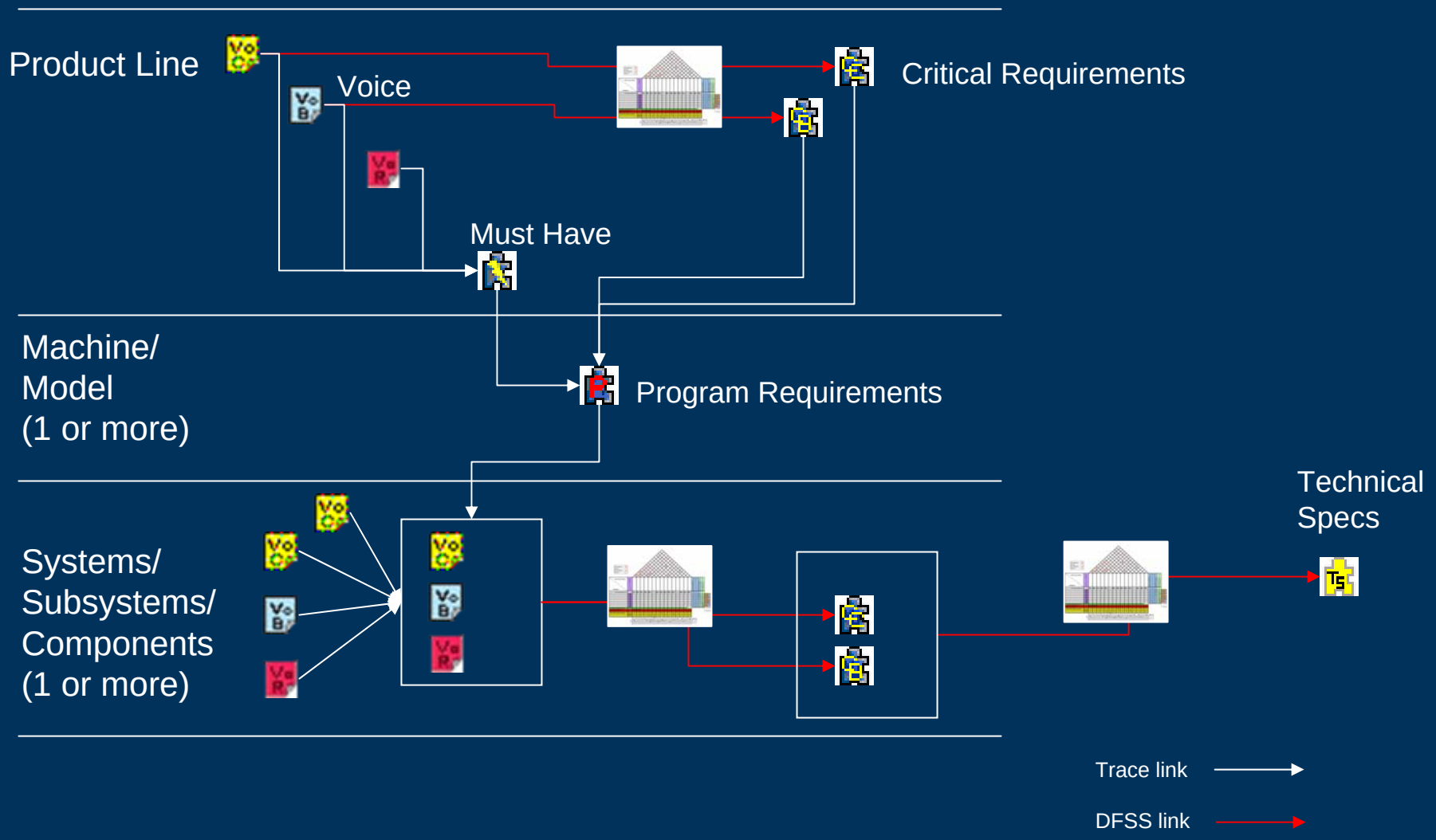
Context Diagram for Requirements



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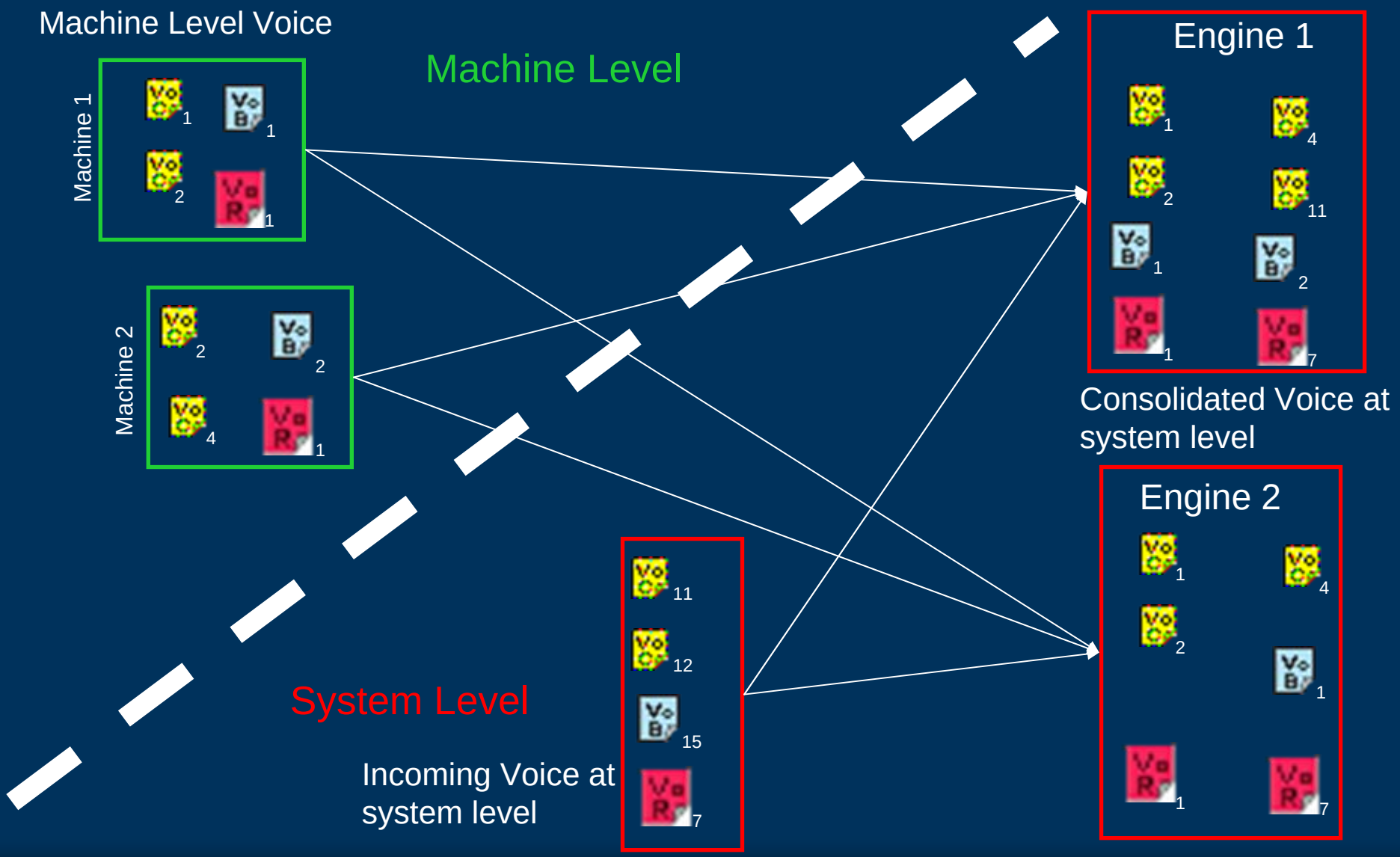
Allocation and Flowdown
Machine to System Level



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Lessons Learned

- Plenty of Challenges
  - Scale and Complexity
  - THWADI
- But Plenty of Opportunities
  - Define and follow an organized approach
  - Solid process foundation
  - Define and validate requirements (vs. IKIWISI)
  - Incremental development
  - Pilots to show small successes early and get feedback (VOC)
  - Improve communications throughout the development process

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Future Plans and Opportunities

- DFSS Template to Automate QFD and Other 6 Sigma Methodologies
- Improve Integration with TcEngineering
  - BOM, Workflow, etc.
- Increase use of Architecture Approach
  - Building Blocks in TcSE
  - MS-Visio
- Identify additional requirements/details at system levels and below

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Questions???

Thank You

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