

SMARTTEAM for Collaborative Systems Engineering

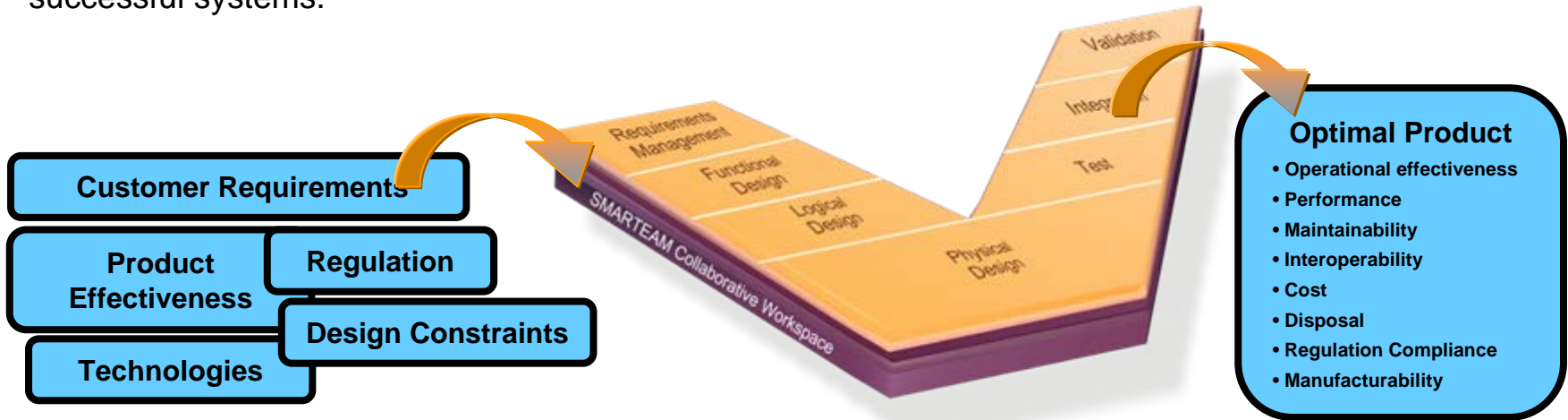
PLM Forum May 30th 2006

Presented by
Daniel Hubert



What we mean by Systems Engineering

- Systems Engineering is an **interdisciplinary approach** and mean to enable the realization of successful systems.



- It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem:

- Operations
- Performance
- Test
- Manufacturing
- Cost & Schedule
- Training & Support
- Disposal

EIA 632

ISO 15288

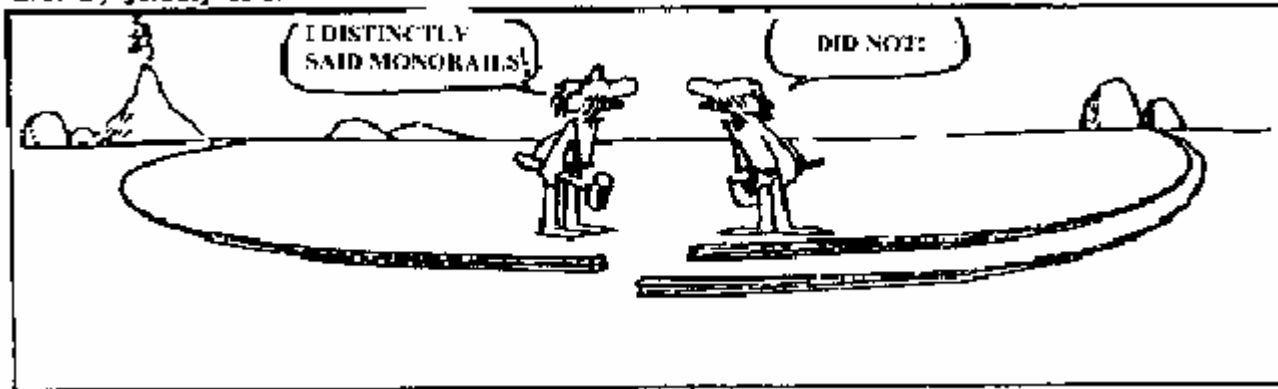


Typical symptoms of poor Systems Engineering

- Weak/non-existent basis to requirements
- Inadequate costing and time-scale estimation
- Weak control of suppliers/sub-contractors
- Recurring integration problems
- Inadequate test and acceptance strategy

*Does this
sound
unfamiliar?*

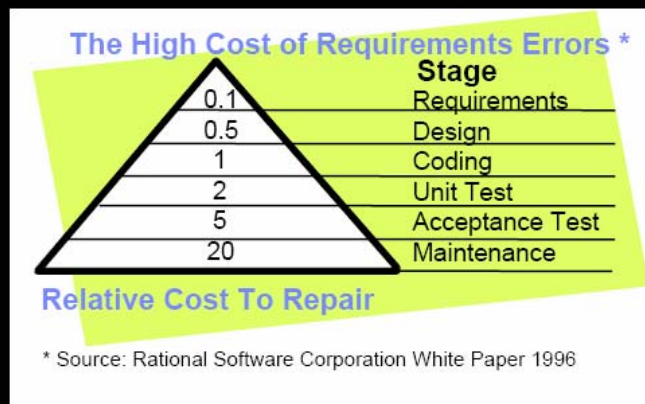
B.C. By Johnny Hart



IBM experience with Systems Engineering

Value of Systems Engineering

- Drives to acknowledged understanding of the customer's business needs.
- Verifies that requirements are delivered: a key to customer satisfaction
 - Testing for functions, performance, reliability, etc.
 - Other agreed-to methods for ease of use, training, etc.



- Requirements and analysis disciplines drive total project costs down
 - Up to 40% of total project cost can be attributed to rework costs.
 - Typically unmeasured costs include missing function and lost market opportunity.

- Requirement management is essential to cost, schedule and implementation success of the project. It controls the project baseline, which:
 - Provides basis for making project decisions concerning technical, cost, schedule, and other issues; and
 - Provides a basis for technical change and risk management.



Characteristics of Complex Systems

■ Technology

- Constantly evolving technology and related standards
- Multitude of interfaces (hard and soft), distributed processing nodes and platforms, security implications
- Information and knowledge intensive

■ Business

- Constantly changing scope, business processes, requirements, and expectations
- Global relevance scope and application
- Evolving marketplace and related vendors and suppliers

■ Organizational

- Numerous stakeholders, with conflicting preferences
- Constraints imposed by legacy organizational structures



The business benefits of Systems Engineering

There are three key business benefits of systems engineering.
These are:

- build the **right system** (and avoid the costs associated with investing in the wrong one)

Right system

- ensure **stakeholder satisfaction** on delivery (and hence ensure the developer gets paid)

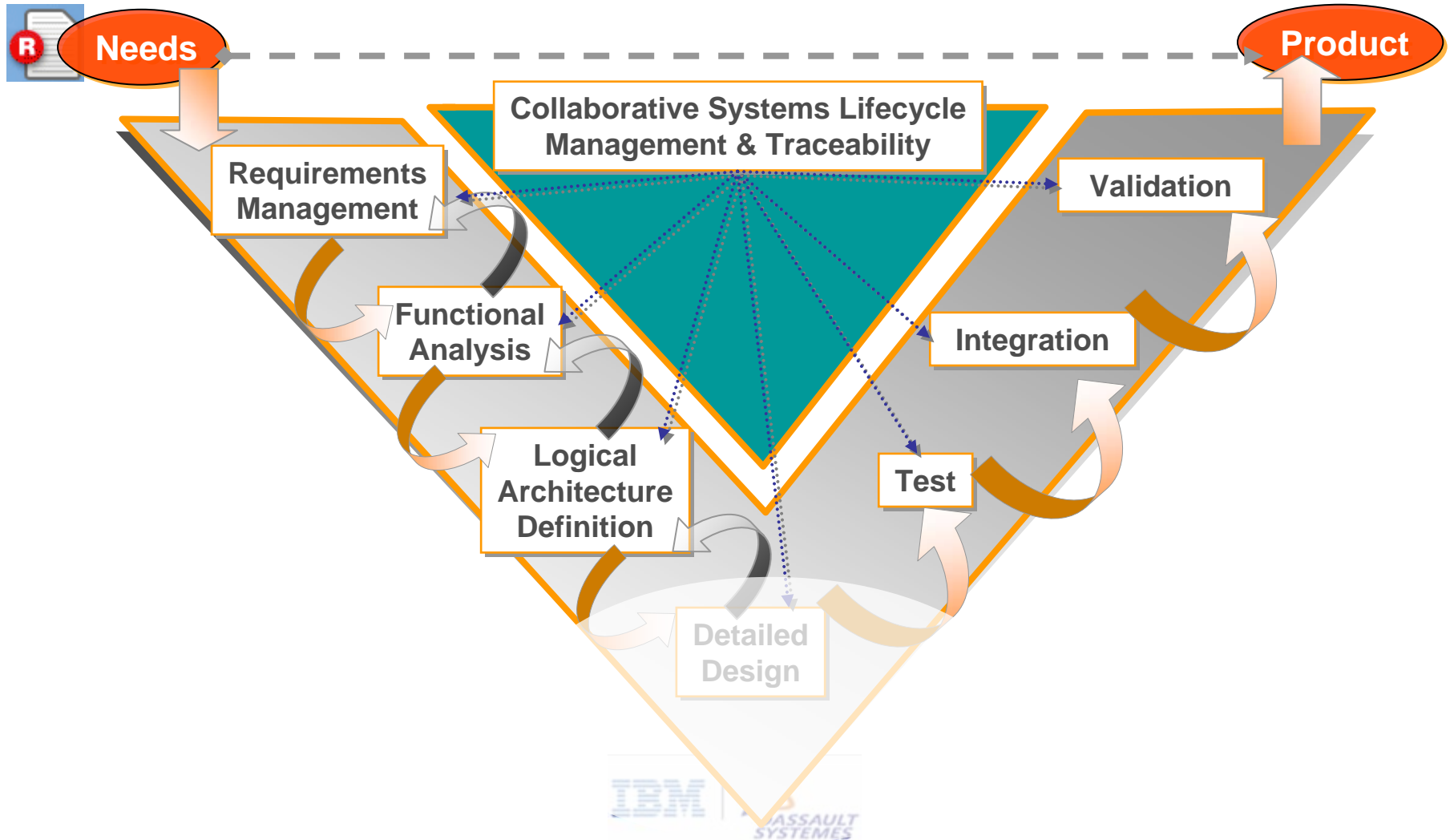
Right requirements

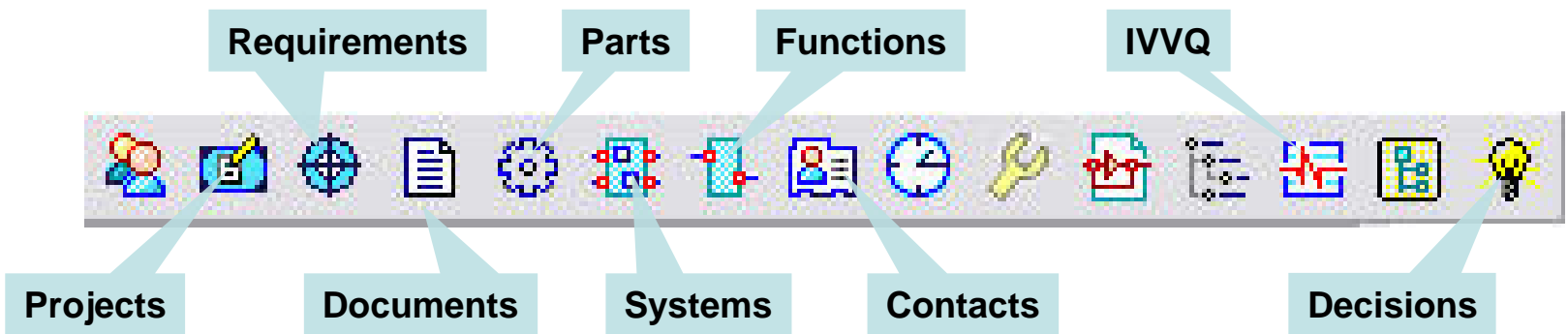
- “**integration by design**”: avoid overspend and overruns in the expensive phase of the lifecycle (generally integration, test and setting to work)

Right architecture

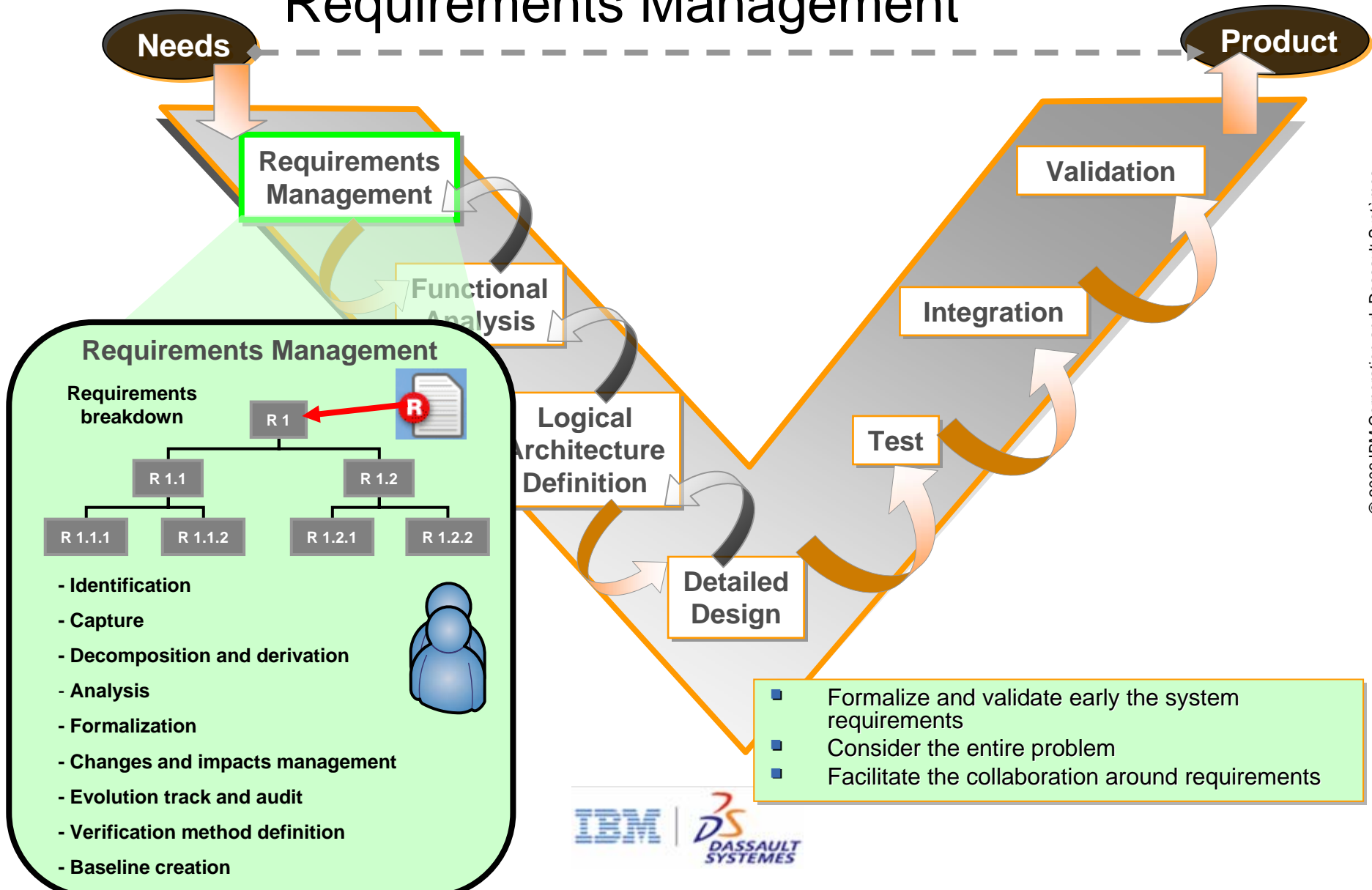


Collaborative Systems Engineering: Key Processes





Requirements Management



Needs

Requirements Management

Functional Analysis

Logical Architecture Definition

Detailed Design

Test

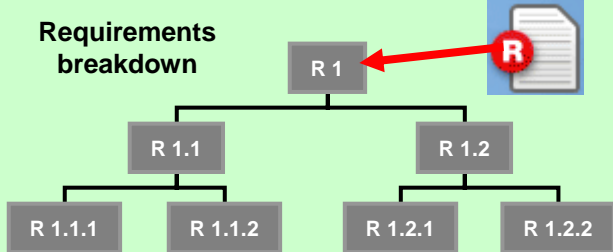
Integration

Validation

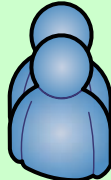
Product

Requirements Management

Requirements breakdown

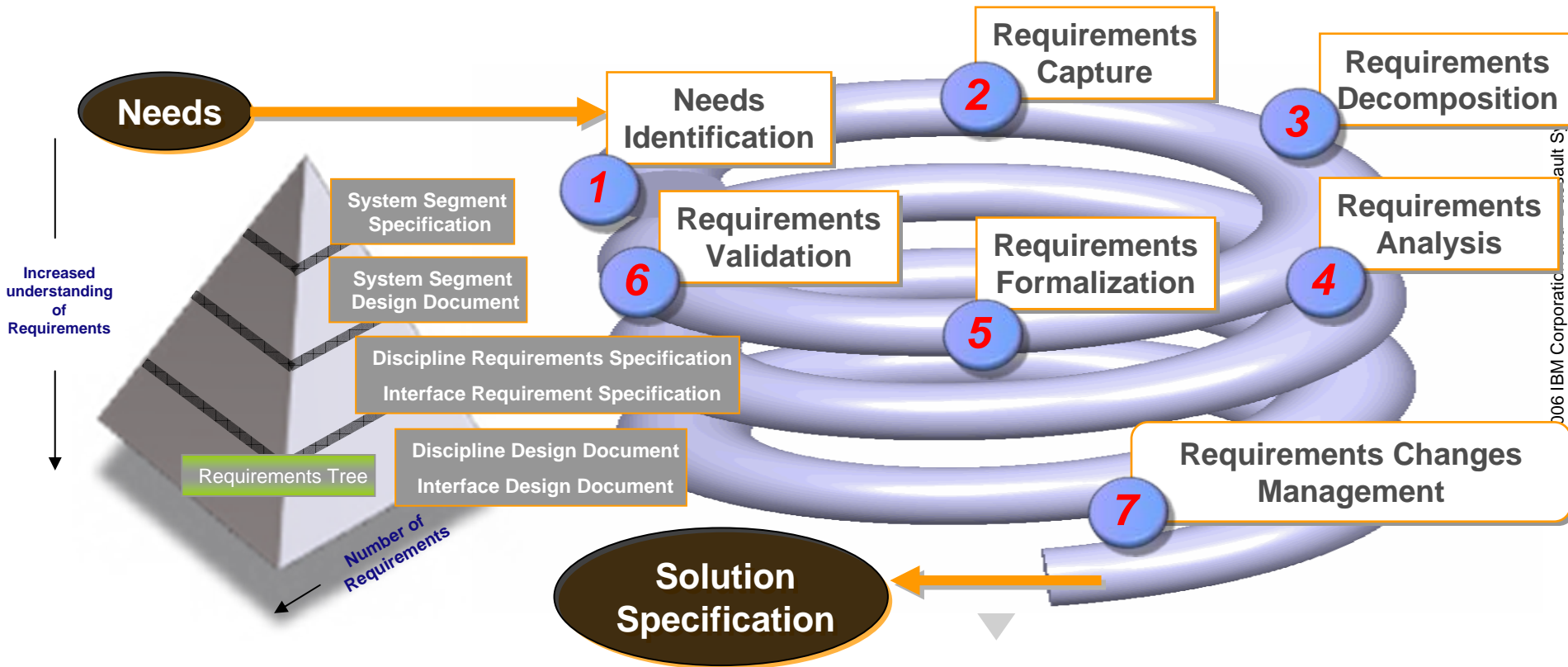


- Identification
- Capture
- Decomposition and derivation
- Analysis
- Formalization
- Changes and impacts management
- Evolution track and audit
- Verification method definition
- Baseline creation

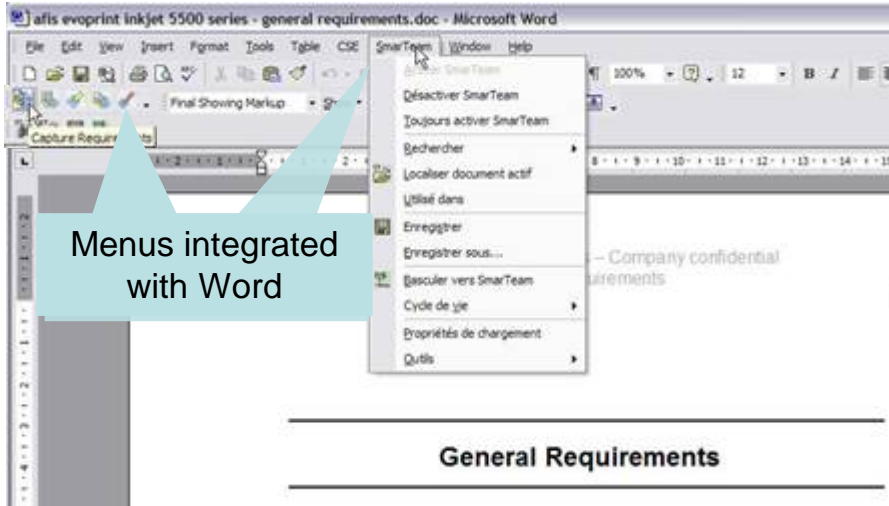


- Formalize and validate early the system requirements
- Consider the entire problem
- Facilitate the collaboration around requirements

Requirements Management: Processes



Requirements capture



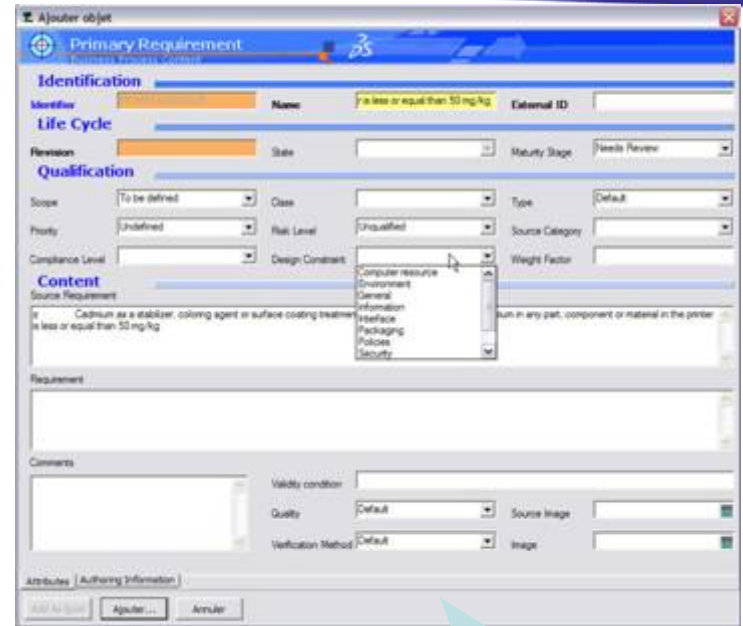
General Requirements

Our printer must not contain:

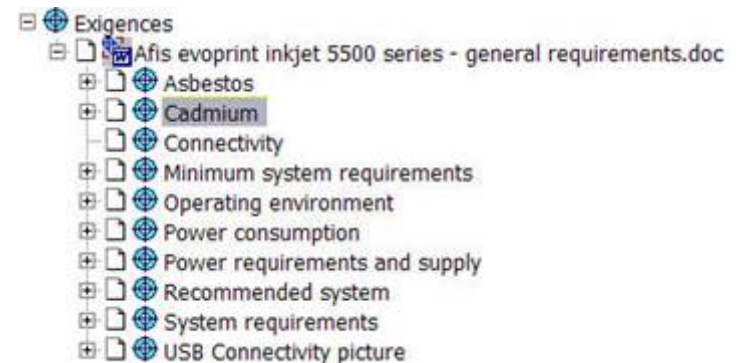
- > [[PRIMREQ-0000023] Asbestos]
- > Cadmium as a stabilizer, coloring agent or surface coating treatment. The total concentration of cadmium in any part, component or material in the printer is less or equal than 50 mg/kg.

Link is created with the source document

- > [[PRIMREQ-0000025] Cadmium as a stabilizer, coloring agent or surface coating treatment. The total concentration of cadmium in any part, component or material in the printer is less or equal than 50 mg/kg]



The captured text becomes a unique object identified in the database



- [-] Storage temperature RQMT-0780.3
 - [-] Humidity RQMT-0780.2
 - [-] Temperature RQMT-0780.1
 - [-] System requirements RQMT-0779
 - [-] Minimum RQMT-0779.1
 - [-] Recommended RQMT-0779.2
 - [-] Software compatibility RQMT-0778
 - [-] MS-DOS RQMT-0778.3
 - [-] Macintosh RQMT-0778.2
 - [-] Packaging RQMT-0776
 - [-] Electrical fields RQMT-0775
 - [-] Magnetic fields RQMT-0774
 - [-] Energy saving RQMT-0773
 - [-] Acoustic noise RQMT-0772
 - [-] Ozone RQMT-0771
 - [-] Dust RQMT-0770
 - [-] Recycling RQMT-0768
 - [-] Dissimilar materials RQMT-0768.2
 - [-] Fasteners and other connections RQMT-0768.3
 - [-] Easy to remove RQMT-0768.3.3
 - [-] Common Tools RQMT-0768.3.3.1
 - [-] Easy to access RQMT-0768.3.2
 - [-] Easy to locate RQMT-0768.3.1
 - [-] High priority parts RQMT-0768.4
 - [-] Number of materials RQMT-0768.1
 - [-] Maximum number of materials RQMT-0768.1.1
 - [-] Plastic Parts RQMT-0768.5
 - [-] Small parts RQMT-0768.6
 - [-] Printer Cartridge RQMT-0759
 - [-] Primary Colors (CMY) RQMT-0735.3
 - [-] Black (K) RQMT-0735.2
 - [-] T1J RQMT-0735.1
- [-] Print Advantages RQMT-0750
 - [-] Cost-effective RQMT-0750.1
 - [-] Easy to use RQMT-0750.2
 - [-] Fast RQMT-0750.3
- [-] Access inside the printer RQMT-0748
- [-] Self-test function for fault finding RQMT-0747

Requirements tree

Attribute Link Comment Revision

Primary Requirement

Business Process Content

Identification

Identifier	RQMT-0759	Name	Printer Cartridge	External ID	
------------	-----------	------	-------------------	-------------	--

Life Cycle

Revision	1.0.0	State	New	Maturity Stage	
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Qualification

Scope	Subsystem Level	Class	Performance	Type	
Priority	High	Risk Level	Medium	Source Category	
Compliance Level	Mandatory	Design Constraint	General	Weight Factor	

Content

Source Requirement

The printer will be designed to use the SX-23D inkjet cartridge which respects the following characteristics, and the dimensions: 20 mm (W) by 53.5 mm (H) by 10.2 mm (D) and the weight: 65 gr.

Requirement

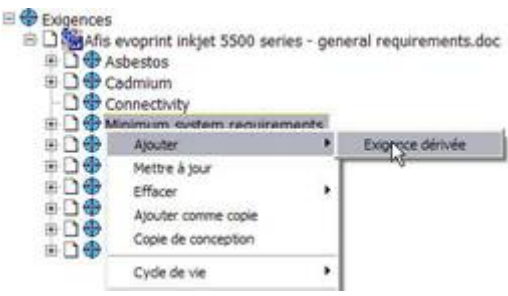
Requirement field (empty)

Comments

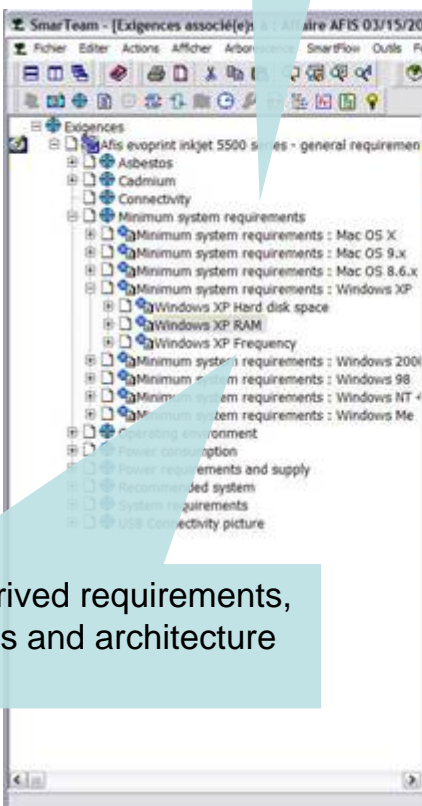
Validity condition	
Quality	Vague
Verification Method	Default

Attributes Authoring Information Parametric Attributes Composition

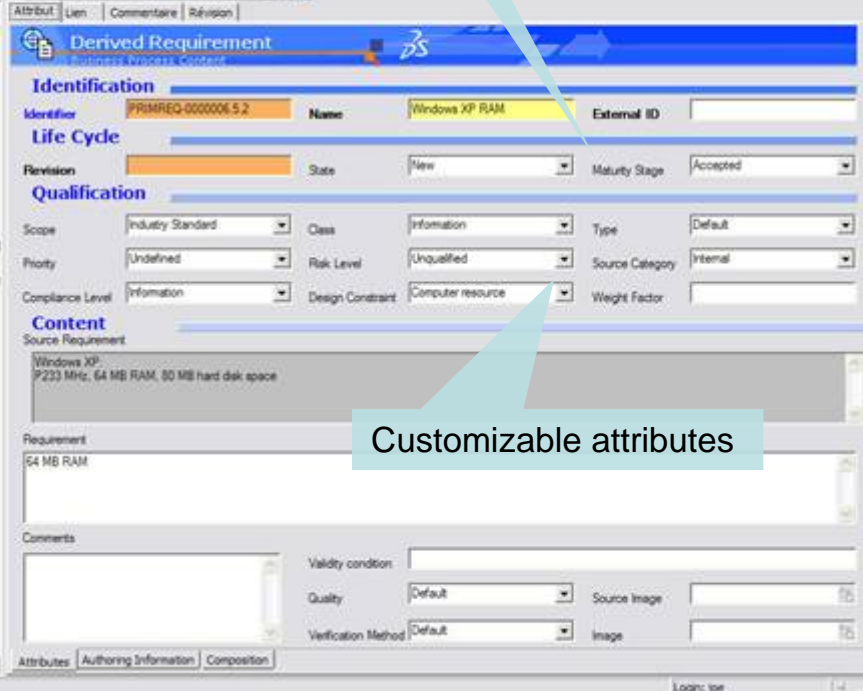
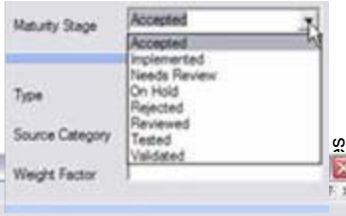
Requirements Decompose & derive



parent – child links



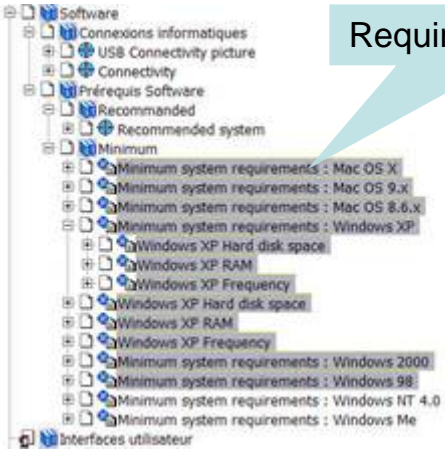
Maturity stage



Customizable attributes

Requirements are broken down into derived requirements, to enable allocation to system functions and architecture components ...

Requirements Analysis



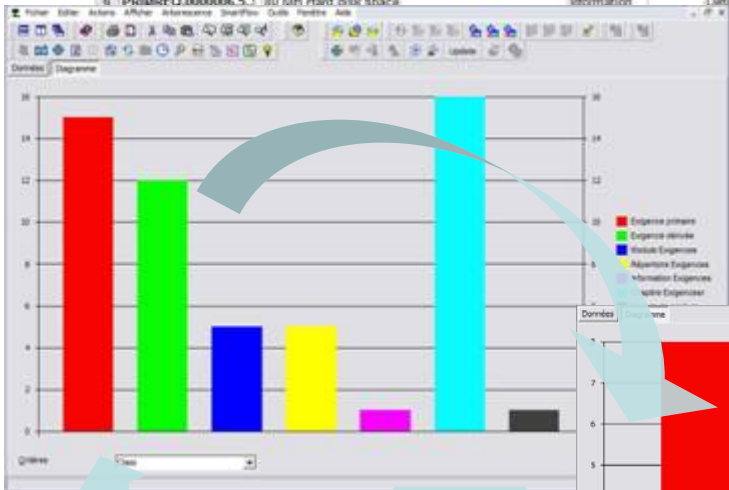
Requirements selection

Requirements comparison

	PRIMREQ-000006.5.3	PRIMREQ-000006.5.2
Revision		
Unique Identifier	PRIMREQ-000006.5.3	PRIMREQ-000006.5.2
Origin	Windows XP Hard disk space	Windows XP RAM
State	New	New
Maturity Stage	Accepted	Accepted
Scope	Industry Standard	Industry Standard
Class	Information	Information
Type	Default	Default
Priority	Undefined	Undefined
Risk Level	Unqualified	Unqualified
Origin	Internal	Internal
Origin	Information	Information
Origin	Computer resource	Computer resource
Value	-1,23E+37	-1,23E+37
Origin	Windows XP P233 MHz, 64 MB RAM, 80 MB hard disk space	Windows XP P233 MHz, 64 MB RAM, 80 MB hard disk space
Origin	64 MB RAM	64 MB RAM

ID	Requirements	Class	Value	Quality	Priority	Origin	Maturity Stage
1	PRIMREQ-000006.8	Mac OS X G3	128 MB RAM	To be refined	Default	Undefined	Needs Review
2	PRIMREQ-000006.7	Mac OS 9 x 11	Mac OS 9 x 11 30 MHz, 32 MB RAM	To be refined	Default	Undefined	Needs Review
3	PRIMREQ-000006.6	Mac OS 9 x 11	Mac OS 9 x 11 30 MHz, 32 MB RAM	To be refined	Default	Undefined	Needs Review
4	PRIMREQ-000006.5.1	Information	RAM 80 MB hard disk space	Information	Default	Undefined	Internal Reviewed
5	PRIMREQ-000006.5.2	Information	P233 MHz	Information	Default	Undefined	Internal Reviewed
6	PRIMREQ-000006.5.3	Information	64 MB RAM	Information	Default	Undefined	Internal Accepted
7	PRIMREQ-000006.5.1	Information	80 MB Hard disk space	Information	Default	Undefined	Internal Accepted
8	PRIMREQ-000006.5.1	Information	30 MB Hard disk space	Information	Default	Undefined	Internal Accepted
9	PRIMREQ-000006.5.1	Information	30 MB Hard disk space	Information	Default	Undefined	Internal Accepted
10	PRIMREQ-000006.5.1	Information	30 MB Hard disk space	Information	Default	Undefined	Internal Accepted
11	PRIMREQ-000006.5.2	Information	64 MB RAM	Information	Default	Undefined	Internal Accepted
12	PRIMREQ-000006.5.3	Information	64 MB RAM	Information	Default	Undefined	Internal Reviewed

Excel sheets with filters on the attributes

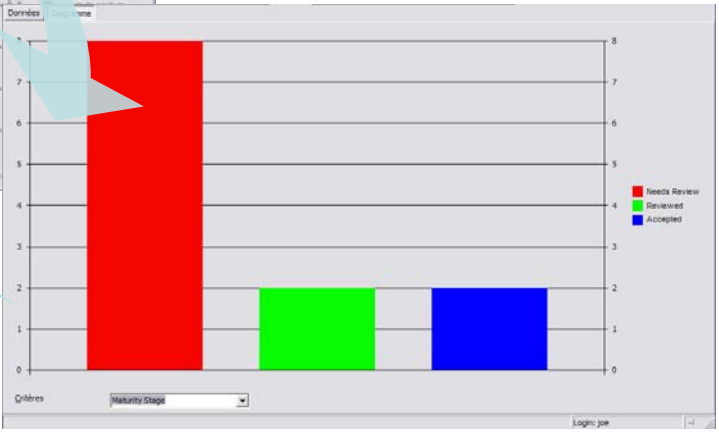


Filters

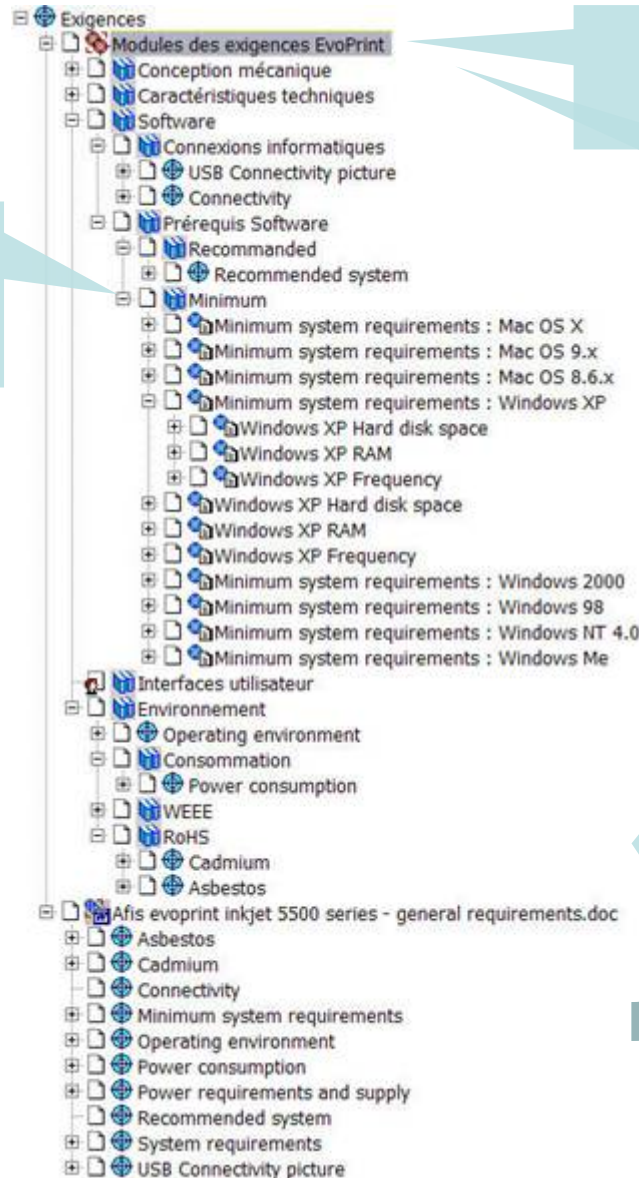
Request



Class	Unique Identifier	State	Revision
1	PRIMREQ-000006.1		
2	PRIMREQ-000006.2		
3	DERIVREQ-000003		
4	PRIMREQ-000006.3		
5	PRIMREQ-000006.4		
6	PRIMREQ-000006.5		
7	PRIMREQ-000006.6		
8	PRIMREQ-000006.7		
9	PRIMREQ-000006.8		
10	PRIMREQ-000006.5.1		
11	PRIMREQ-000006.5.2		
12	PRIMREQ-000006.5.3		



Manage requirements in « Modules »



Modules are containers to help organize requirements for business purpose: by requirements type; by discipline...

Modules enable independent views to be created for the different roles; All disciplines and roles can collaborate around the same single managed requirements reference repository.

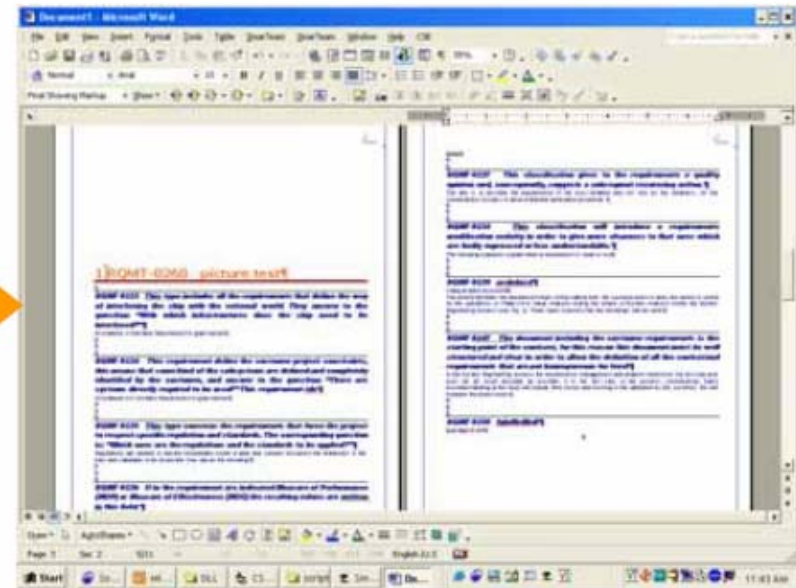
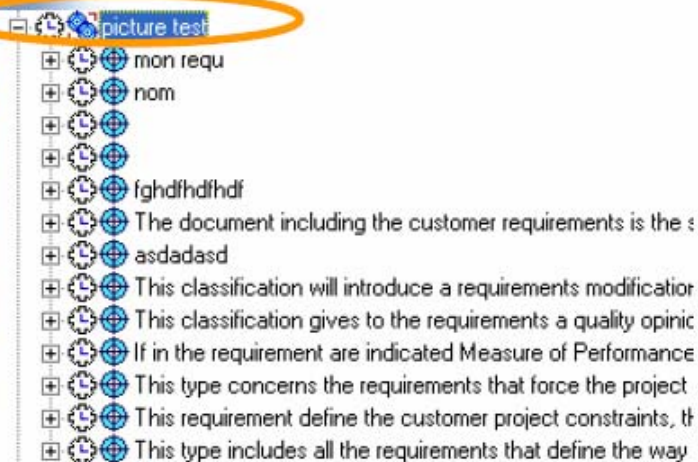
« Drag & drop » used to allocate Requirements to chapters, etc..

Requirements can be organized by chapters and subchapters to facilitate document production



Publish Requirement Document

- CSE provide the capability to generate several document report base on a module
- The different document report are controled by admin settings:
 - 👤 The path of the template
 - 👤 The name of the Word styles
 - 👤 ...



Allocation: Object link creation 1/2

Architectures système - Affaire AFIS 03/15/2005:

Class	Name	Revision	Link State	State	Unique Identifier
1	Energie		Validated		FUNC-000016

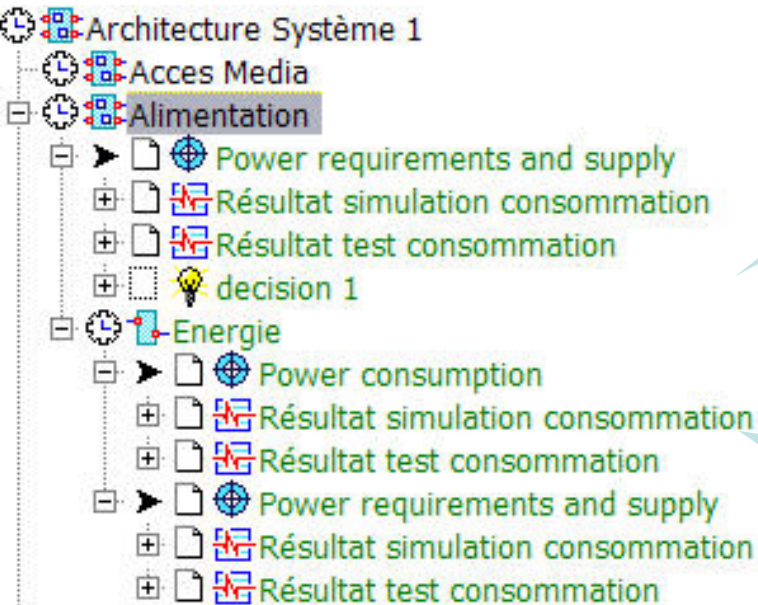
Services système - Affaire AFIS 03/15/2005:

Class	Name	Revision	Link State	State	Unique Identifier
1	Alimentation		Validated		SYS-000016

Links are created by « Drag & Drop » and abide to pre-established rules

Rules can be related to maturity, conditions on verification, etc.. to authorize the link allocation

Allocation: Object link creation 2/2



Dynamical links are exposed and visible in the views and facilitate navigation and impact assessments

- Typical link types:
- requirement to requirement
 - requirement to function
 - requirement to system component
 - IVVQ link
 - justification link, etc ...

Links are objects managed in the DB with specific customizable attributes

Link to justification object

Maturity stage

- Link State
- Validated
 - Validated
 - Suspect
 - Conflit
 - Redondant
 - Composé de
 - Induit
 - Système
 - Alloué

Link management & traceability

Excel export to trace allocation links and their maturity stage

Exigences-Systemes Traceability								
Functions - Systems	SYS-0000003	SYS-0000006	SYS-0000012	SYS-0000008	SYS-0000005	SYS-0000013	SYS-0000022	SYS-0000023
PRIMREQ-0000027					Suspect			
PRIMREQ-0000025					Suspect			
PRIMREQ-0000016					Unknown			
PRIMREQ-0000006					Unknown			
PRIMREQ-0000006.1					Unknown			
PRIMREQ-0000006.2					Validated			
PRIMREQ-0000006.3					Validated			
PRIMREQ-0000006.4					Unknown			
PRIMREQ-0000006.5					Unknown			
PRIMREQ-0000006.S.1					Unknown			
PRIMREQ-0000006.S.2					Validated			
PRIMREQ-0000006.S.3					Validated			
PRIMREQ-0000006.6					Suspect			
PRIMREQ-0000006.7					Unknown			
PRIMREQ-0000006.8					Suspect			
PRIMREQ-0000014								
PRIMREQ-0000012								
PRIMREQ-0000010								
PRIMREQ-0000008					Suspect			
PRIMREQ-0000004								
PRIMREQ-0000018					Unknown			

Retrieve unallocated requirements

Native tool capabilities to retrieve unallocated links

Reporting

Search the unallocated requirements to the Systems

Search the unallocated requirements to the Functions

Search the unallocated requirements to the Requirements Modules

OK

Category	Value
Unallocated	10
Allocated	5
Invalid	3

« top-down » & « bottom-up » views to facilitate management and analysis

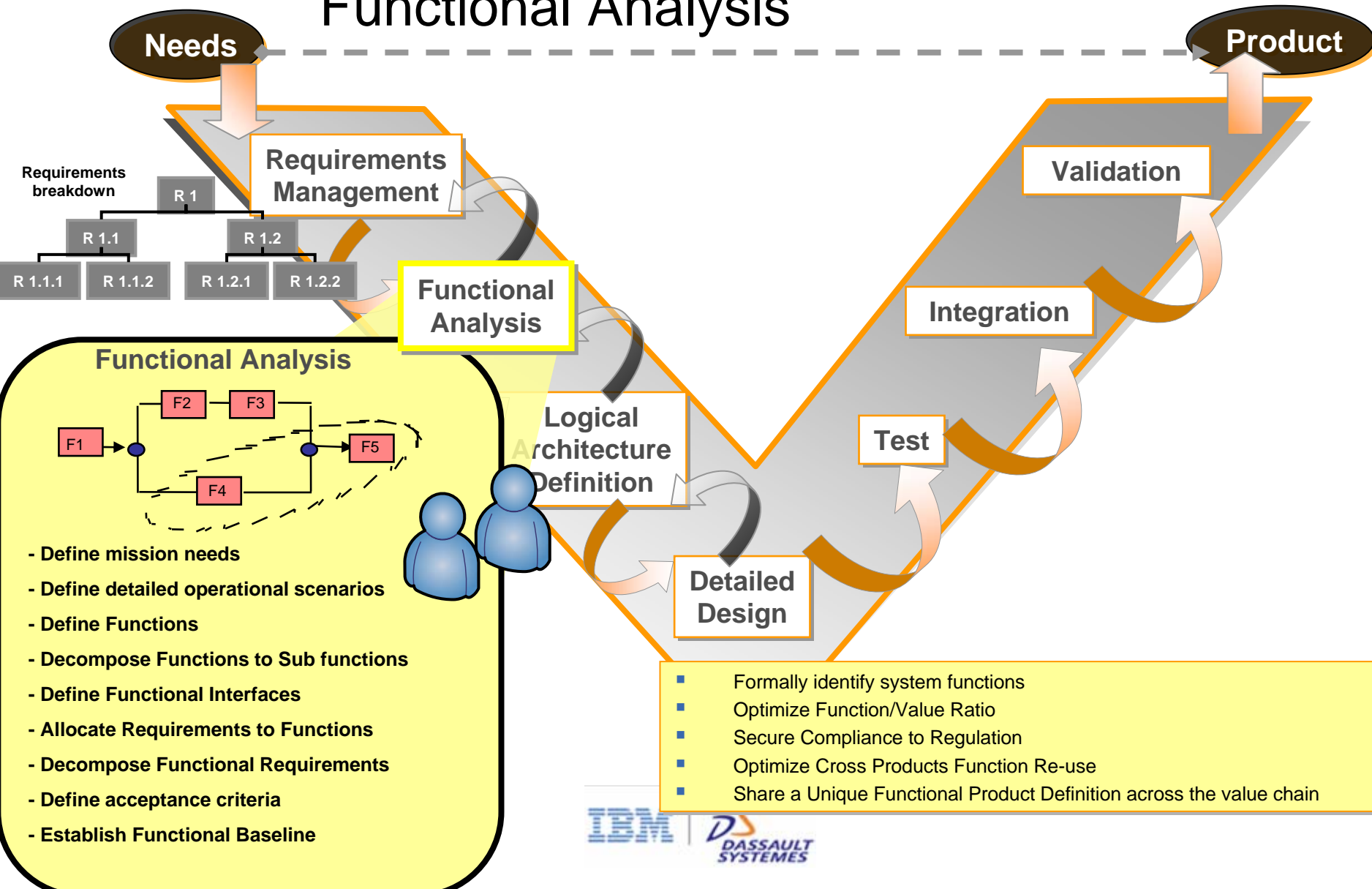
« top-down » & « bottom-up » views to facilitate management and analysis

- Ajouter
- Mettre à jour
- Vacer
- Ajouter comme copie
- Copie de conception
- Cycle de vie
- Associer au projet...
- Lancer le processus
- Envoyer à
- Configurer par utilisateur
- Parcourir
- Ouvrir vues
 - Arborescence descendante
 - Vue Objet unique
 - Utilisé dans
 - Composé d'une liste
 - Arborescence ascendante
 - Liens généraux
 - Vue des révisions
- Objets associés
- Trier l'arborescence par
- Propriétés de l'arborescence

Shows dependent documents: requirements, functions, components, test results...

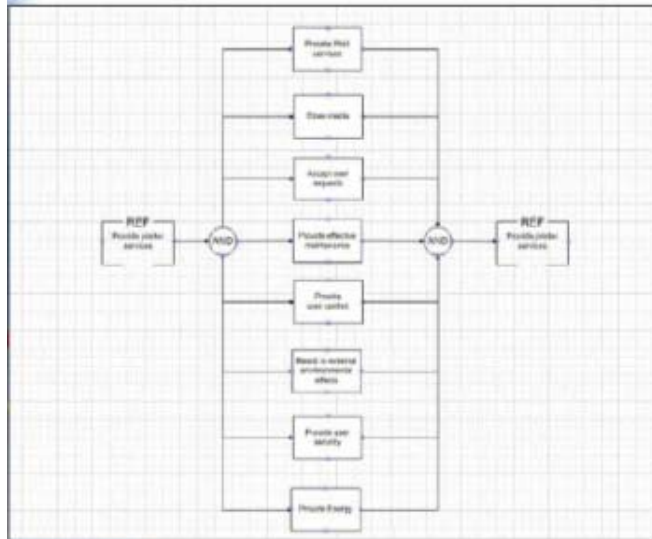
- Power requirements and supply
 - Alimentation
 - decision 1
 - Energie
 - Alimentation
 - Power consumption
 - Energie
 - Alimentation
 - Résultat simulation consommation
 - Résultat test consommation
- Résultat simulation consommation
- Résultat test consommation

Functional Analysis

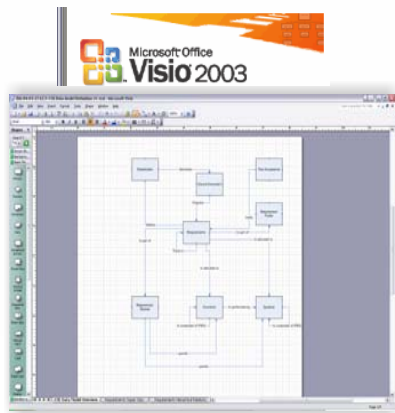
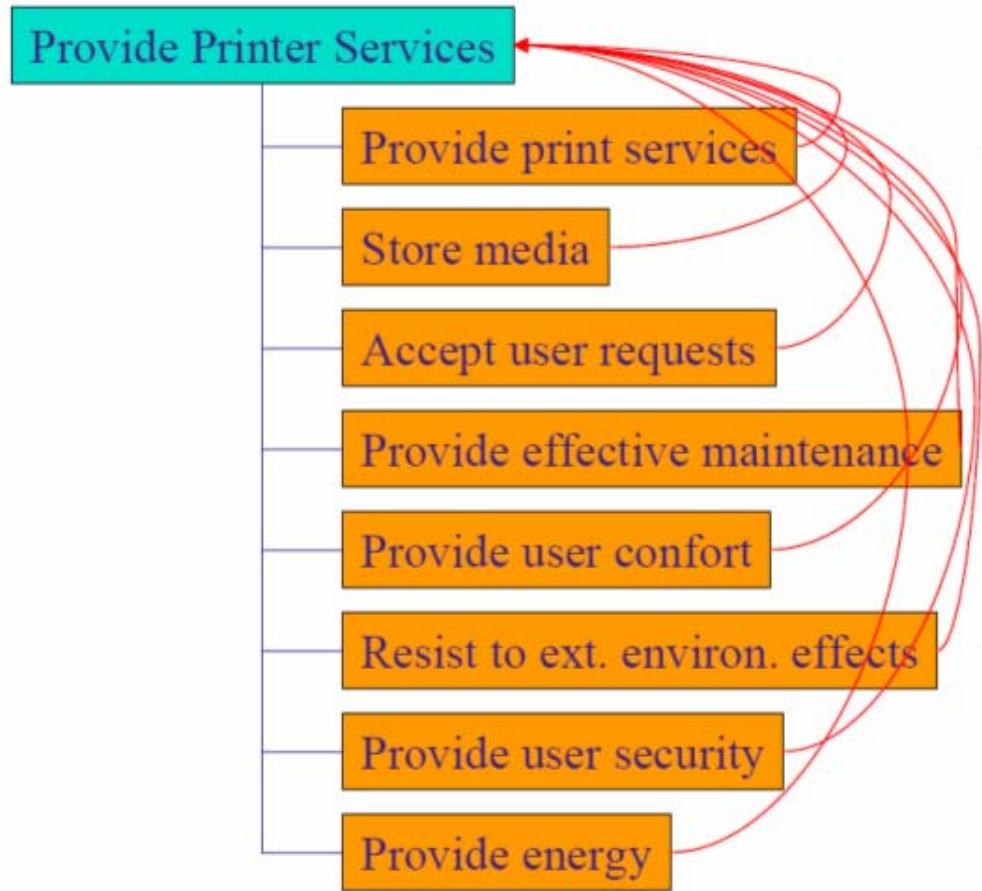


Functional Analysis example: MS Visio integration

Diagram View



Data View



- Accept Network Requests FUNC-0026.1.5.3
- Provide user confort FUNC-0026.5
 - AND FUNC-0026.5.4
 - AND FUNC-0026.5.5
 - Provide a low-level noise emission FUNC-0026.5
 - Provide a pleasant touch FUNC-0026.5.6
 - Provide a pleasant look FUNC-0026.5.1
- Provide effective maintenance FUNC-0026.4
 - Allow user to refill ink FUNC-0026.4.6
 - NC-0026.4.6.1
 - NC-0026.4.6.12
 - disable refilling mode FUNC-0026.4.6.4
 - Move carriage to initial position FUNC-0026.4.
 - Open printer carriage FUNC-0026.4.6.11
 - Pause printing activity FUNC-0026.4.6.8
 - Refill ink FUNC-0026.4.6.3
 - Request carriage move FUNC-0026.4.6.6
 - Request carriage position FUNC-0026.4.6.5
 - Resume printing activity FUNC-0026.4.6.13
 - Stop carriage motion (X axis) FUNC-0026.4.6.:
 - Stop paper mouvement (Y axis) FUNC-0026.4
 - Provide hardware diagnostic FUNC-0026.4.1
 - Display diagnostic results FUNC-0026.4.1.6
 - Get printer status FUNC-0026.4.1.9
 - Initialize hardware scan FUNC-0026.4.1.10
 - LP FUNC-0026.4.1.7
 - LP FUNC-0026.4.1.8
 - Reboot printer FUNC-0026.4.1.5
 - Scanning hardware for errors FUNC-0026.4.1.
 - Stop all current actions FUNC-0026.4.1.1
 - Waiting for user validation FUNC-0026.4.1.4
 - Provide software update FUNC-0026.4.3
 - Check remote connection availability FUNC-00
 - Checking for latest update FUNC-0026.4.3.5
 - Checking installation FUNC-0026.4.3.12
 - Communicate with host FUNC-0026.4.3.3
 - Downloading latest software version FUNC-00
 - Erasing outdated software FUNC-0026.4.3.10
 - Get current printer software version FUNC-00
 - Get printer status FUNC-0026.4.3.1

Functions tree

Attribute Link Comment Revision

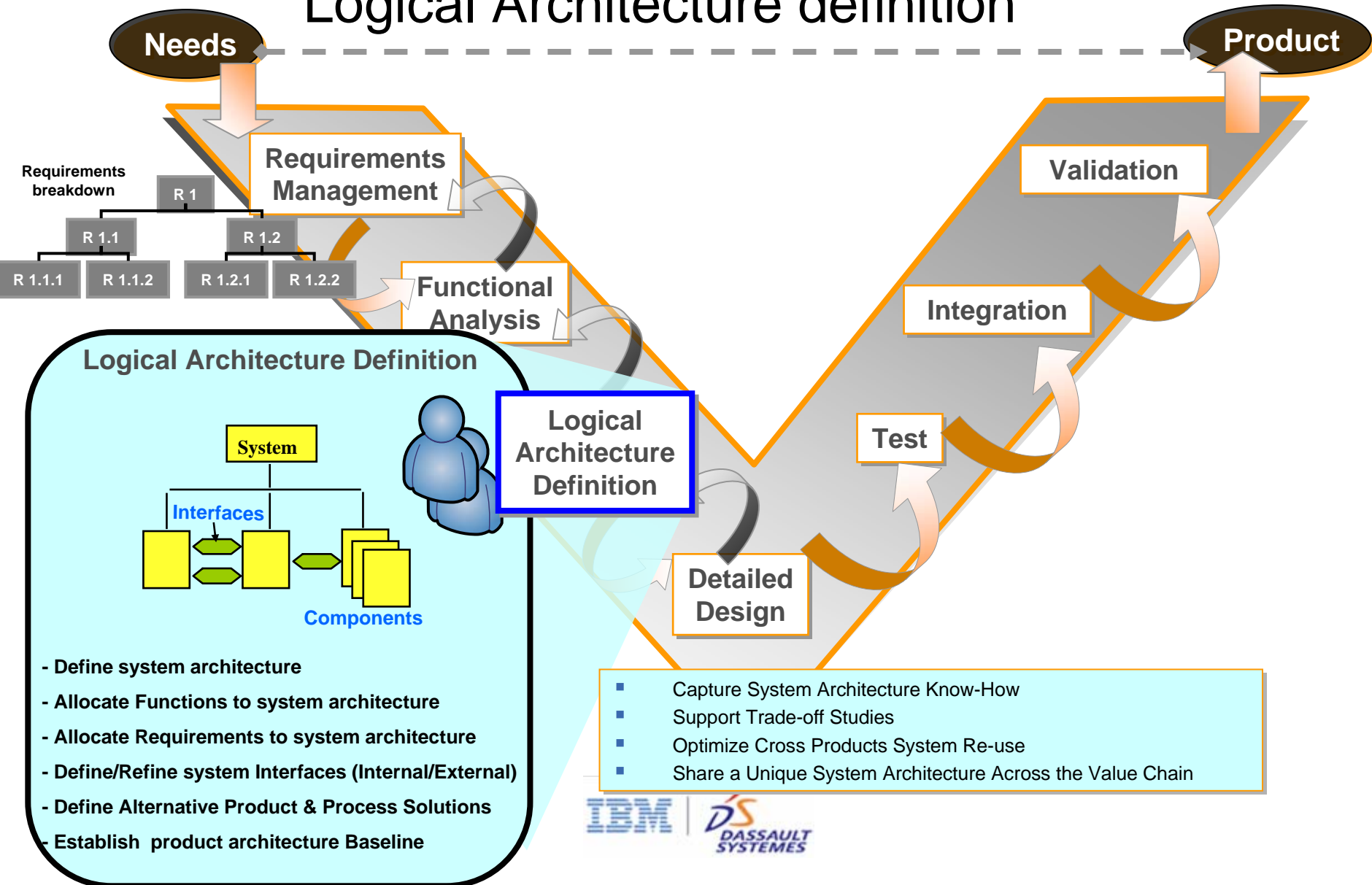
Functions Folder

Business Process Content

Identifier	FUNC-0025
State	Pending
Creation Date	07/23/2004 11:55
Created by:	joe
Modified by:	
Last modification date	
Name	EvoPrint InkJet 5500 Series
Function State	
Owner	
Type	

Attributes Attributes1

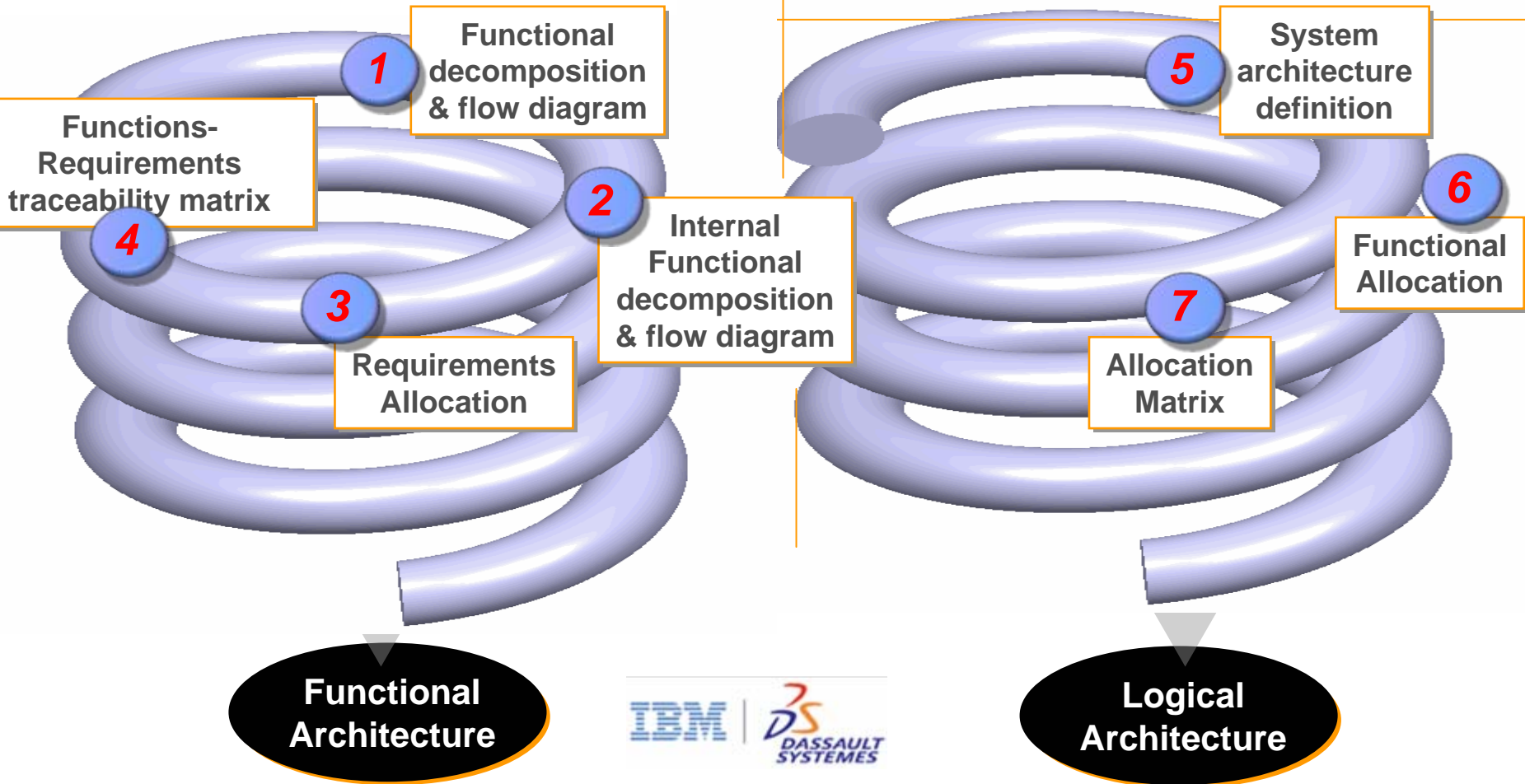
Logical Architecture definition



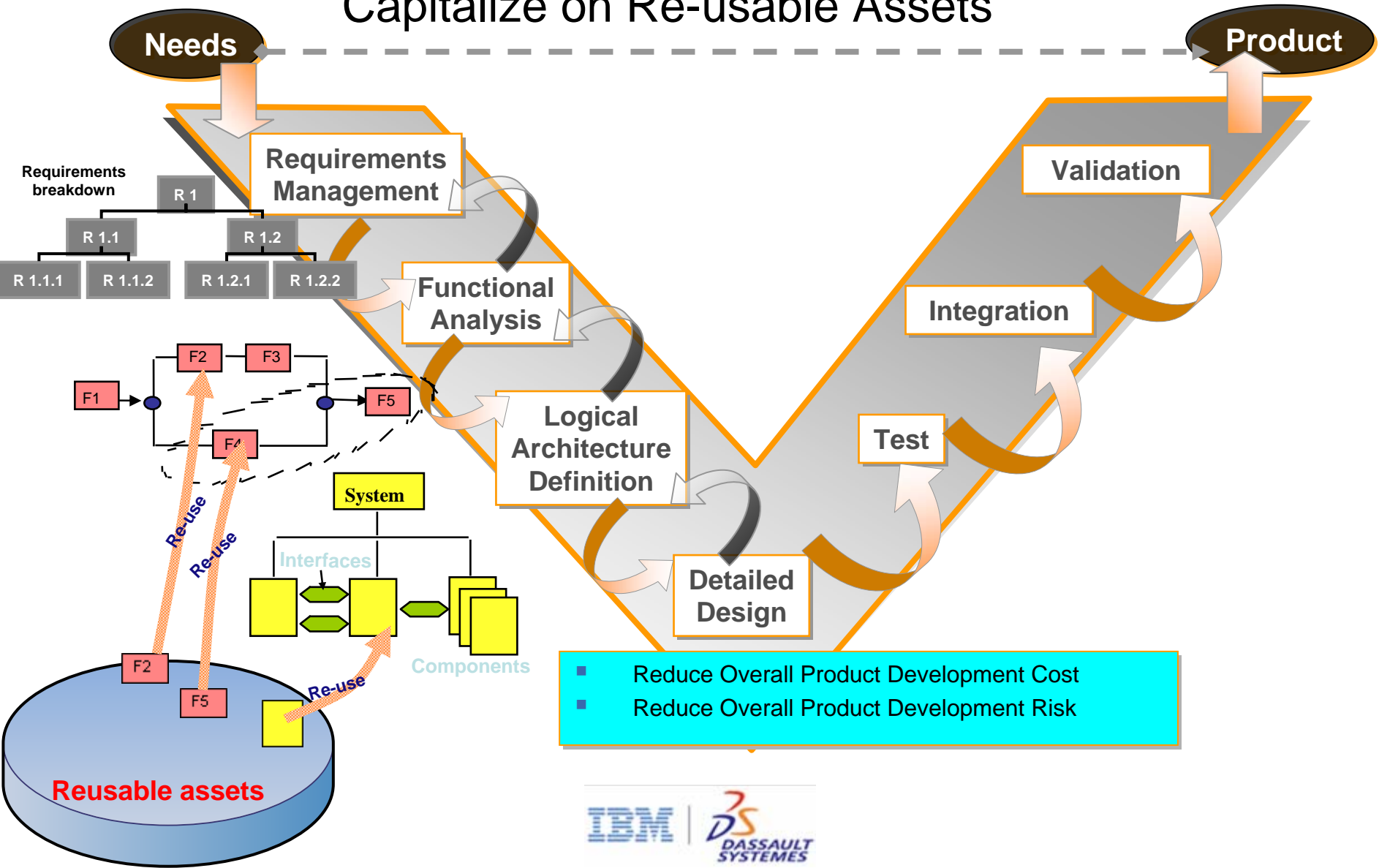
Functional Analysis and System Architecture Definition Iterative Processes

Functional Analysis

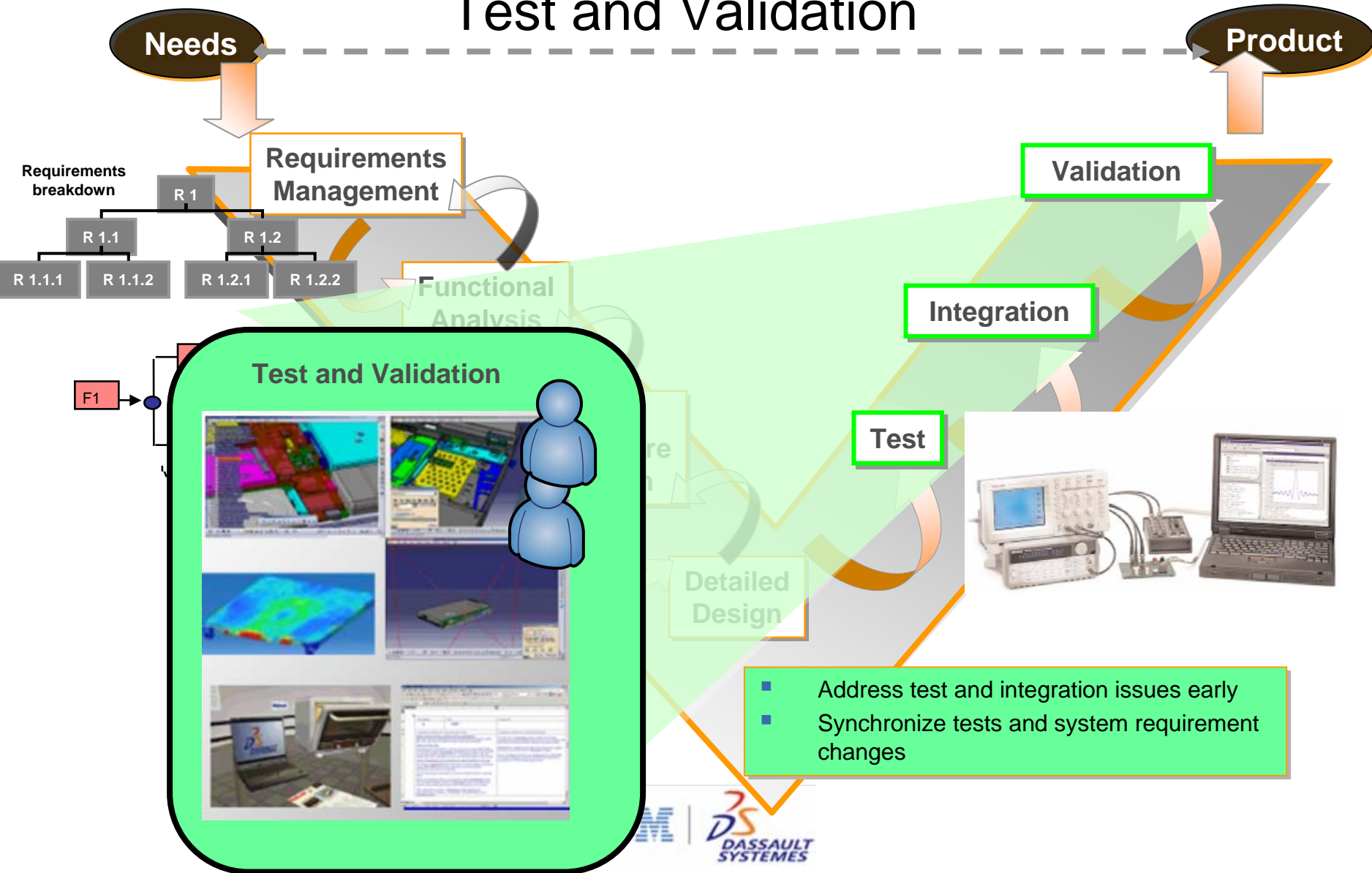
System Architecture Definition



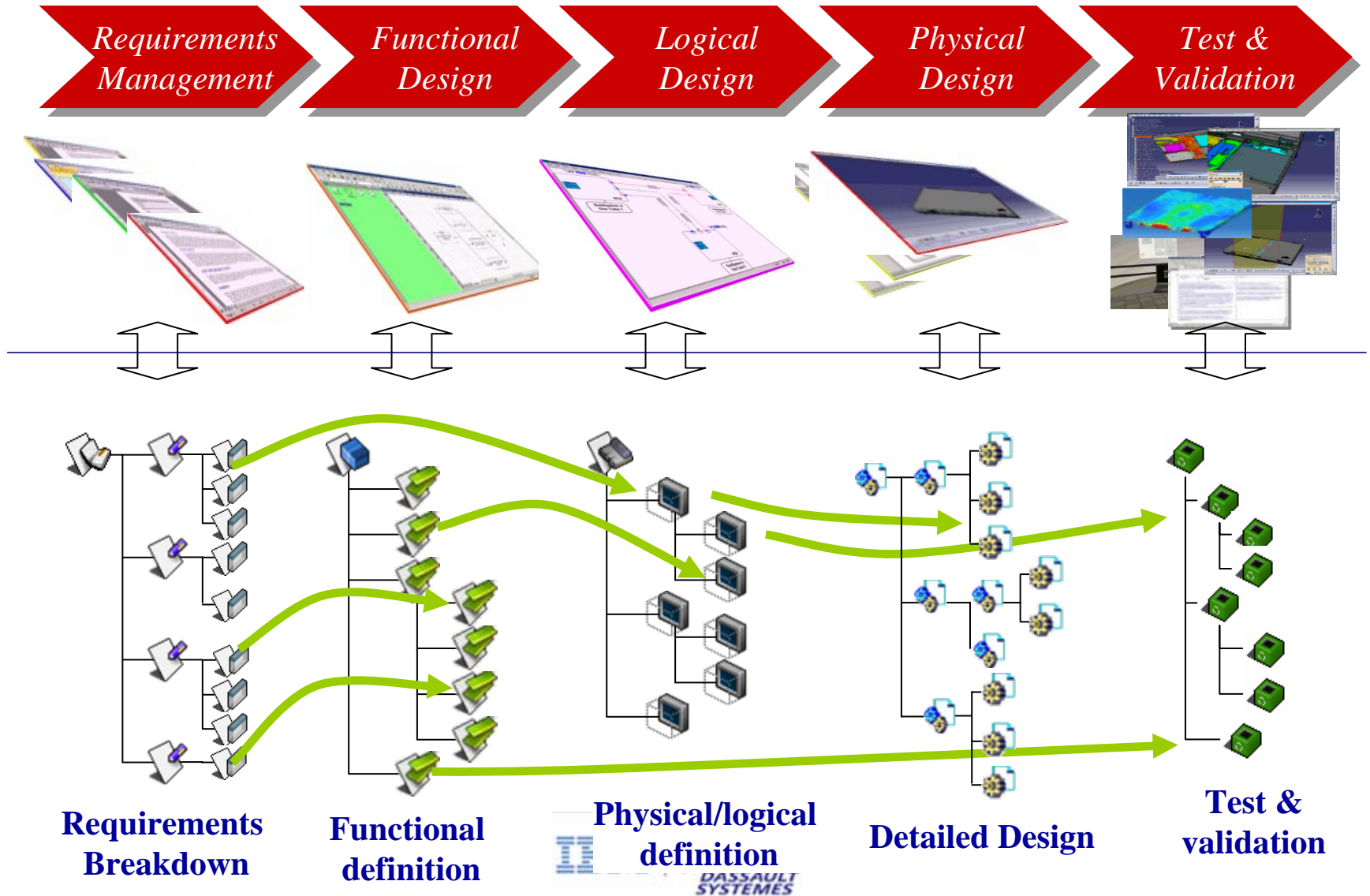
Capitalize on Re-usable Assets



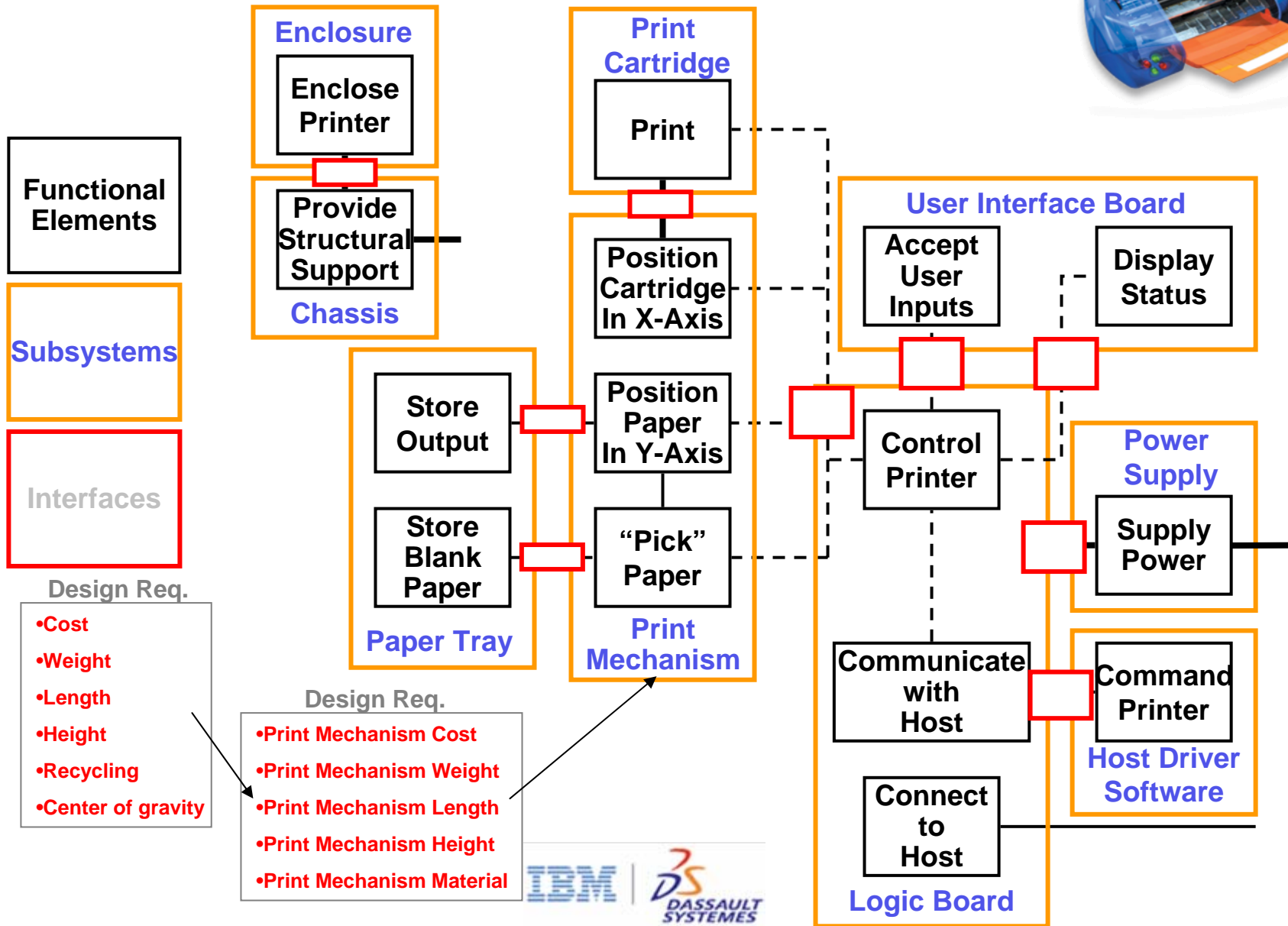
Test and Validation



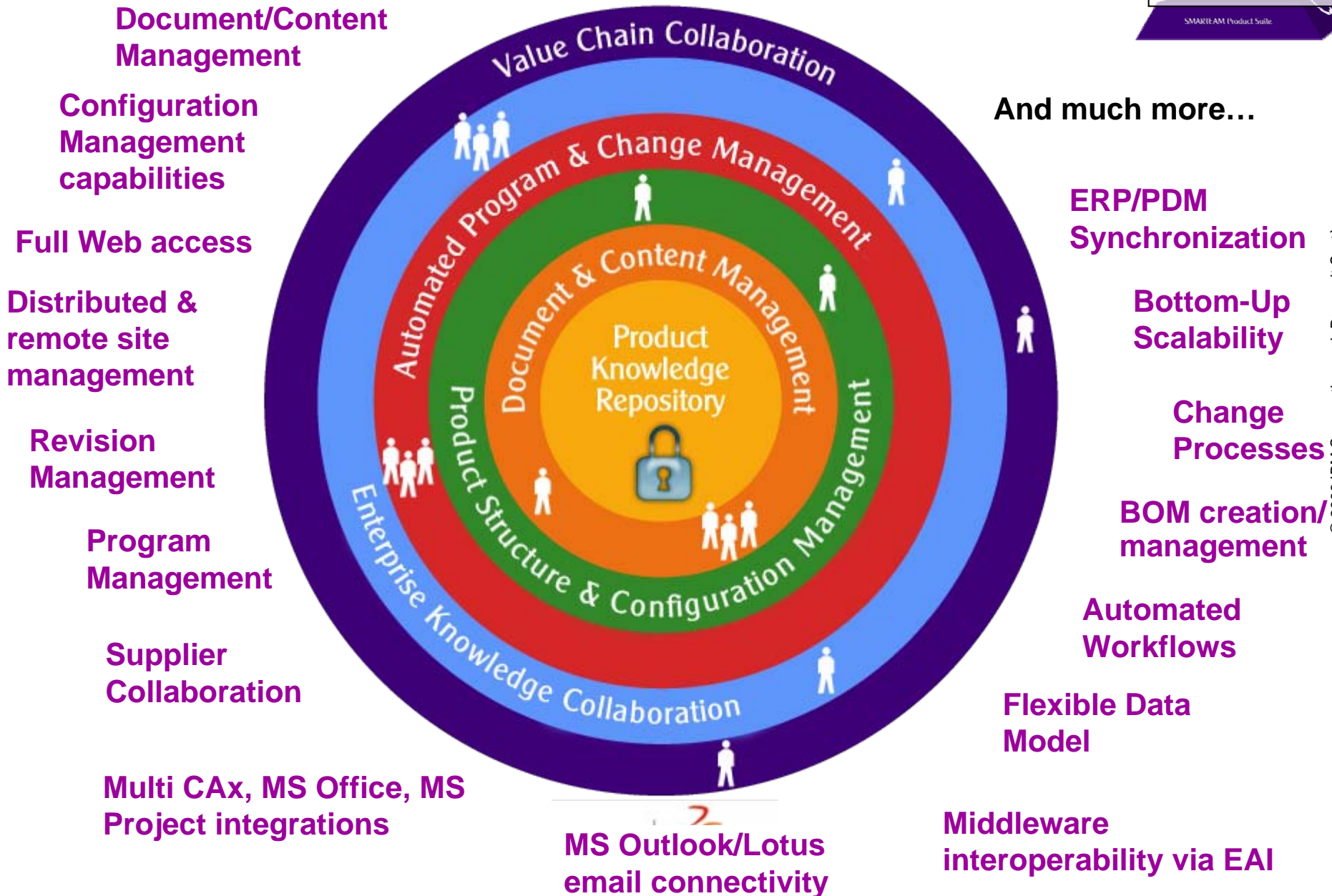
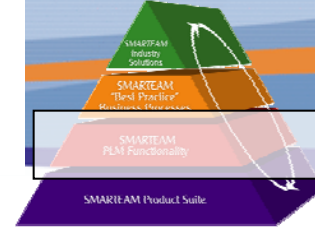
Net: A comprehensive & managed reference model of the system



Product Architecture view

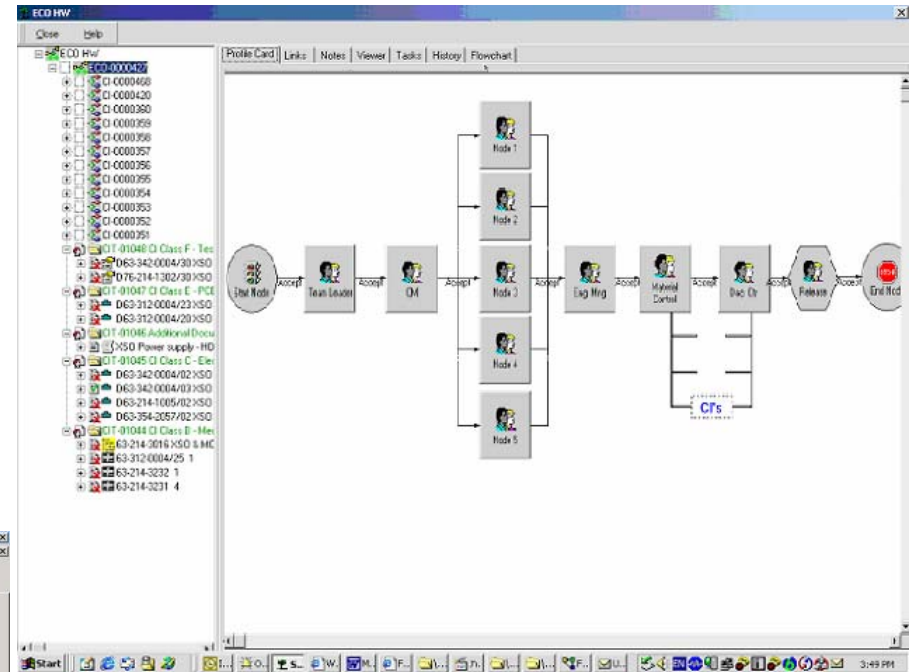
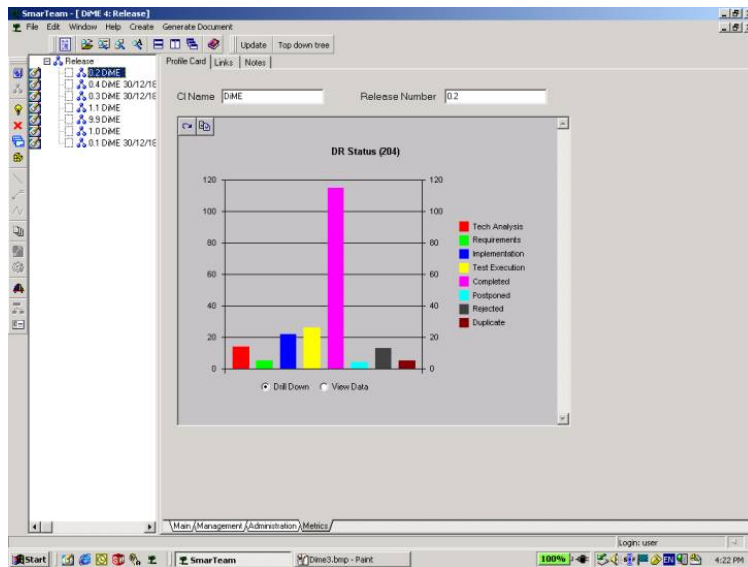


CSE is built on SmarTeam rich functionality



Process Management leverage SMARTTEAM workflow automation

- examples:
 - needs elicitation
 - stakeholder validation
 - mandatory approvals
 - phase reviews
 - change management
 - ...



➤ Streamline and formalize approval processes

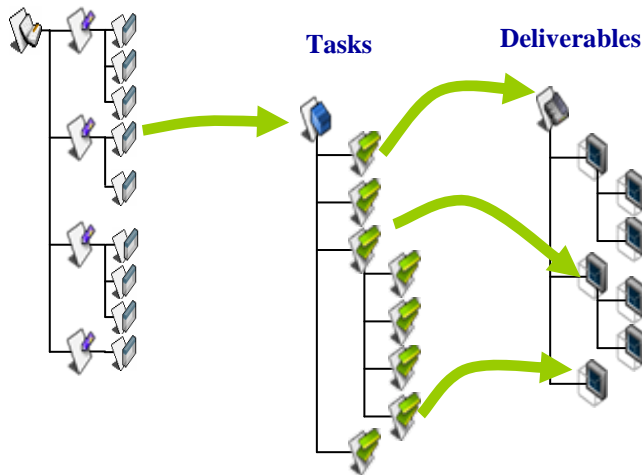


Process Management

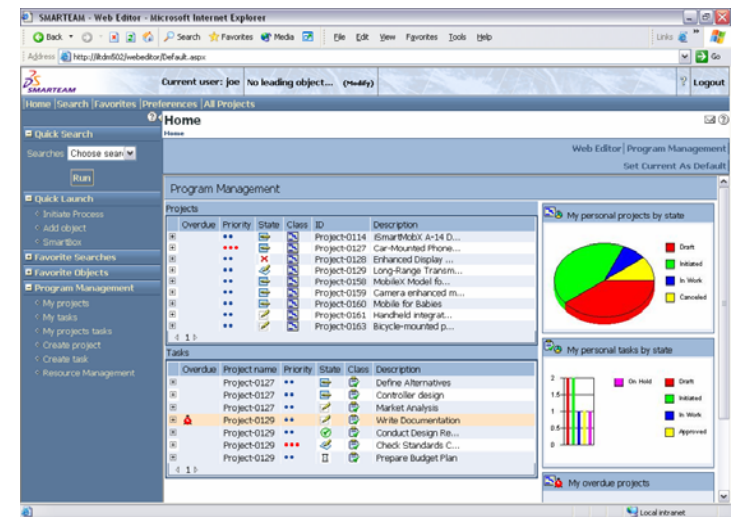
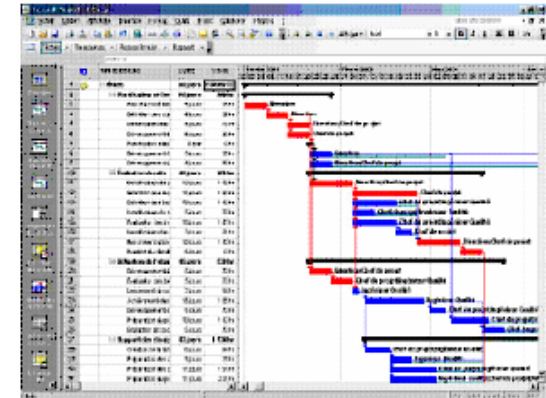
Exploit linkage with project management

- Manage timeline and resources
- Link tasks and deliverables

Projects

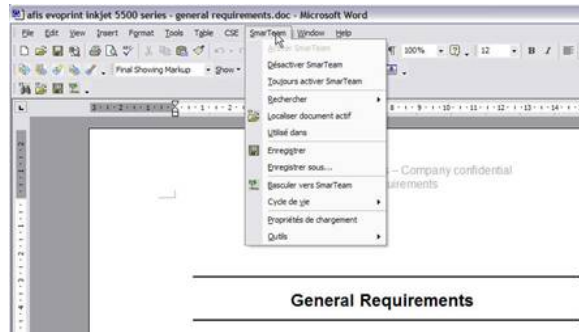
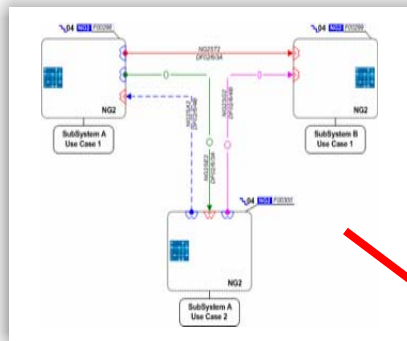


➤ integrated project management

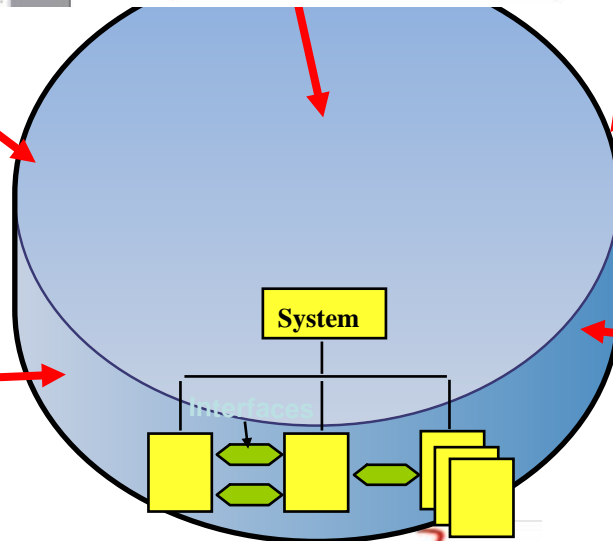
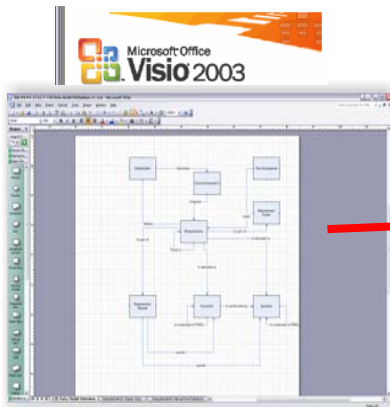
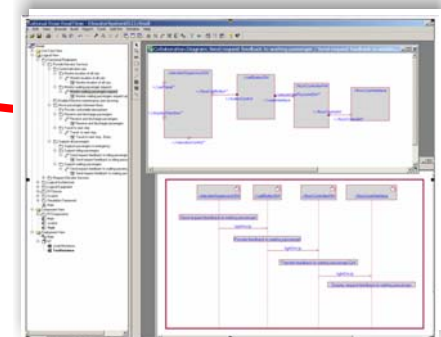
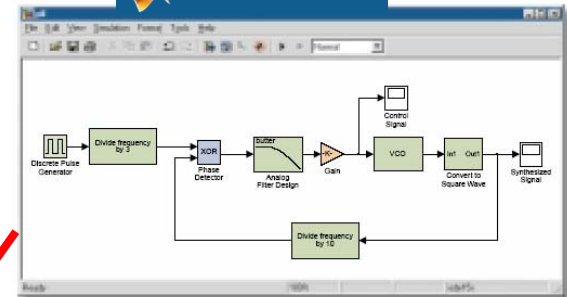


Domain tools and enterprise application integration

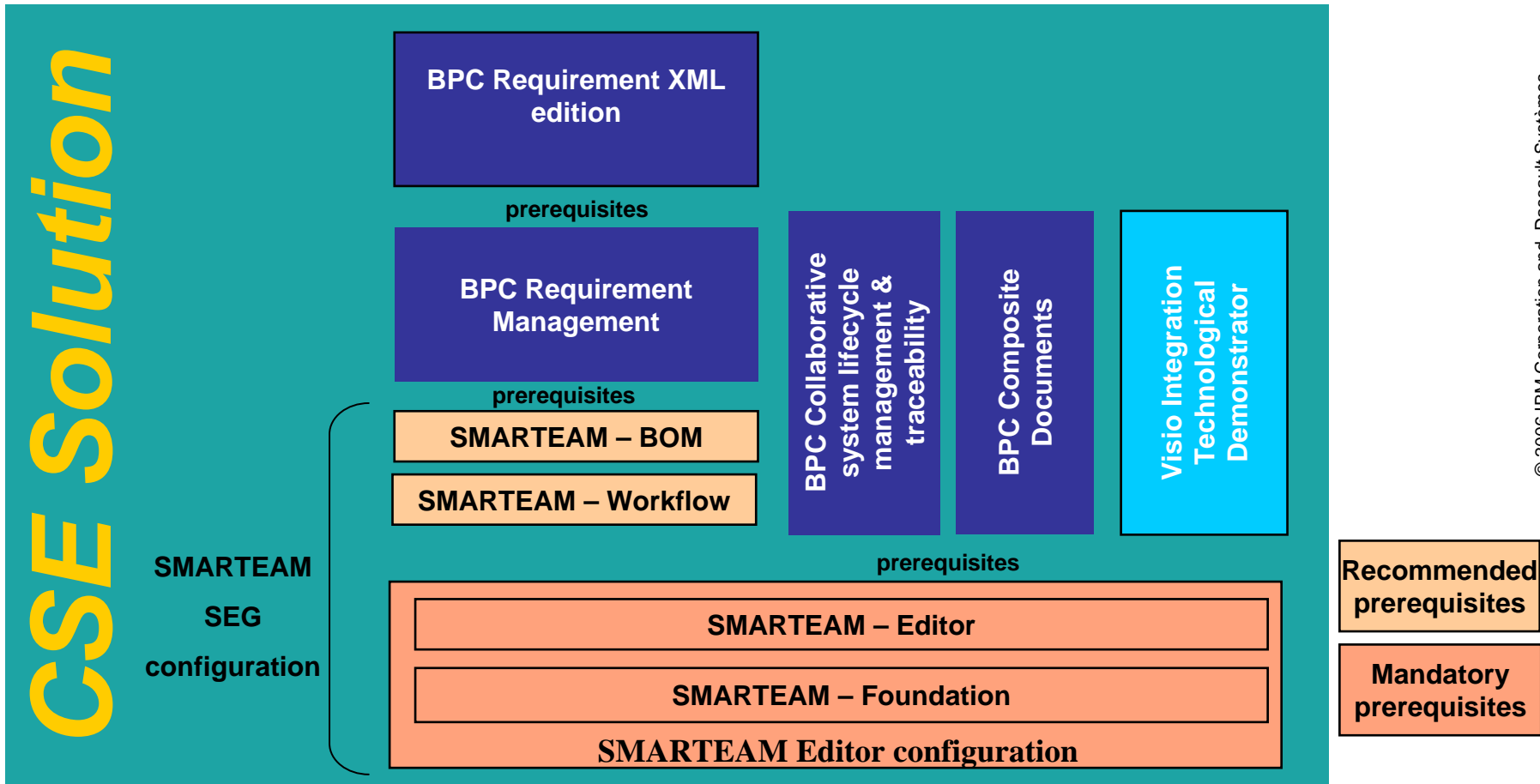
A rich set of integration tools to enable your specific processes



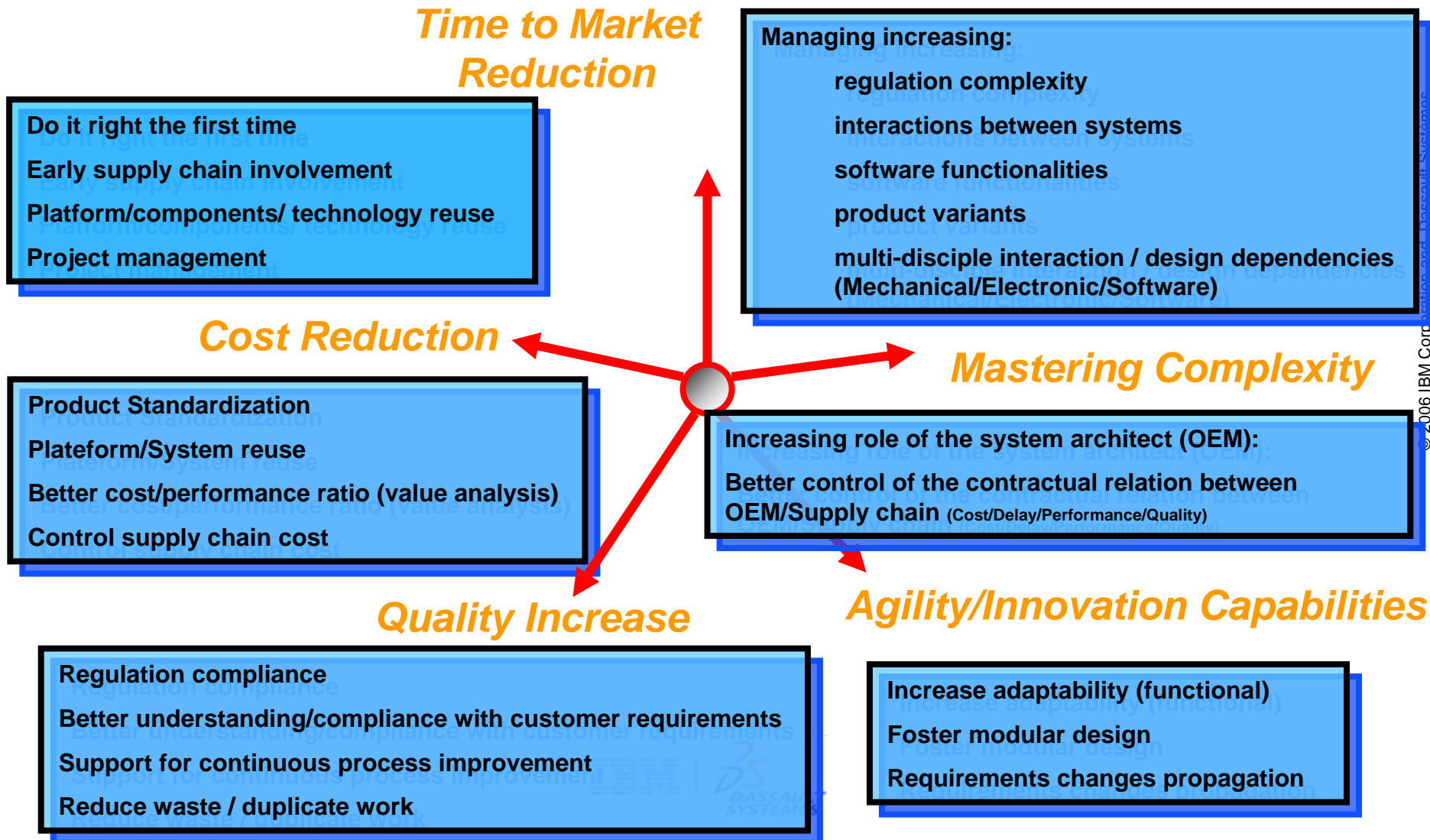
General Requirements



SMARTTEAM Products & Configurations used in the Collaborative System Engineering (CSE) Solution

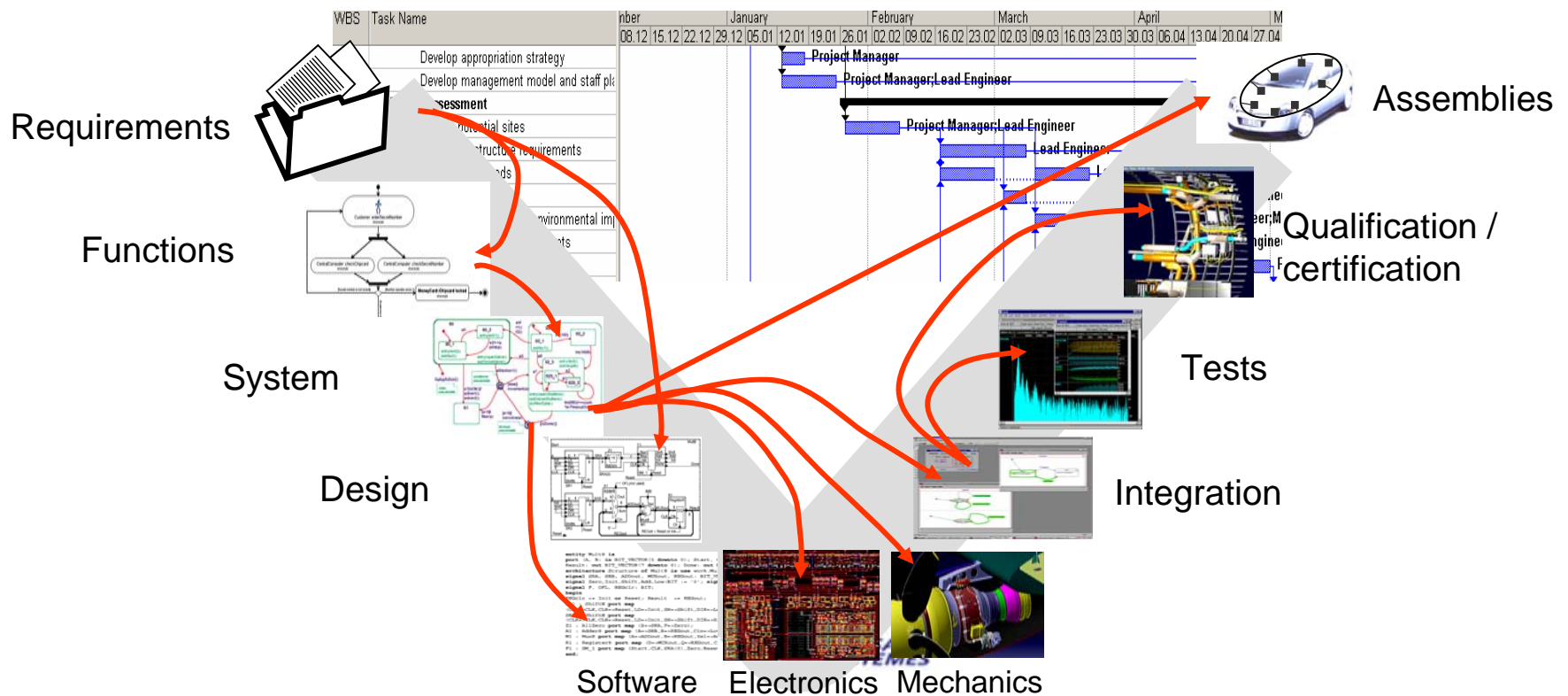


Collaborative Systems Engineering key benefits



Take away

- SMARTEAM / CSE a flexible and powerful framework to support your Systems Engineering process and focus on the **early critical stages of product development**
- SMARTEAM / CSE an integrated and full feature **Requirements Management** solution to insure compliance and customer satisfaction



Thank You !