3DEXPERIENCE

Mastering Complex Systems Design: Parametric Requirements

REFSQ Conference
April 9, 2014

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DASSAULT SYSTEMES | The 3DEXPERIENCE Company

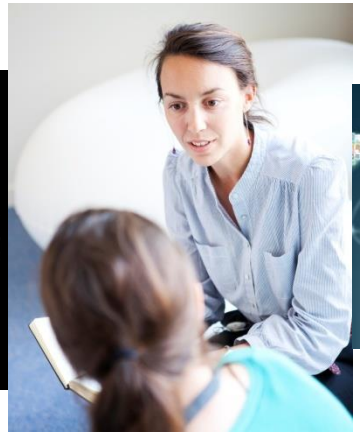
Agenda

1. Dassault Systemes
2. Challenges
3. Parametric Requirements
4. Use cases
5. Conclusion

Our Company

a **Scientific** company

Combining **Science, Technology** and **Art** for a sustainable society



11,000 passionate people

- 106 nationalities
- One global R&D/36labs
- Game changing **3D**EXPERIENCE solutions

170,000 enterprise customers

- 12 industries in 140 countries
- >10 million on premise users
- >100 million online users

3,500 partners

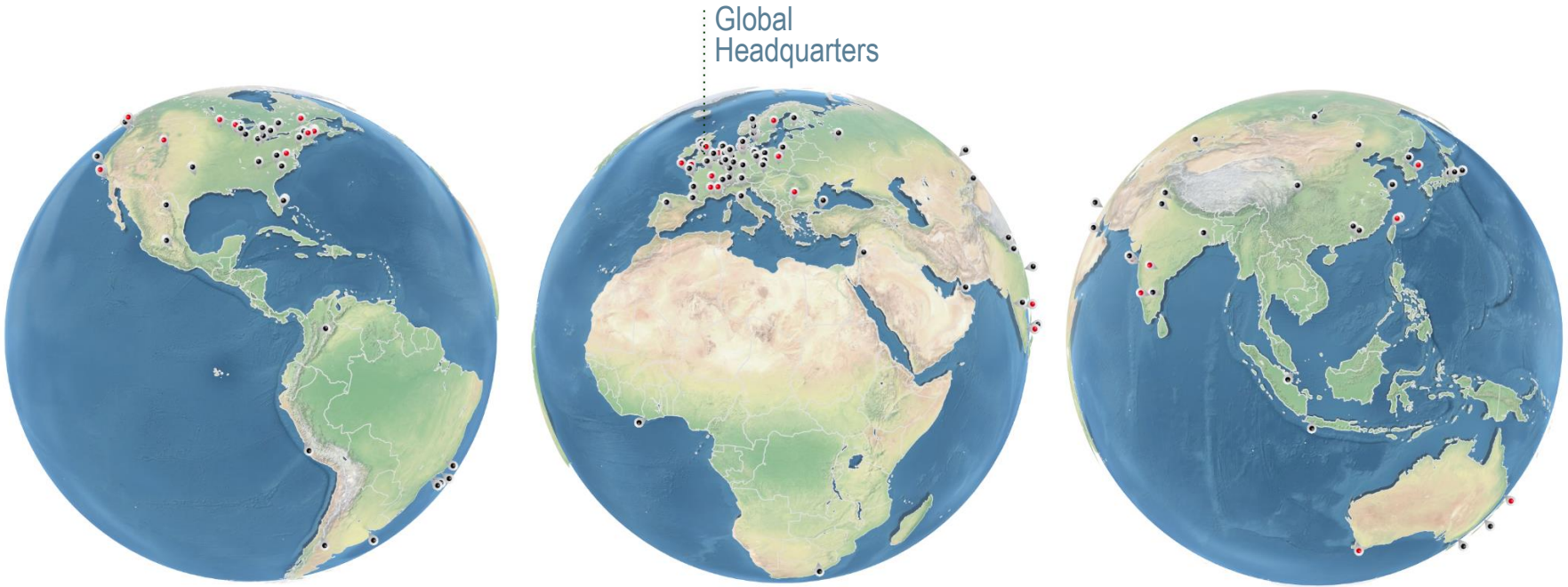
- Research & Education
- Software & Technology
- Sales & Services

Long-term driven

- Majority shareholder control
- **Revenue**: **$ 2.6 Bn***
- Operating margin: 31.6%*

** Non-IFRS*

Our Presence



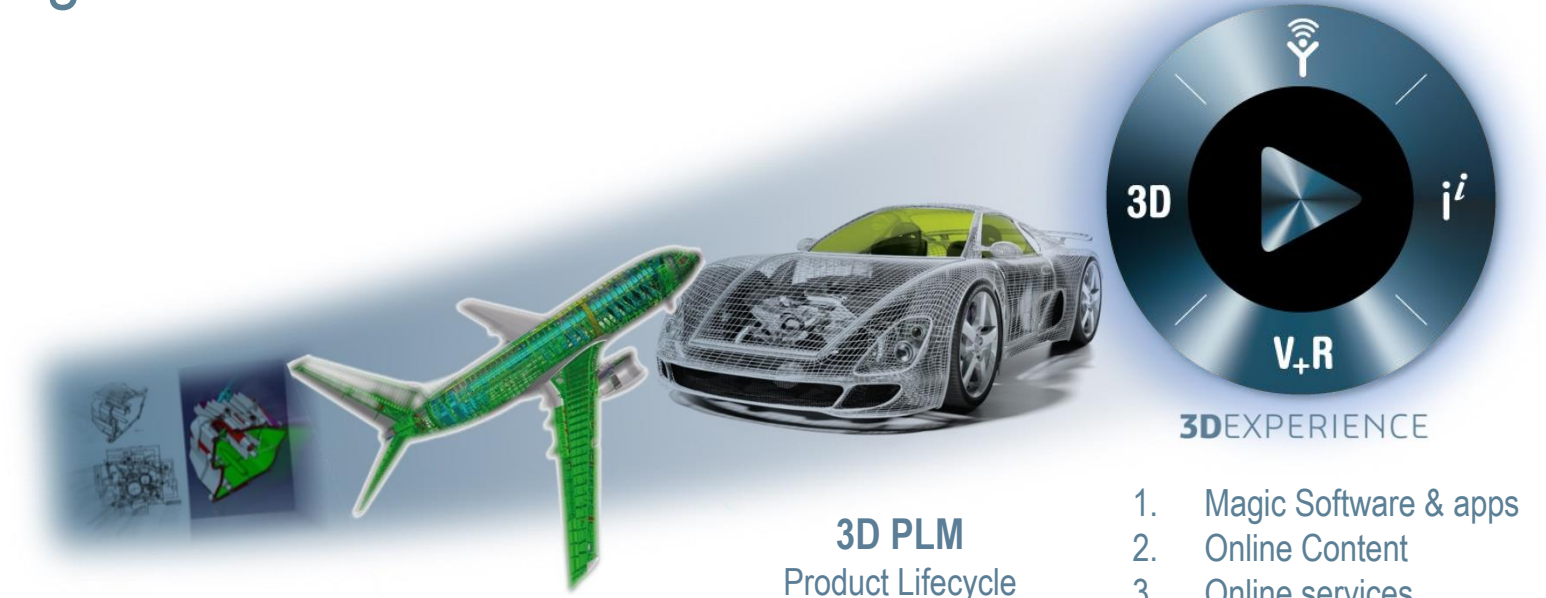
R&D labs (36)

3DS Offices (149)

Our Customers… from shampoo bottles to airplanes

	TRANSPORTATION & MOBILITY
	AEROSPACE & DEFENSE
	MARINE & OFFSHORE
	INDUSTRIAL EQUIPMENT
	HIGH-TECH
	CONSUMER GOODS - RETAIL
	CONSUMER PACKAGED GOODS - RETAIL
	LIFE SCIENCES
	ENERGY, PROCESS & UTILITIES
	ARCHITECTURE, ENGINEERING & CONSTRUCTION
	FINANCIAL & BUSINESS SERVICES
	NATURAL RESOURCES

Opening a New Horizon with **3D**EXPERIENCE



3D
Design

3D DMU
Digital Mock-up

3D PLM
Product Lifecycle Management

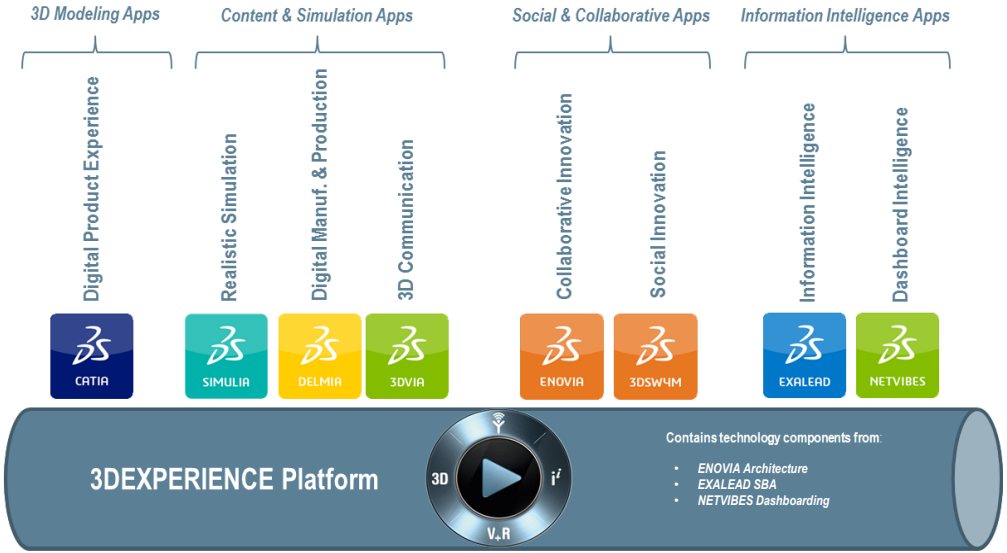
1. Magic Software & apps
2. Online Content
3. Online services
4. Breakthrough user experience
5. On the cloud and on premise
6. Mobility

V3 **V4** **V5** **V6**

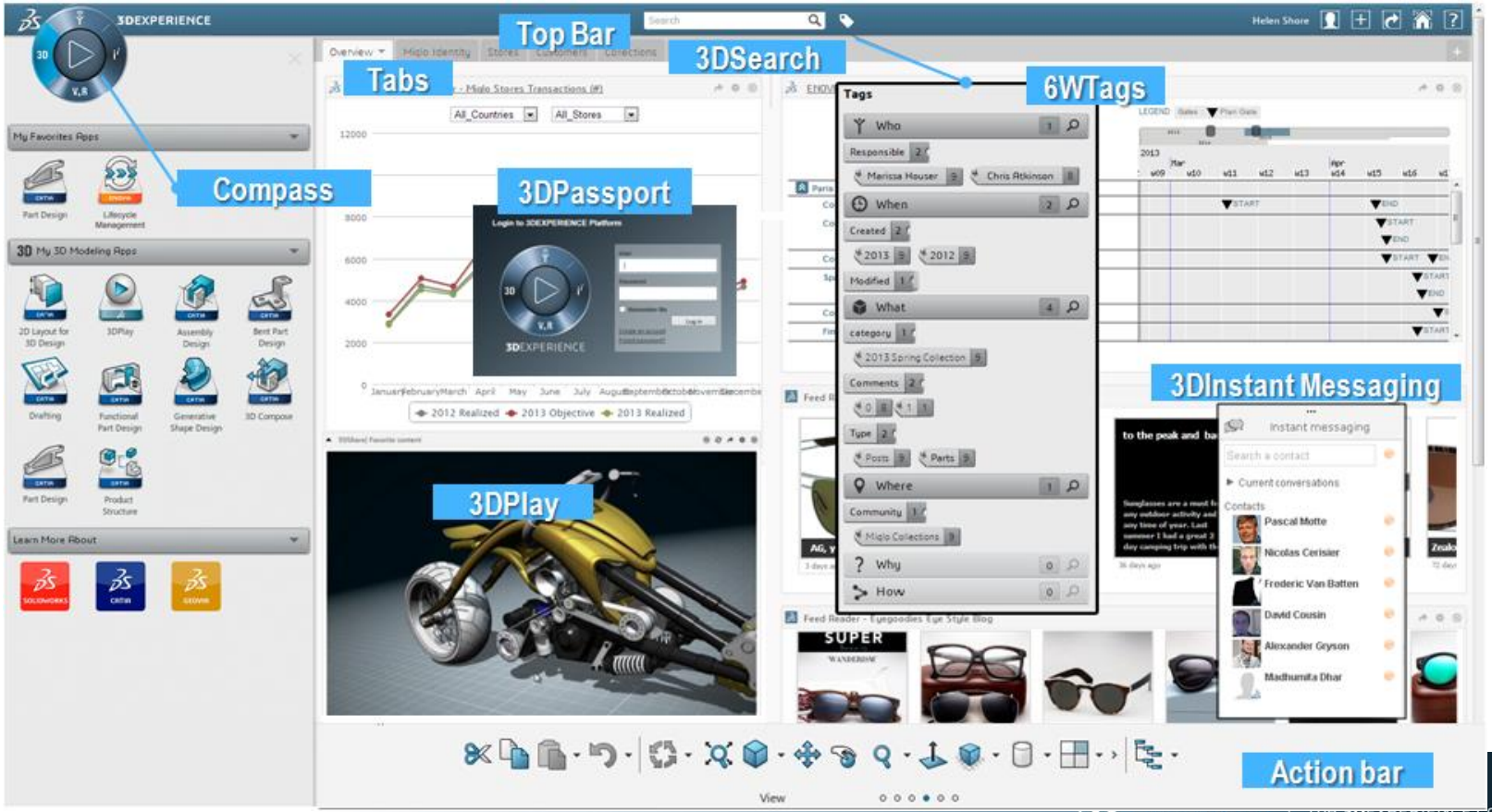
3DEXPERIENCE Powers our Brand Applications for 12 Industries

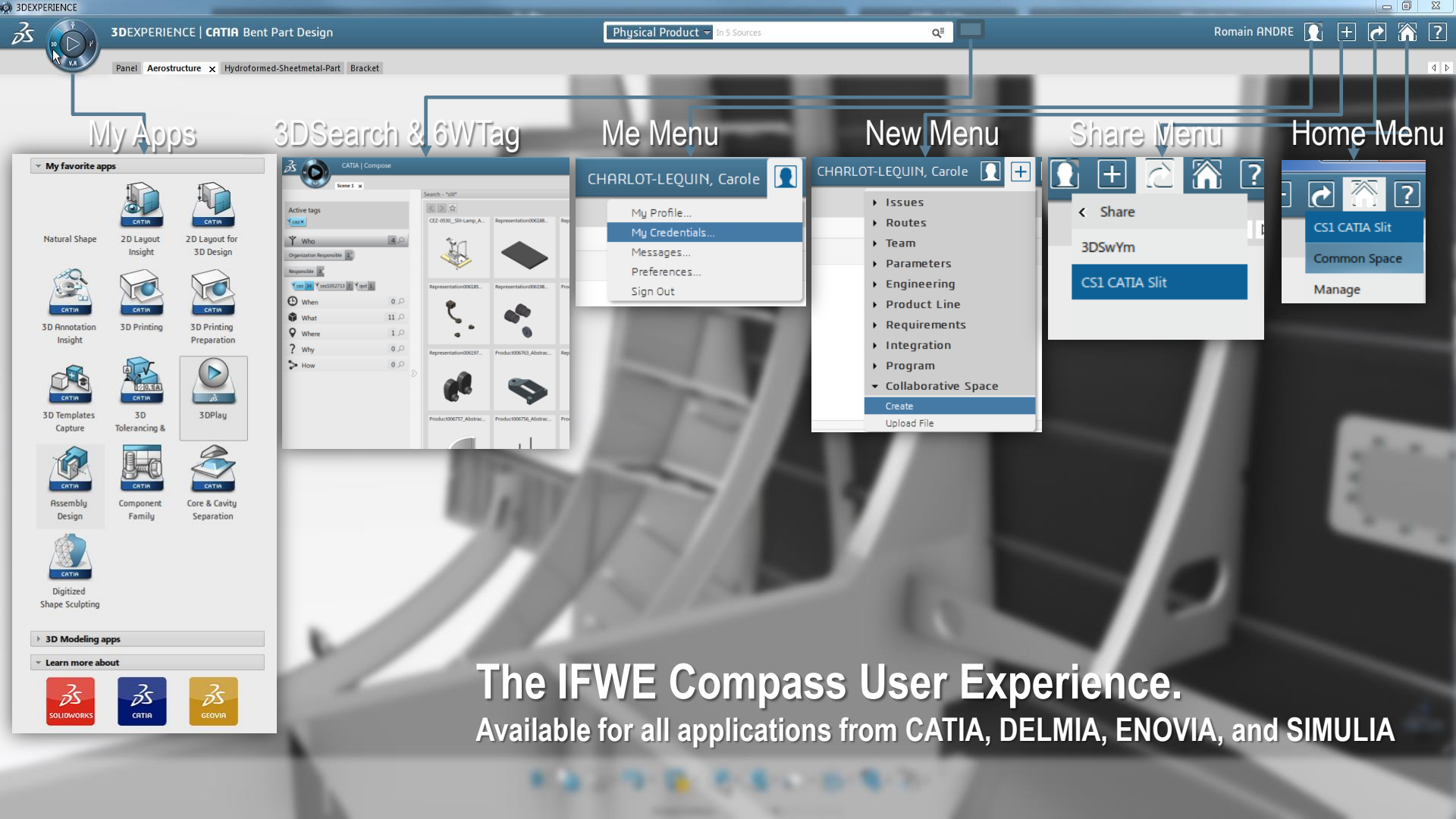
Includes solutions for systems Engineering & Detailed Design (Mechanical, Electrical, Embedded…)

ient_2013



IFWE Compass User Experience




3DEXPERIENCE
3DEXPERIENCE | CATIA Bent Part Design
Physical Product
In 5 Sources
Romain ANDRE
Panel
Aerostructure
Hydroformed-Sheetmetal-Part
Bracket
My Apps
3DSearch & 6WTag
Me Menu
New Menu
Share Menu
Home Menu
My favorite apps
Natural Shape
2D Layout Insight
2D Layout for 3D Design
3D Annotation Insight
3D Printing
3D Printing Preparation
3D Templates Capture
3D Tolerancing &
3DPlay
Assembly Design
Component Family
Core & Cavity Separation
Digitized Shape Sculpting
3D Modeling apps
Learn more about
SOLIDWORKS
CATIA
GEOVIA
CATIA | Compose
Active tags
Who
What
Where
When
Why
How
CHARLOT-LEQUIN, Carole
My Profile...
My Credentials...
Messages...
Preferences...
Sign Out
CHARLOT-LEQUIN, Carole
Issues
Routes
Team
Parameters
Engineering
Product Line
Requirements
Integration
Program
Collaborative Space
Create
Upload File
Share
3DSwYm
CS1 CATIA Slit
CS1 CATIA Slit
Common Space
Manage
The IFWE Compass User Experience.
Available for all applications from CATIA, DELMIA, ENOVIA, and SIMULIA

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2. **Challenges**
3. Parametric Requirements
4. Use cases
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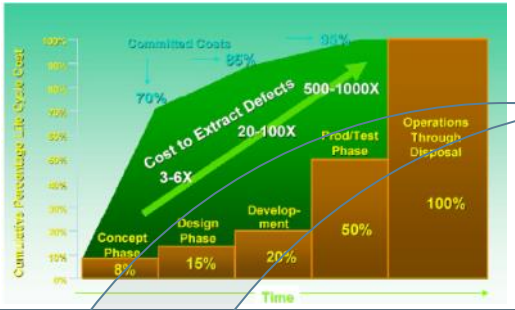
Challenges

Cost impact of poor Requirements Engineering



(Source Defense Management College)

Skills in System Engineering and Certification

- 3% to 5% of the global manpower in major companies.
- A need for 3000 new SE engineers for the next 5 years in France.
- A discipline recently addressed by universities: less than 100 new SE engineers per year.

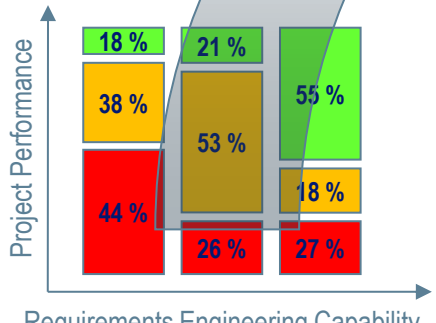
Systematic survey 2008
Vision AFIS 2020

« Lean » Requirements Engineering
More efficient, at lower cost, maximizing customers value and project performances

- More agility in the developments
- Completeness of System Knowledge repositories, no implicit information
- Right requirements with early validation
- Mastering of complexity and volume of requirements
- Use of models as requirements or for verification
- Efficient traceability
- Harmonization of methods and tools

RAMP survey 2010

Correlation between Project Performances & Requirements Engineering capability



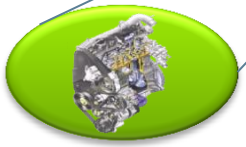
Survey of Systems Engineering Effectiveness (source: SEI & NDIA) -2008

Context (1)

Average : 500 000 Requirements

VEHICLE

3000 Requirements



POWER TRAIN

CHASSIS

BODY

x5 = 15 000 Req

ELECTRONICS

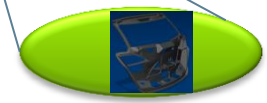
DOORS,
STRUCTURE…

ECU, HARNESS,
MECHATRONICS,
SENSORS,
ACTUATORS…

x5 = 75 000 Req

PISTON

HINGE



TAILGATE
STRUCTURE

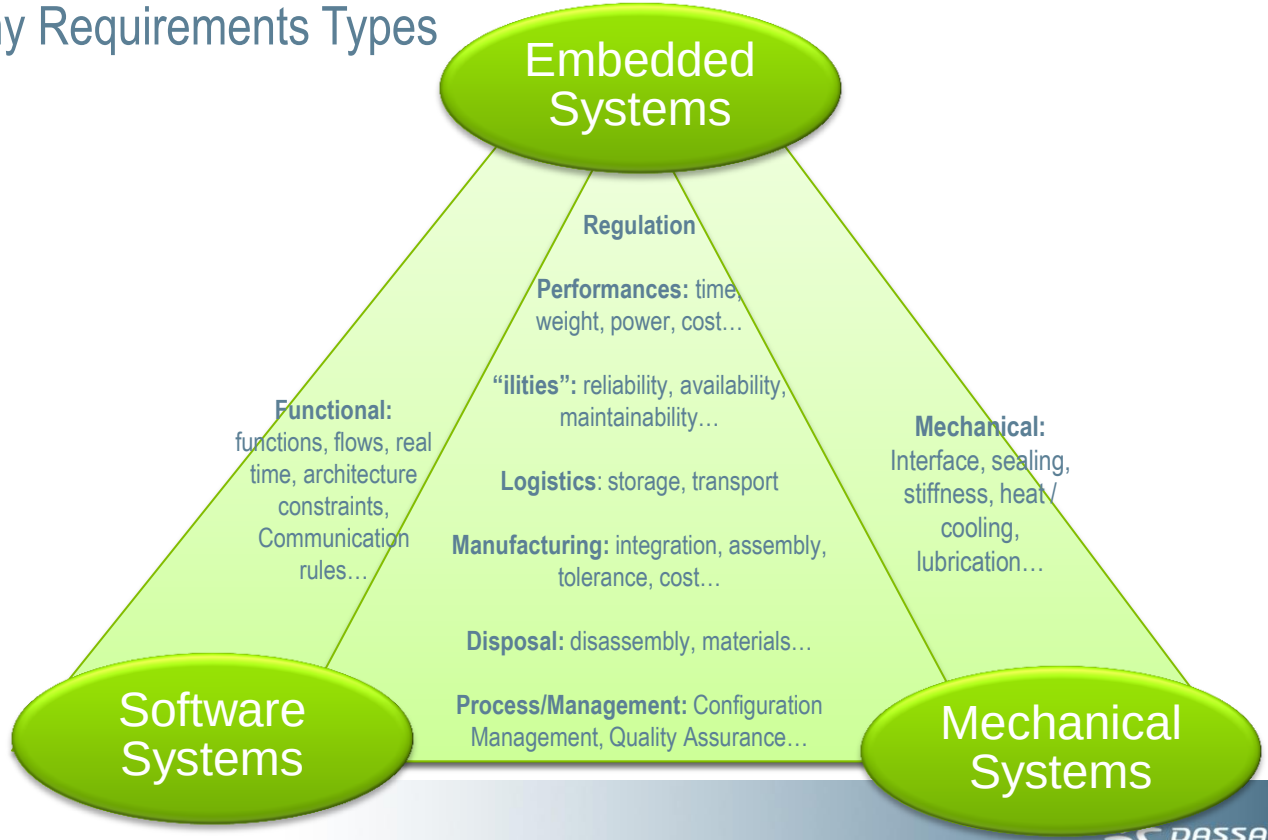
HW

SW

x5 = 375 000 Req

Context (2)

Many Requirements Types



Problem to solve on Requirements: CCC

Correctness

Completeness

Consistency

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3. **Parametric Requirements**
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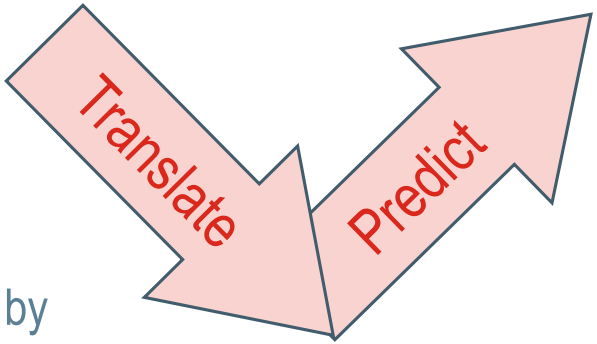
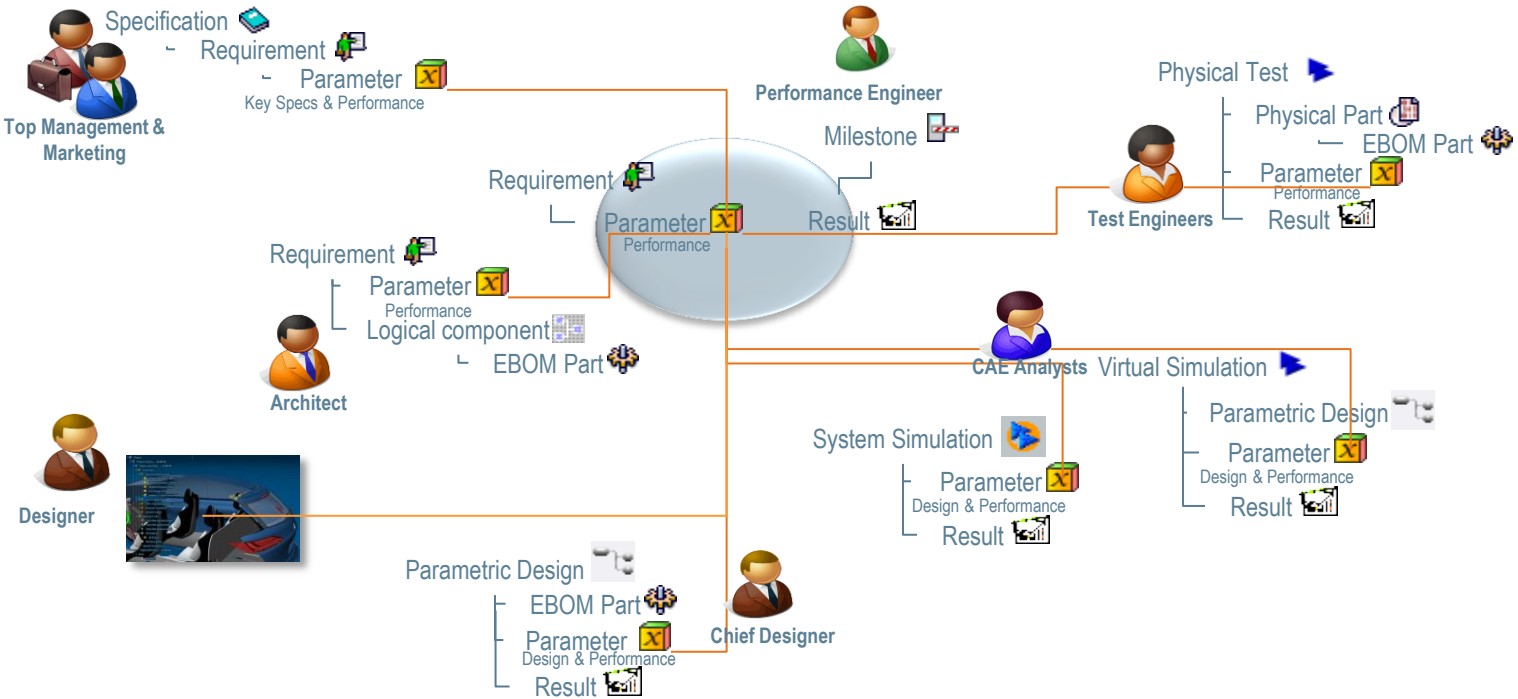
Parametric Requirements

- Requirements parameters
  - Semi-formal representation
  - Parameters assigned to requirements as formal descriptions
- Cornerstone for Systems Engineering
  - Link to System Design
  - Link to System Simulation
  - Link to System Testing
- Parameters with their own lifecycle that may be shared by many actors during the complete design and verification/validation process



Requirements parameters

Parameter management is at the heart Systems Engineering



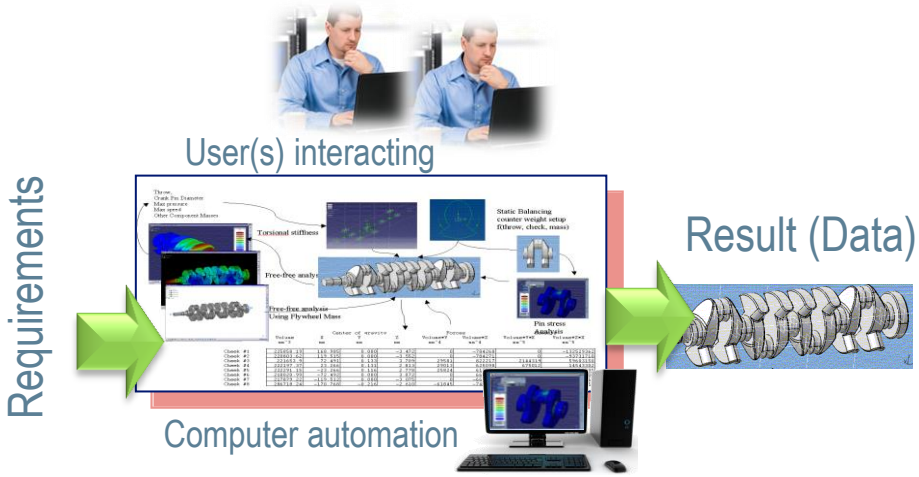
Knowledge Base Engineering

Ability to create a design taking into account:

- Company's existing knowledge
- Company standards or international rules

Knowledge is captured and formalized:

- Directly available to engineers
- Automation to reach the optimum level of benefit

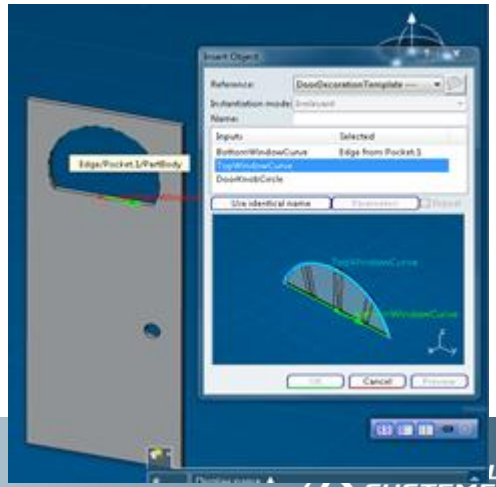


✓**1st challenge is to achieve efficiently the engineering process**

✓**2nd challenge is to maintain, manage & share this Knowledge across the people and across the programs**

Requirements Parameters with Knowledge

- Use of Knowledge with Parameters
  - Formulas & Rules, Checks, Reports,..
- Use of templates for engineering artifacts with an associated behavior and using knowledgeware parameters



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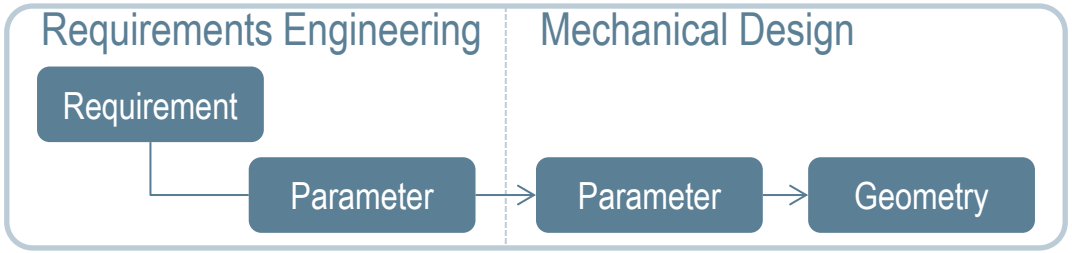
Use Case 1: Dimensional Requirements

- Some requirements are directly describing dimensions/parameters which are driving the design
  - Distance between wheels, Engine stroke, Number of pistons….



- This enables to drive directly the design from the requirement management
  - Single source of truth
  - Clear role between Requirement Engineering and Physical Design/Geometry

Use Case 1: Dimensional Requirements

- Requirement & Parameter Management

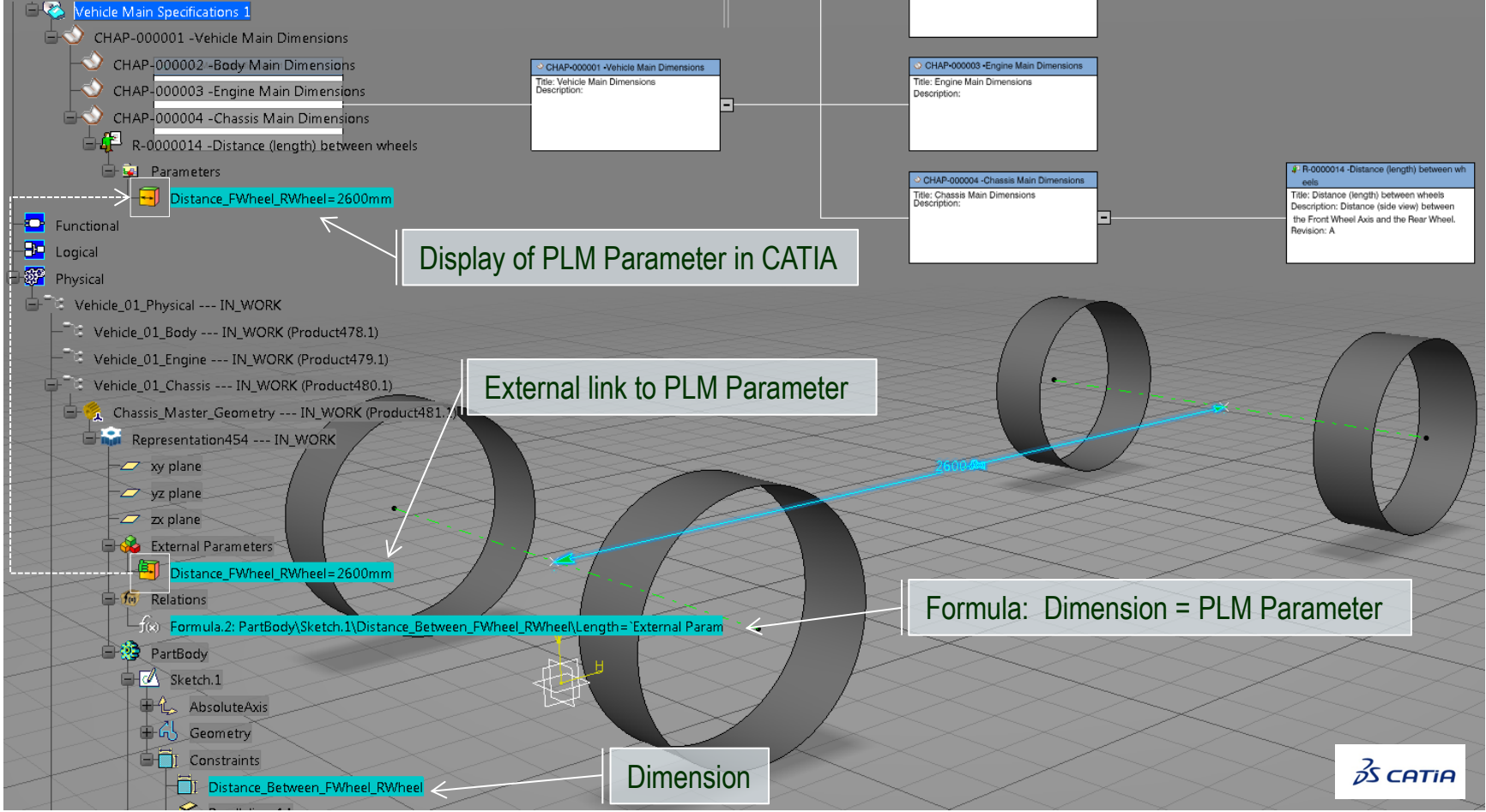
Name	Revision	Title	Type	Description
Vehicle Main Specifications	1	Vehicle Main Specifications	Requirement Specification	Description of the Main Specification of the Vehicle - structured as chapters
CHAP-000001	1	Vehicle Main Dimensions	Chapter	
CHAP-000002	1	Body Main Dimensions	Chapter	
CHAP-000003	1	Engine Main Dimensions	Chapter	
CHAP-000004	1	Chassis Main Dimensions	Chapter	
R-0000014	A	Distance (length) between wheels	Requirement	Distance (side view) between the Front Wheel Axis and the Rear Wheel Axis

R-0000014 A

Associated Parameters

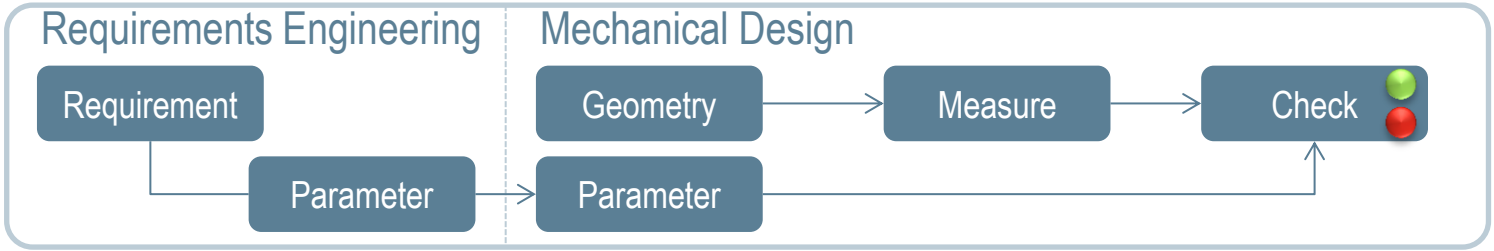
Categories | Add New Parameter | Add Existing Parameter | Remove Selected | Enable Edit | View

Object Name	Revision	Parameter Type	Parameter Name	Parameter Value
PlmParameter-0000146	A	LENGTH Parameter	Distance_FWheel_RWheel	2600.0 MM



Use Case 2: Dimensional Criteria

- Some requirements are describing dimensional criteria
  - Maximum distance, Minimum Volume, ….
- Design checks and check reports



- This enables to validate a design according to requirement dimensions
  - Instant view of requirement compliancy
  - Checks can be imbedded in Product Templates

Use Case 2: Dimensional Criteria

- Requirement & Parameter Management in Requirement Enineering

Name	Revision	Title	Type	Description
Vehicle Main Specifications	1	Vehicle Main Specifications	Requirement Specification	Description of the Main Specification of the Vehicle - structured as chapters of requirements and parameters
CHAP-000001	1	Vehicle Main Dimensions	Chapter	
CHAP-000005	1	General Regulations	Chapter	
CHAP-000006	1	EuroNCAP requlations	Chapter	
CHAP-000007	1	Lighting Regulations - ECE48	Chapter	
CHAP-000008	1	ECE48 - Front Lighting	Chapter	
R-0000015	A	Front Area Positioning of High Beam	Requirement	High Beam focal point has to be in a defined area for height and witdh

R-0000015 A

Associated Parameters

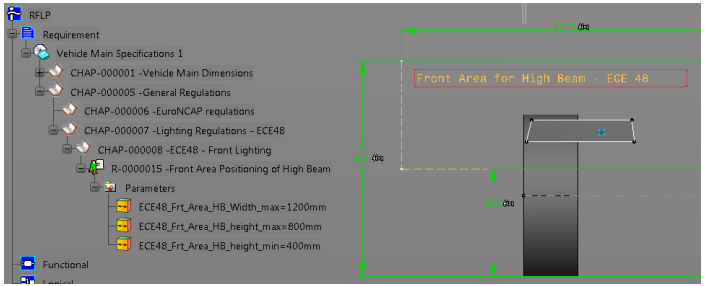
View:parameter_view

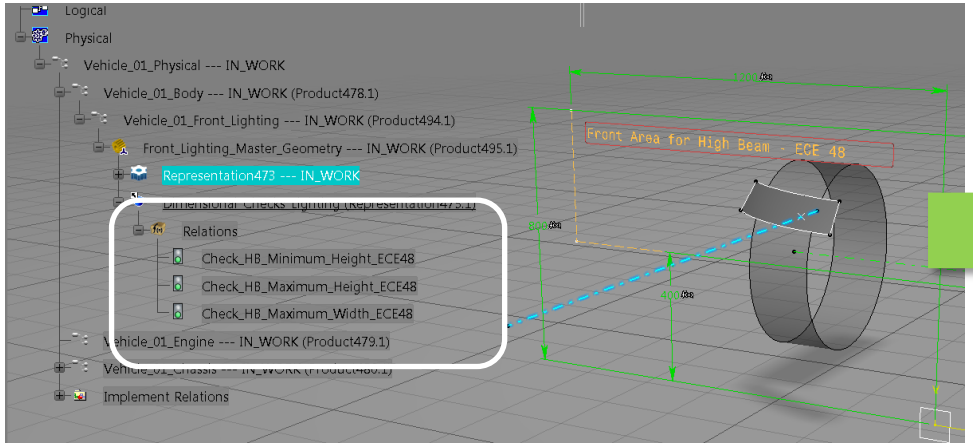
Categories | Add New Parameter | Add Existing Parameter | Remove Selected | Enable Edit | View

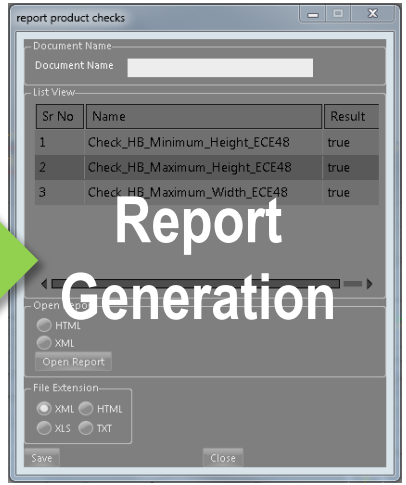
Object Name	Revision	Parameter Type	Parameter Name	Parameter Value
PlmParameter-0000147	A	LENGTH Parameter	ECE48_Frt_Area_HB_height_min	400.0 MM
PlmParameter-0000148	A	LENGTH Parameter	ECE48_Frt_Area_HB_height_max	800.0 MM
PlmParameter-0000149	A	LENGTH Parameter	ECE48_Frt_Area_HB_Width_max	1200.0 MM

Use Case 2: Dimensional Criteria

- Parameters are re-used in CATIA as reference parameters
- Checks enable to validate the design compliancy



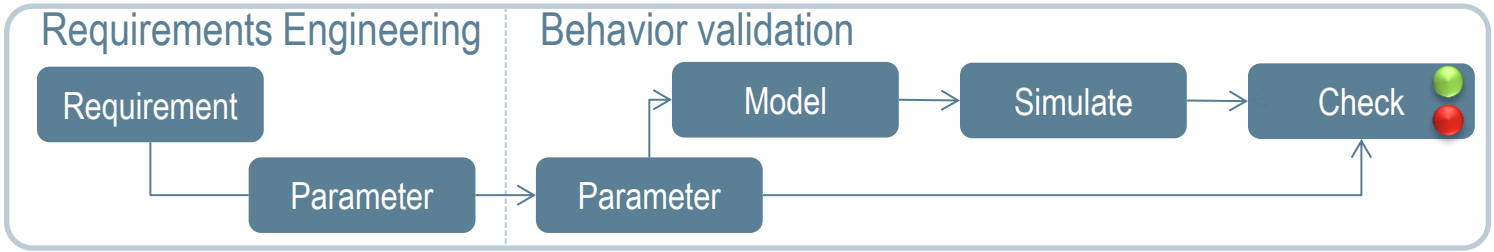




Report Generation

Use case 3: System optimization

- Some requirements are describing physical characteristics
  - Resistance, heat, vibration ….
- Multi-physics behavior checking through simulation



- This enables to validate the physical behavior of a component or set of components in a design according to requirements
  - Instant view of requirement compliancy
  - Checks can be imbedded in Product Templates

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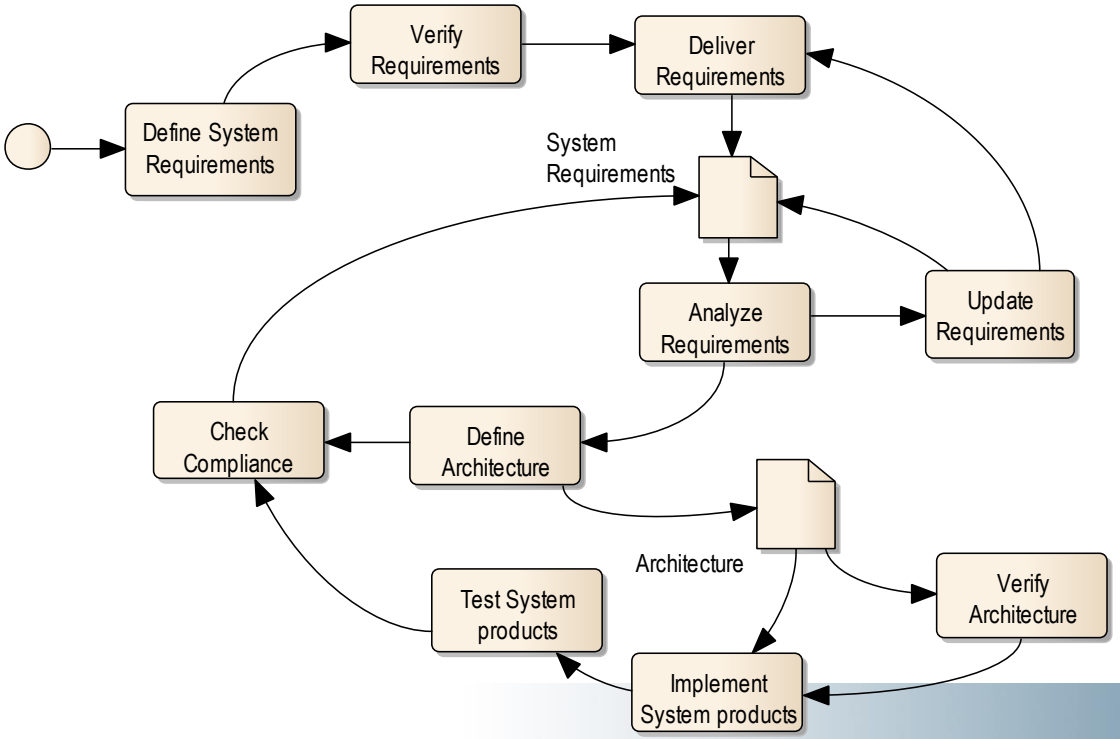
Conclusion

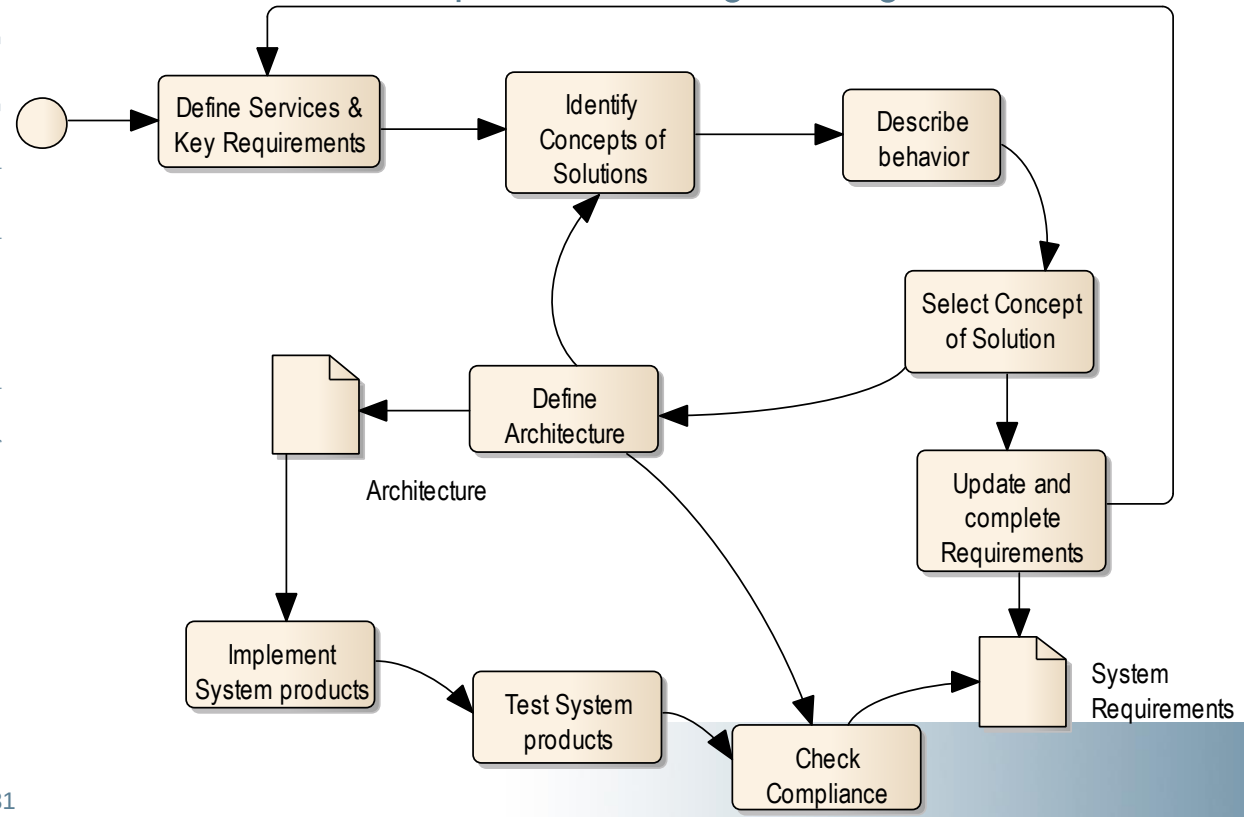
As-Is: Traditional Requirements Engineering



- Sequence of engineering steps with **time & efforts waste** in the process and **heavy rework** :
  - Non-optimized verification loops
  - Late Design verification against System Requirements

Conclusion

To Be: Lean Requirements Engineering



- Progressive and early model based verification
- Iterations between Needs & Possible solutions
- Requirements Consistency & Completeness checking
- Better efficiency: use of parameters, knowledge & templates

Conclusion

Pathways for Lean Systems Engineering