Multi-discipline Program Office and Functional Integration – Challenges and Solutions

Ravi Rangan, Chief Technical Officer
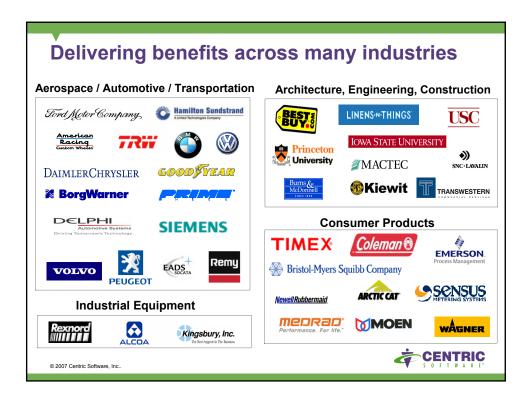
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Outline

- Lifecycle context for Simulation and Modeling
  - Practices and evolution
  - Deployment considerations
- Accounting for patterns
  - CM process dynamics support within domain model
  - Leveraging available infrastructure, and organic evolution
- Use Cases
  - Functional Integration
  - Multi-Discipline Program Office
- Summary

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Delivering benefits across many industries

Aerospace / Automotive / Transportation

Ford Motor Company, Hamilton Sundstrand, American Racing Custom Wheels, TRW, BMW, Volkswagen, DAIMLERCHRYSLER, GOODYEAR, BorgWarner, PRIMA, DELPHI Automotive Systems, SIEMENS, VOLVO, PEUGEOT, EADS SOCATA, Remy

Architecture, Engineering, Construction

BEST BUY.com, LINENS·N·THINGS, USC, Princeton University, IOWA STATE UNIVERSITY, SNC·LAVALIN, MACTEC, Burns & McDonnell, Kiewit, TRANSWESTERN

Consumer Products

TIMEX, Coleman, EMERSON Process Management, Bristol-Myers Squibb Company, Newell Rubbermaid, ARCTIC CAT, SENSUS METERING SYSTEMS, MEDRAD Performance. For life., MOEN, WAGNER

Industrial Equipment

Rexnord, ALCOA, Kingsbury, Inc.

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Key Business Drivers

- Global Operations
  - Design anywhere/ build anywhere
- Outsourced Operations and partnerships
  - M&A, outsourcing
- Business Concurrency & Decision Support
  - Cycle time reduction, mass customization
- Bigger investment in upfront design
- Rapid time-to-benefit

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Implementation Challenges

Easy   Hard   Easy

Existing Tools and Methods

Implementation Path

Next Gen Tools and Methods

- Lack of system engineering mindset
- Optimized around old technologies
- Limited application scope
- Hidden inefficiencies

- Established user base reluctant to change ways
- Management that doesn't understand key technical issues
- Workload demands don't permit loss of productivity

- Robust, system engineering mindset
- Flexible and modular to handle new technologies
- Broad application scope

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Lesson learned: We need to better understand deployment and adoption patterns

GM: BRYANT'S LAW (modified)

$$S = (100E + 10P + 1T)* D$$

where

    S = Success + Realized value
    E = Empowered, trained people
    P = Process
    T = Technology
    D = Data (legacy, current, future)
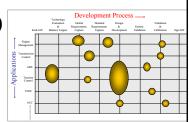
Rangan, Rohde, Peak, Chadha, Bliznakov, Streamlining Product Lifecycle Processes: A Survey of Product Lifecycle Management Implementations, Directions, and Challenges, pp. 227-237, ASME JCISE, Sept, 2005; Systems Modeling EIM Deployment within an Automotive OEM, Mark Jennings, Ford, ASME EIM Panel 2003

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Key Patterns

Evolution of Business Object Management Practices

Business Value (High → Low)

- **1. Document-based control**
- **2. Document-based control with Part identity reference**
- **3. Part-based control with change management within BOM**
- **4. Part, function and system with change management across configurations**

Part ← Breadth of lifecycle addressed → Complete System

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Functional Silos Prevent Optimal Execution
Crucial Product Data Lives Everywhere

Value

→ Intelligent Information Aggregation

Multi-domain Processes

Insight and Understanding

Information

Data

COLLECT

ASSESS **Product Intelligence** DECIDE

EXECUTE

Business Intelligence

Unstructured and Unmanaged Data

PLM, Doc Mgt, CAD

SCM, CRM, ERP

Product Professionals   Business Professionals

User Category

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Domain Model accounts for Business Method Robustness

Manage as Isolated, un-intelligent content (document centric configuration management)

Account for Impact analysis
Manage relationships for System Effects process continuity

Balance Concurrence, role autonomy, change isolation and Process dynamics through Interfaces
•Delegation
•Lean processes
•Accountability / Traceability
•Uniform and common process

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Centric Manages Across Parts, Functions and Systems

SYSTEMS ENGINEER / MODELER

Functional Integration and Model Management
Manage Cross-domain Functional Integration Mappings/ Product Architecture and related information against PI aggregated context

PROGRAM MANAGER

Multi-Discipline Program Management
Project Visibility and KPI Tracking (Scheduling and Reporting) against aggregated PI content

New Product Development and Launch

Product and Program Portfolio Management

Aircraft Completions Management

Global BOM De-fragmentation

Product and Capital Program Search

CENTRIC PRODUCT INTELLIGENCE DOMAIN MODEL + COLLECTION & AGGREGATION SERVICES

Private Label Product Sourcing

OTHER...

Ready for

IBM. | SOA

Specialty

Step1 → Step2 → Step3 → Step5 → Step6
Step4
BPEL

SOA Enterprise Service Bus

REQUIREMENTS

SYSTEM ENGR.

SIMULATION

CAD PDM

ECAD

CAE

PROJECT PLANNING

PLM

Unstructured File Systems

Unstructured File Systems

ERP

MRO/ InService

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Functional Integration Use Cases

Solution Drivers

- Streamline design data integration process across product domains
    - Unified view of logical system and functional design
    - Secure management of mappings & allocations between logical system and geometric product structures
- Leverage off-the-shelf connectivity products
- Lower cost of ownership of integrated system
- Rapid deployment with responsive iterative feedback cycles
- Formally accommodate aggregated visibility and allocation use-cases and CM process dynamics

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Complex Products - More than BOMs

	Phase	Example
Requirements Analysis	Requirements	• Customer Needs • Business Needs
High Level Conceptual Design	Abstract Function	• Mass • Energy Flow Patterns • Causal Network
	Generalized Function	• Feedback Control • Cooling, Propulsion, etc. • No Physical Implication
	Physical Function	• Engine Characteristics • Transistor: Signal Matrices • Limiting Properties
Detail Design Prototyping, Production, Sustaining	Physical Form	• Geometry • Analysis/ Test Results • BOM, Materials, etc.
	Production Process	• Process • Parameters • Process Selection
	Operations Process	• Maintenance • Service Bulletins • Retrofit

XXX

YYY

ZZZ

Cross-domain Mappings & Allocations

Centric PI

Product Intelligence

COLLECT

DECIDE

EXECUTE

ASSESS

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Complex systems: Elaborate through multiple levels of abstractions

Requirements

Functional Design

Logical Design

Physical Design

Chosen abstraction levels establish process (certain levels skipped)

Allocations for Accountability

Capture traceability & rationale, as needed

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Enable CM across existing systems and processes

and mappings across domains

Search Aggregate & Execute

SOA-based Connectivity
(Synchronized Product Intelligence)

Centric Connector

Centric Connector

Centric Connector

Functional/ Logical System Design (XXX)

Component Connectivity (YYY)

Design Configuration (ZZZ)

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Functional Integration

1. **Provides the *Full System View***
   - Review design perspectives from various workgroup data repositories
   - Combined reconciliation of the Integrated Product Architecture

2. **Present relevant information at each level of design abstraction**
   - Drill-down to any level of detail
   - Capture and preserve product semantics
   - Aggregate and allocate design perspectives without losing functional integrity

3. **Enable information relationships across functional boundaries**
   - Native support of Functional Integration concepts
   - Allocation between design perspectives to ensure audit & accountability
   - Configuration Management for Functional Integration

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http://mirror.productsight.com:4500 - Manage Data Item Project Braking System - Microsoft Internet Explorer

Project: Braking System, First Release Braking System

Data Item Data | Perspectives | Configurations | Allocations | Action Items | Where Used | Baselines

Perspectives

Perspective	Perspective ID and Revision	Release Comment	State	Start Date
Functional Hierarchy	FH-001, 1	Initial Release	Draft	26-Oct-06
Logical Design	LD-001, 1	Initial Release	Draft	26-Oct-06
Physical Implementation	PI-001, 1	Initial Release	Draft	26-Oct-06
Requirements Hierarchy	RH-001, 1	Initial Release	Draft	26-Oct-06

Configurations

Name, Rev	State	Description	Perspectives	
Config_ID_001A, 1	Draft	Test Bench Build	FH-001, 1, Draft, LD-001, 1, Draft, PI-001, 1, Draft, RH-001, 1, Draft	
Config_ID_PTY001B, 1	Draft	Baseline Config for approval	FH-001, 1, Draft, LD-001, 1, Draft, PI-001, 1, Draft, RH-001, 1, Draft	

Allocations

Name	Description	From Spec	To Spec	Frozen?	
Physical-Logical Mapping	Allocation of Physical Implementation to Logical Design	LD-001, 1	PI-001, 1	No	

http://mirror.productsight.com:4500 - Allocation Functional-Logical Mapping - Microsoft Internet Explorer

File Edit View Favorites Tools Help

User: Eric

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Home | Action Items | Folders | Documents | Data Items | Logoff | Help

Project Braking System > Allocation Functional-Logical Mapping

Allocation Functional-Logical Mapping

Printer Friendly

Allocation Data	Allocation

[Boundary I/O Report]   [Interaction I/O Report]

Allocation Data [Edit]

Name	Functional-Logical Mapping
Type	Functional Allocation
Description	Allocation of Functional Hierarchy to Logical Design
Logical Design	LD-001, 1
Implementation	FH-001, 1
Copied from	

Allocation

[Save] [Freeze] [Copy]   Export for Excel

	FNC-102094				FNC-102134				FNC-102165		
	SFNC-102101	SFNC-102121	SFNC-102127	SFNC-102130	SFNC-102140	SFNC-102150	SFNC-102160	SFNC-102163	SFNC-102171	SFNC-102177	SFNC-102180
EQP-0020321	○	○	○	○	○	○	○	○	○	○	○
EQP-0020322	○	○	○	○	○	○	○	○	○	○	○
EQP-0020323	○	○	○	○	○	○	○	○	○	○	○
EQP-0020324	○	○	○	○	○	○	○	○	○	○	○
EQP-0020325	○	○	○	○	○	○	○	○	○	○	○
EQP-0020326	○	○	○	○	○	○	○	○	○	○	○
EQP-0020327	○	○	○	○	○	○	○	○	○	○	○
EQP-0020328	○	○	○	○	○	○	○	○	○	○	○
EQP-0020329	○	○	○	○	○	○	○	○	○	○	○
EQP-0020330	○	○	○	○	○	○	○	○	○	○	○
EQP-0020331	○	○	○	○	○	○	○	○	○	○	○

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http://mirror.productsight.com:4500 - Super Report for Config-FT0041, 1 - Microsoft Internet Explorer

1.1	EQP-0020321	Cockpit Sensor	SYS-00418	Config_001A, 1	FLW-0004022	friction signal	Input		SFNC-102121
1.1	EQP-0020321	Cockpit Sensor	SYS-00418	Config_001A, 1	FLW-0004023	Temperature sensor signal	Input		SFNC-102121
1.1	EQP-0020321	Cockpit Sensor	SYS-00418	Config_001A, 1	FLW-0004021	Brake pedal Transfer	Output		SFNC-102121
1.2	EQP-0020322	Road surface sensor	SYS-00418	Config_023A, 1				ASM-100624	
1.2	EQP-0020322	Road surface sensor	SYS-00418	Config_023A, 1	FLW-0004022	Road surface friction signal	Output	ASM-100624	
1.3	EQP-0020323	Environmental sensor	SYS-00418	Config_002B, 1				ASM-100564	SFNC-102121
1.3	EQP-0020323	Environmental sensor	SYS-00418	Config_002B, 1	FLW-0004023	Temperature sensor signal	Output	ASM-100564	SFNC-102121
1.4	EQP-0020324	Data collection	SYS-00418	Config_ID_843796w25, 1				ASM-100564	
1.4	EQP-0020324	Data collection	SYS-00418	Config_ID_843796w25, 1	FLW-0004021	Brake pedal Transfer	Input	ASM-100564	
1.4	EQP-0020324	Data collection	SYS-00418	Config_ID_843796w25, 1	FLW-0004024	Sensor data signal	Output	ASM-100564	
1.5	EQP-0020325	Sensor Wire Harness	SYS-00418					ASM-100564	
1.6	EQP-0020326	Sensor Processor Interface	SYS-00418	Config_ID_002134, 1				ASM-100564	SFNC-102130
2	SYS-00524	Anti-Lock Processing System		Config_011, 1					
2.1	EQP-0020327	Processor Sensor Interface	SYS-00524					ASM-100564	SFNC-102130
2.2	EQP-0020328	Procesor Hardware	SYS-00524					ASM-100731	
2.3	EQP-0020329	Processor Software	SYS-00524					ASM-100731	SFNC-102163
2.4	EQP-0020330	Processor Wire Harness	SYS-00524						SFNC-102160
3	SYS-00567	Anti-Lock Braking System		Config_021, 1					
3.1	EQP-0020331	Braking Processor Interface	SYS-00567	Config_ID_021189, 1				ASM-100731	
3.1	EQP-0020331	Braking Processor Interface	SYS-00567	Config_ID_021189, 1	FLW-0004026	Processor to Braking Signal	Input	ASM-100731	
3.2	EQP-0020332	Brake Valve	SYS-00567	Config_ID_00129, 1				ASM-100624	
3.2	EQP-0020332	Brake Valve	SYS-00567	Config_ID_00129, 1	FLW-0004027	Processor to Valve Transfer	Input	ASM-100624	
3.3	EQP-0020333	Brake Pump	SYS-00567	Config_ID_09451, 1					SFNC-102150
3.3	EQP-0020333	Brake Pump	SYS-00567	Config_ID_09451, 1	FLW-0004028	Processor to Pump Transfer	Input		SFNC-102150
3.4	EQP-0020334	Brake Discs	SYS-00567					ASM-100731	SFNC-102180

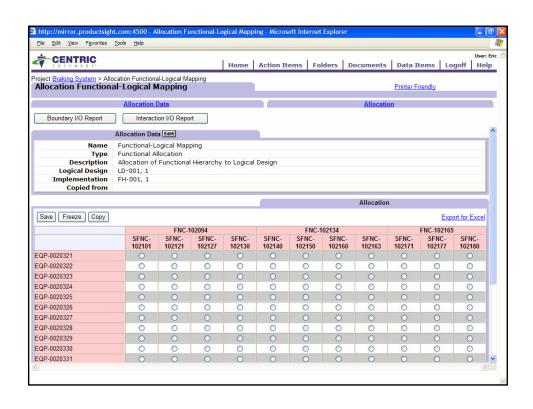Done   Internet
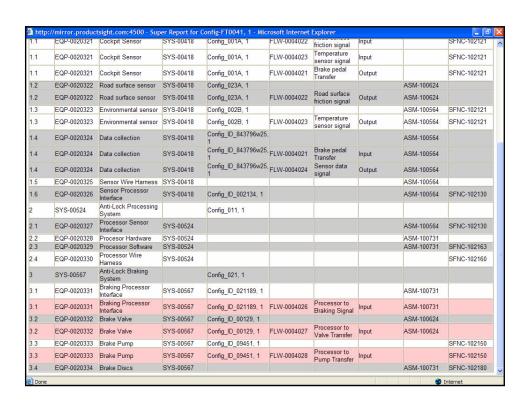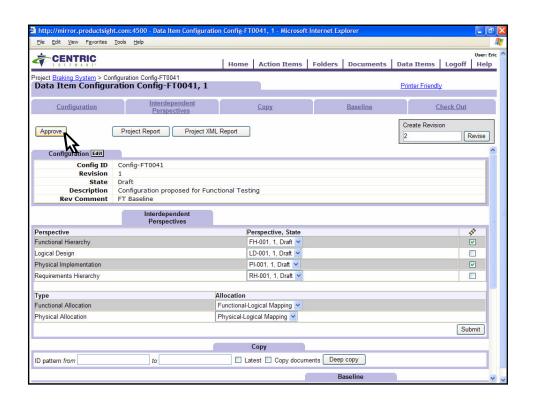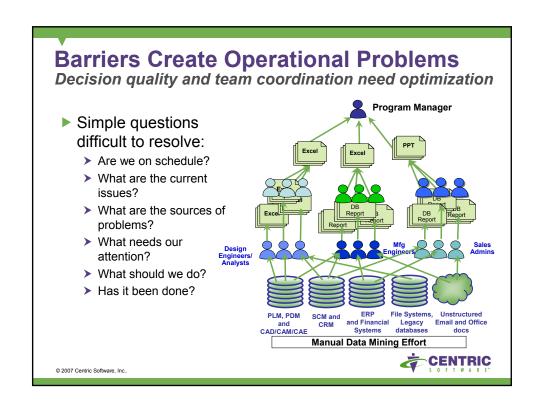
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Centric for Functional Integration

1. **Provide a *Full System View* from bottom-up implementations**
   - Review design perspectives from various workgroup data repositories
   - Systems level visibility and interaction with Integrated Product Architecture

2. **Presents relevant information at each level of design abstraction**
   - Drill-down to any level of detail
   - Capture and preserve product semantics
   - Aggregate and allocate design perspectives without losing functional integrity

3. **Enable information relationships across functional boundaries**
   - Native support of Functional Integration concepts
   - Allocation between design perspectives to ensure audit & accountability
   - Configuration Management for Functional Integration

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Use Case: Multi-disciplinary Program Office → actionable dashboard

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Barriers Create Operational Problems
Decision quality and team coordination need optimization

- ▶ Simple questions difficult to resolve:
  - ➤ Are we on schedule?
  - ➤ What are the current issues?
  - ➤ What are the sources of problems?
  - ➤ What needs our attention?
  - ➤ What should we do?
  - ➤ Has it been done?

Program Manager

Excel   Excel   PPT

DB Report   DB Report

Excel   DB Report   DB Report   DB Report

Design Engineers/ Analysts   **Mfg Engineers**   **Sales Admins**

PLM, PDM and CAD/CAM/CAE   **SCM and CRM**   **ERP and Financial Systems**   **File Systems, Legacy databases**   **Unstructured Email and Office docs**

Manual Data Mining Effort

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Program Office Example

Top Problems Addressed
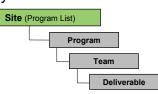
- Early warning of risks to on-time delivery
- Faster response to customer change requests with improved impacts analysis
- Earlier awareness of cost overruns
- Faster determination of overrun cause and financial responsibility
- Increase program efficiency and productivity utilizing existing resources
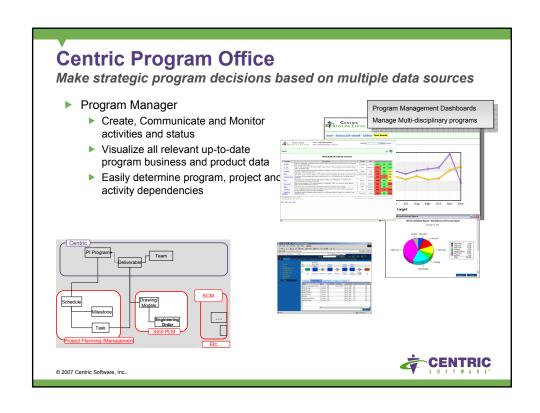
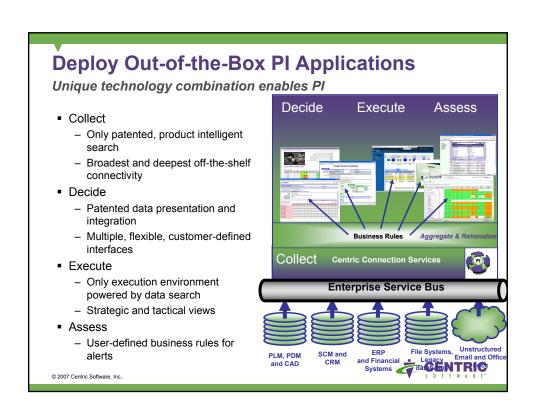**CENTRIC** SOFTWARE™

Program Office Navigation & Hierarchy

- Decision Center's navigation & hierarchy is flexible!
- In Decision Center Program Office application, users navigate & information is organized by:
    - *Site (List of Programs)*
    - *Program*
    - *Team (Functional Teams)*
    - *Deliverable*

Site (Program List) → **Program** → **Team** → **Deliverable**

- Provides information appropriate for every level in the organization.
- Higher level views (Site, Program, etc.) are "roll-ups" of information created and managed at lower levels.

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Centric Program Office

Make strategic program decisions based on multiple data sources

- ▶ Program Manager
  - ▶ Create, Communicate and Monitor activities and status
  - ▶ Visualize all relevant up-to-date program business and product data
  - ▶ Easily determine program, project and activity dependencies

Program Management Dashboards

Manage Multi-disciplinary programs

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Deploy Out-of-the-Box PI Applications

Unique technology combination enables PI

- ▪ Collect
  - – Only patented, product intelligent search
  - – Broadest and deepest off-the-shelf connectivity
- ▪ Decide
  - – Patented data presentation and integration
  - – Multiple, flexible, customer-defined interfaces
- ▪ Execute
  - – Only execution environment powered by data search
  - – Strategic and tactical views
- ▪ Assess
  - – User-defined business rules for alerts

Decide   Execute   Assess

Business Rules   *Aggregate & Rationalize*

Collect   **Centric Connection Services**   PI

Enterprise Service Bus

PLM, PDM and CAD   **SCM and CRM**   **ERP and Financial Systems**   **File Systems, Legacy data sources**   **Unstructured Email and Office docs**

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Summary

- Systems validation and functional integration requires appropriate levels of abstractions
  - Respecting business object authority semantics
  - with support for allocations, relationship capture across domains
  - Change propagation and change insulation semantics across systems
  - Macro-level program management with actionable performance visibility

- For effective adoption, applications must anticipate:
  - installed IT investments
  - prevalent processes, practice patterns

- Pragmatic solutions available today, based on:
  - Intelligent connectivity (SOA based support)
  - Configurable domain model with process dynamics semantics