NASA/DoD Materials and Process Information Strategy to Support Sustainable Acquisition

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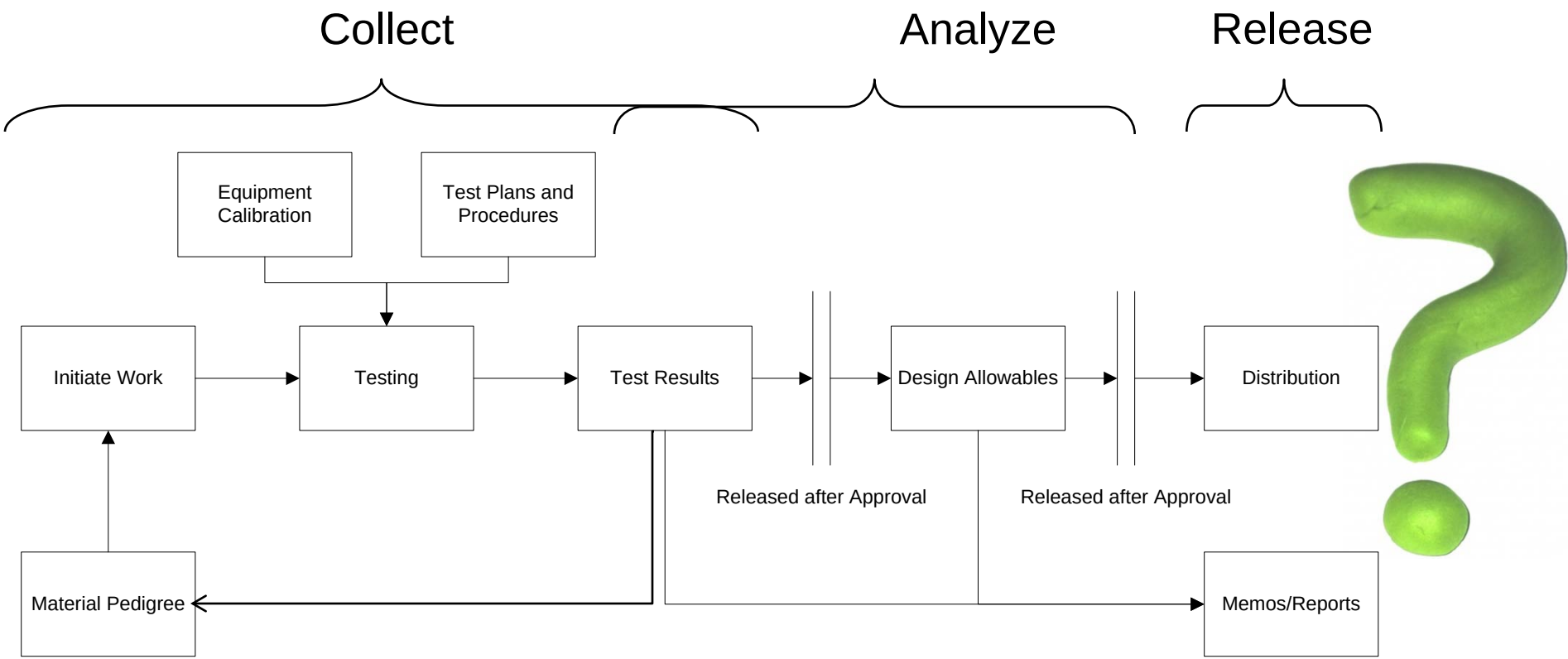
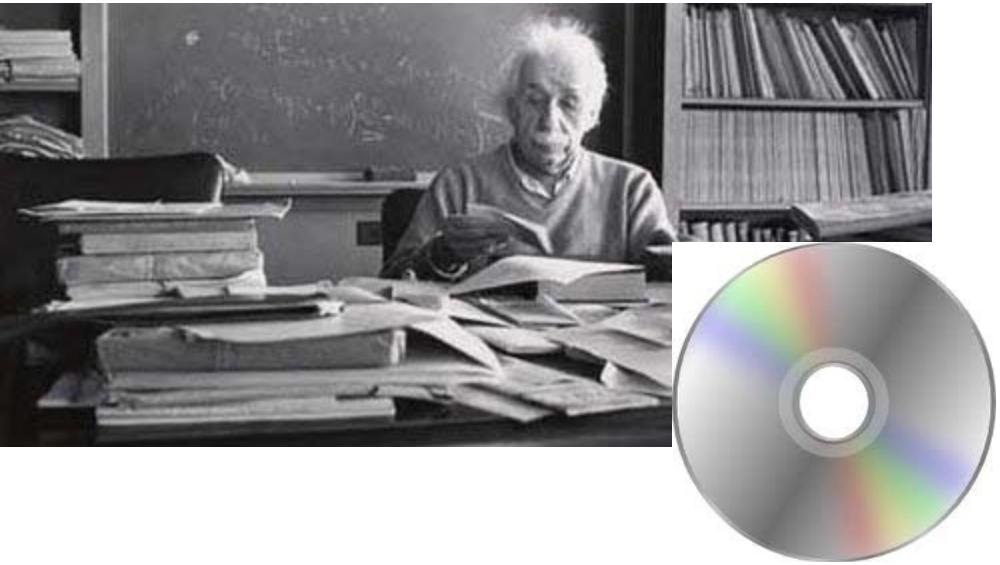
Dennis Griffin & Ben Henrie, NASA MSFC

Traditional Life of Materials & Process Information



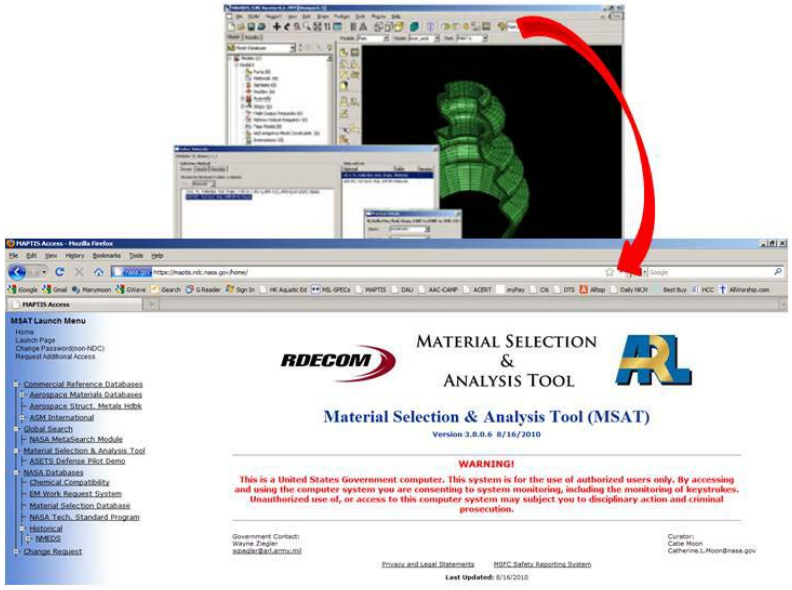
Includes both material property and process data

Materials & Process Information Management



FROM THIS

TO THIS



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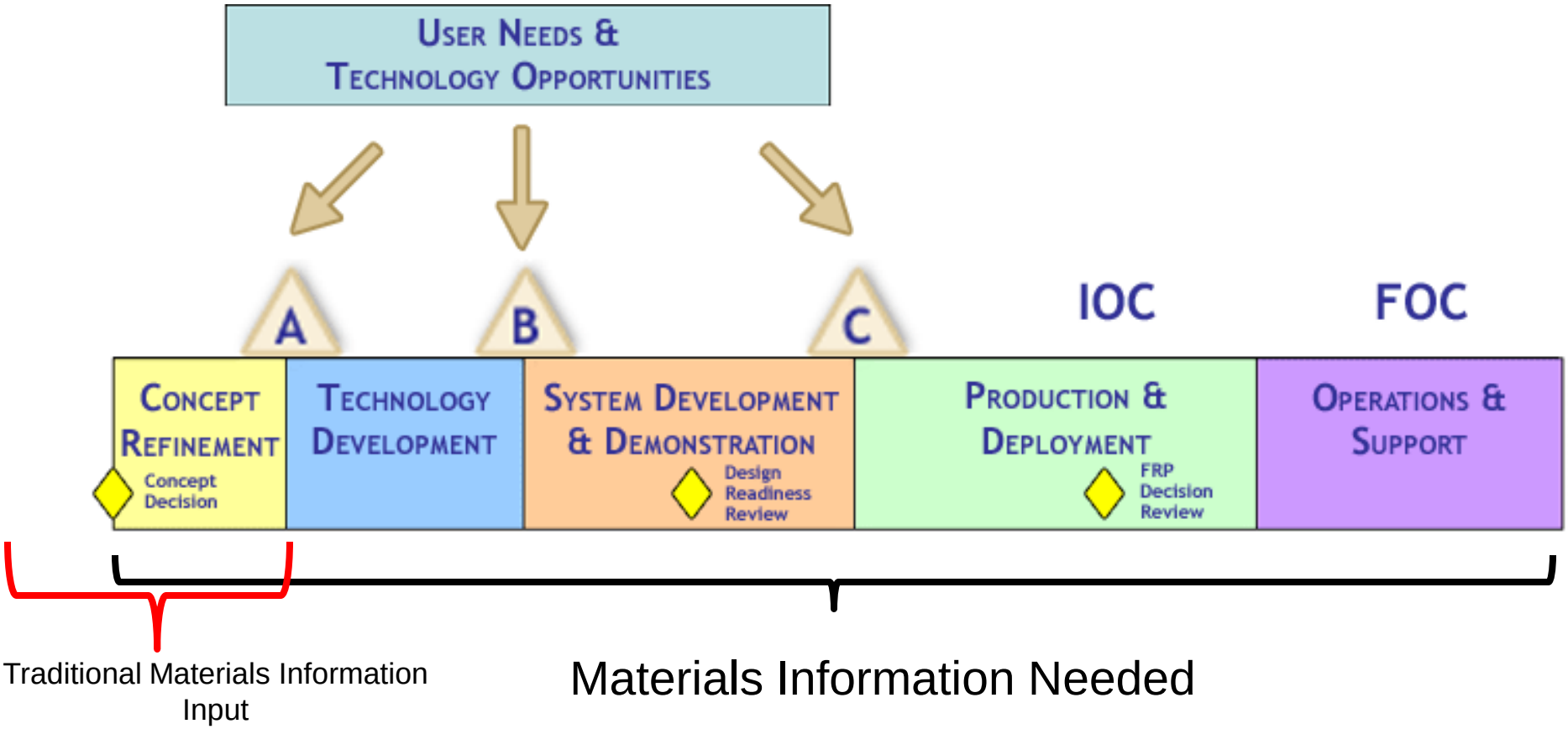
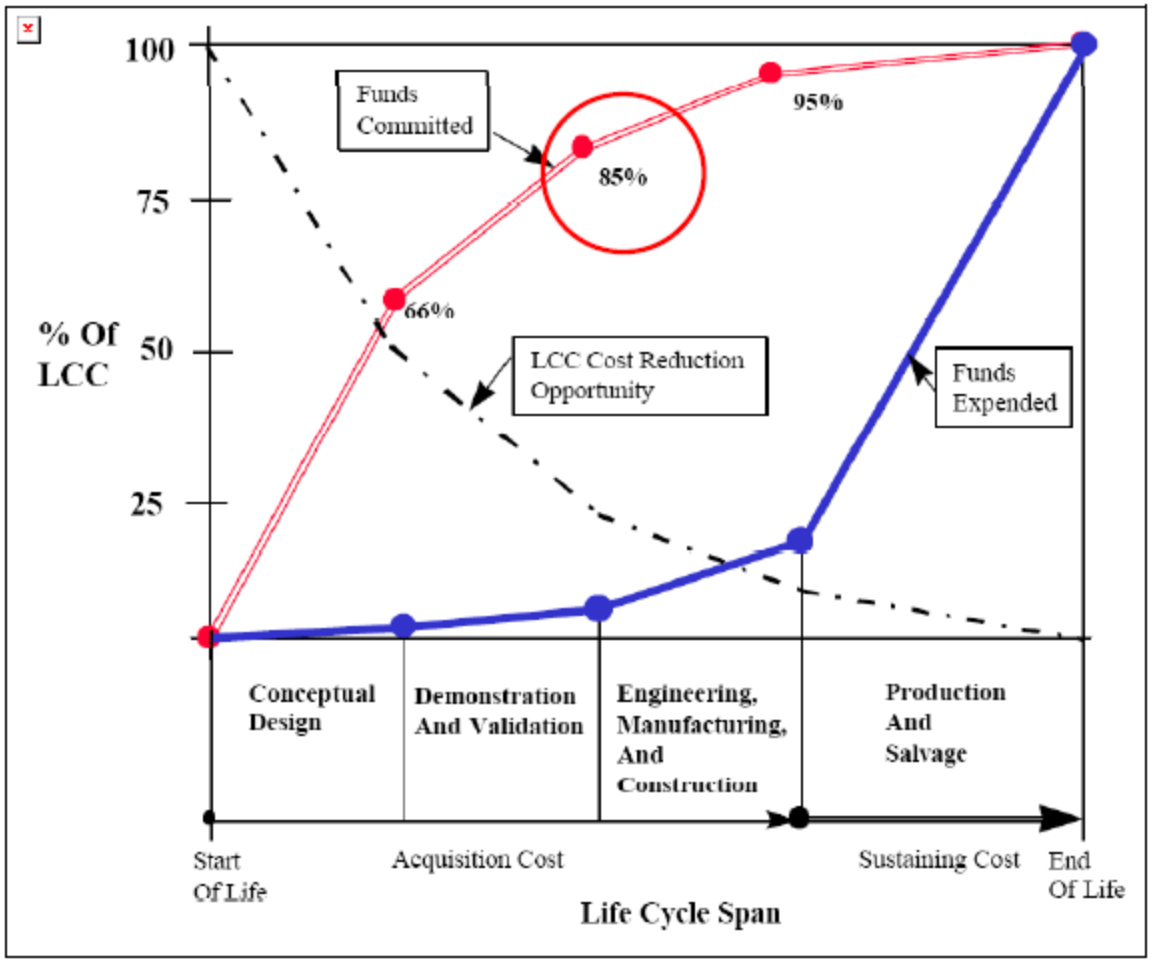
Materials & Process Information in the Acquisition Life Cycle



Impact of materials and process information on product lifecycle

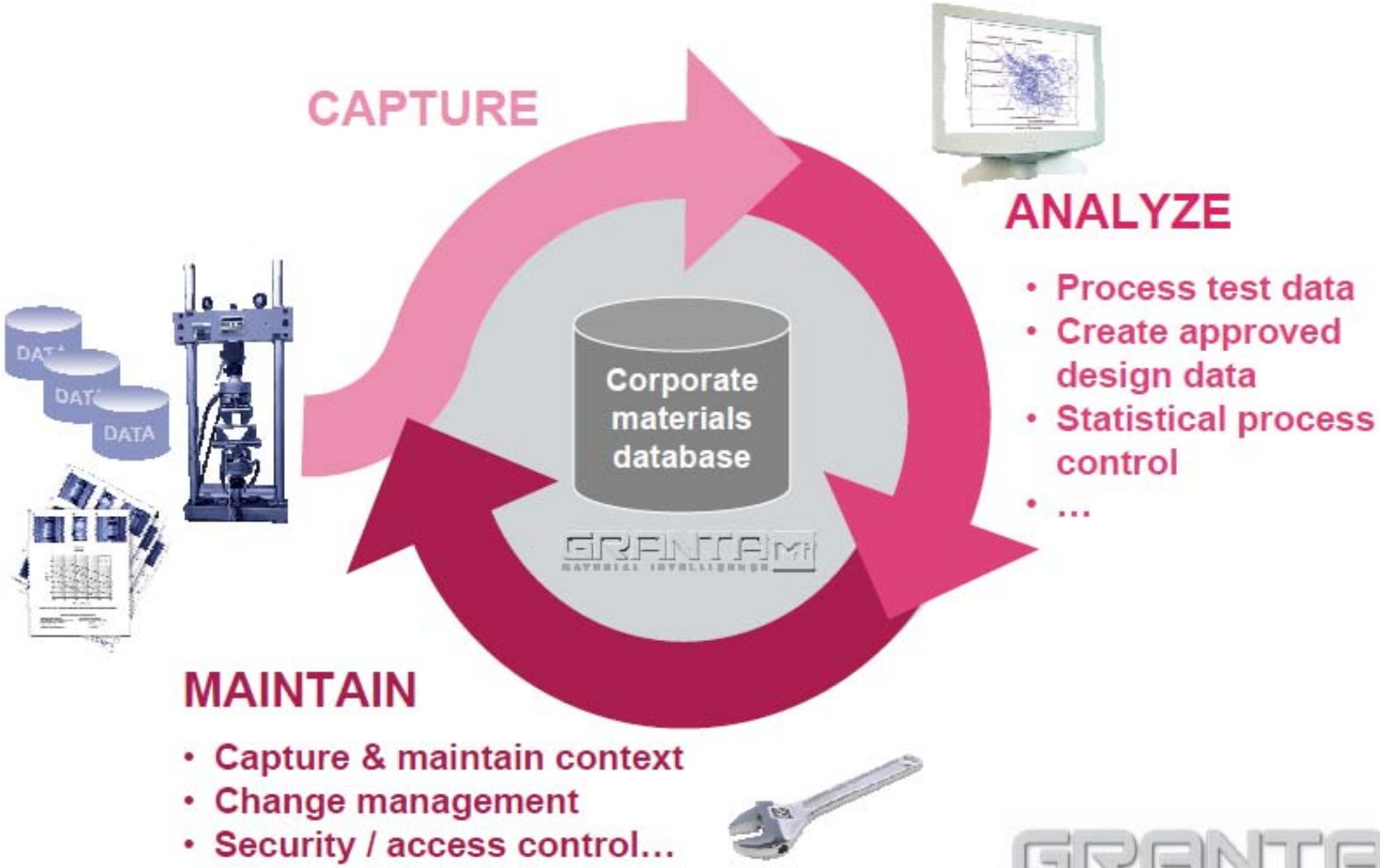


Project Funding Trends by Commitment and Expenditure of Lifecycle Cost (LCC))

85% of life cycle costs and environmental impact is built-into products during design

From: H. P. Barringer & D. P. Weber (1996) "Lifecycle Cost Tutorial"

Materials & Process Information Role in R & D



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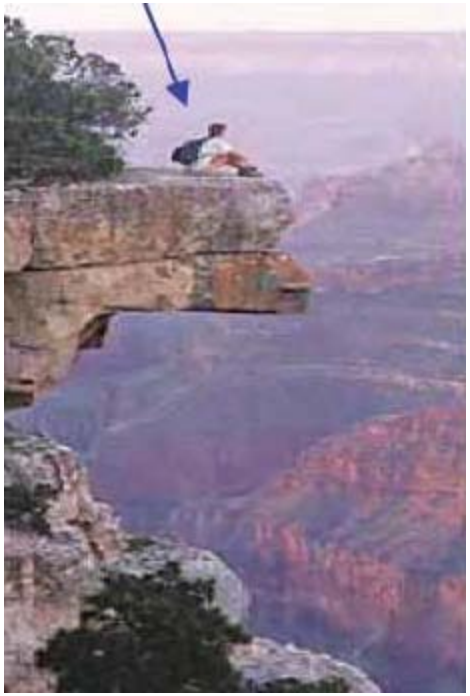
Technology Development

- Cycle times 7-30 Years
- Developed independent of application
- Empirical developments
- Modeling
- Multi-scale issues

"The Valley of Death"

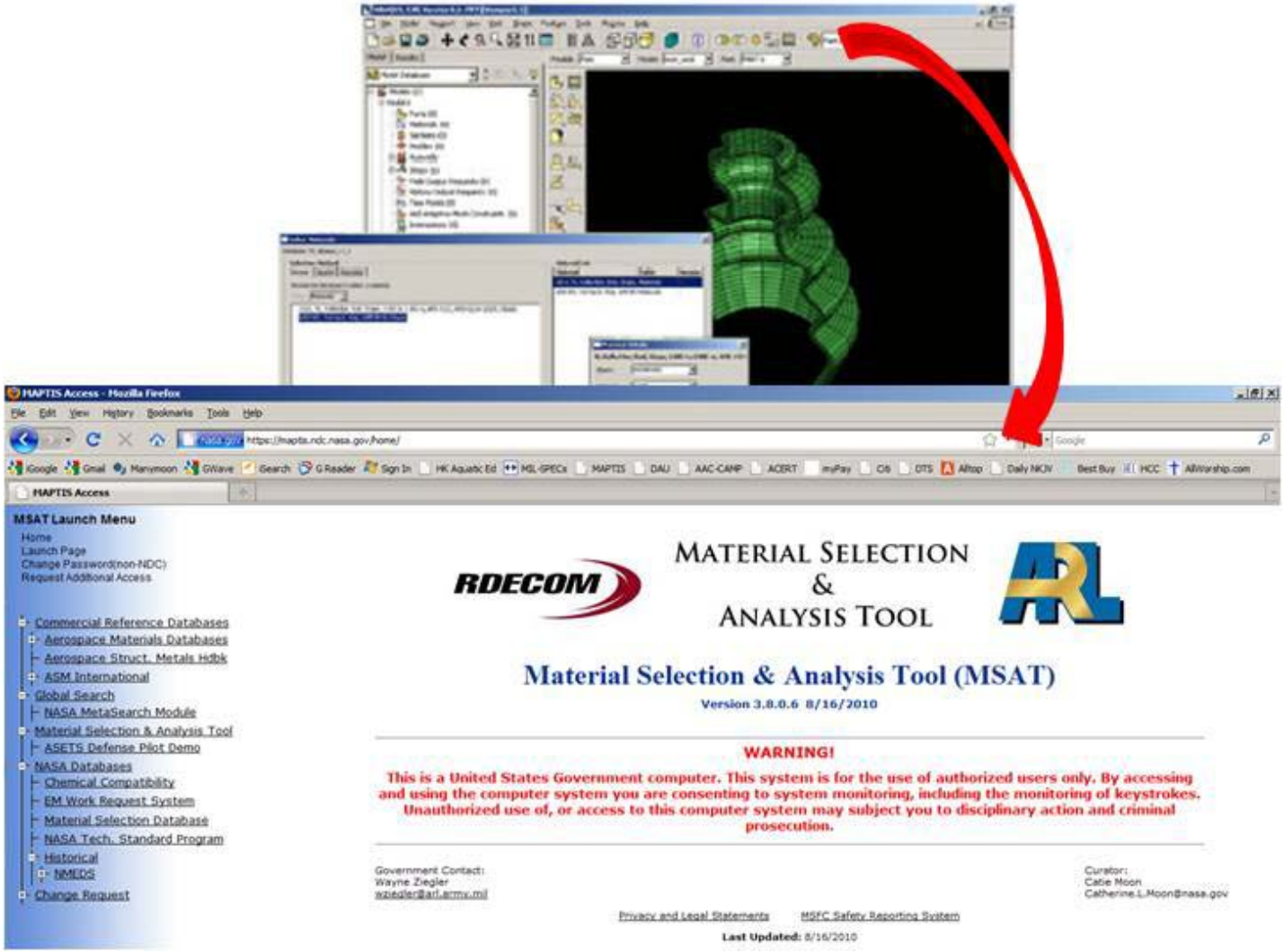


Engineering Design

- Cycle times 3-5 Years
- Requires confidence in materials system
- Risk Averse
- Modeling enables rapid developments in design

Use of New Materials & Processes only Occurs With Mitigation of Risk

Materials & Process Information Role in Design



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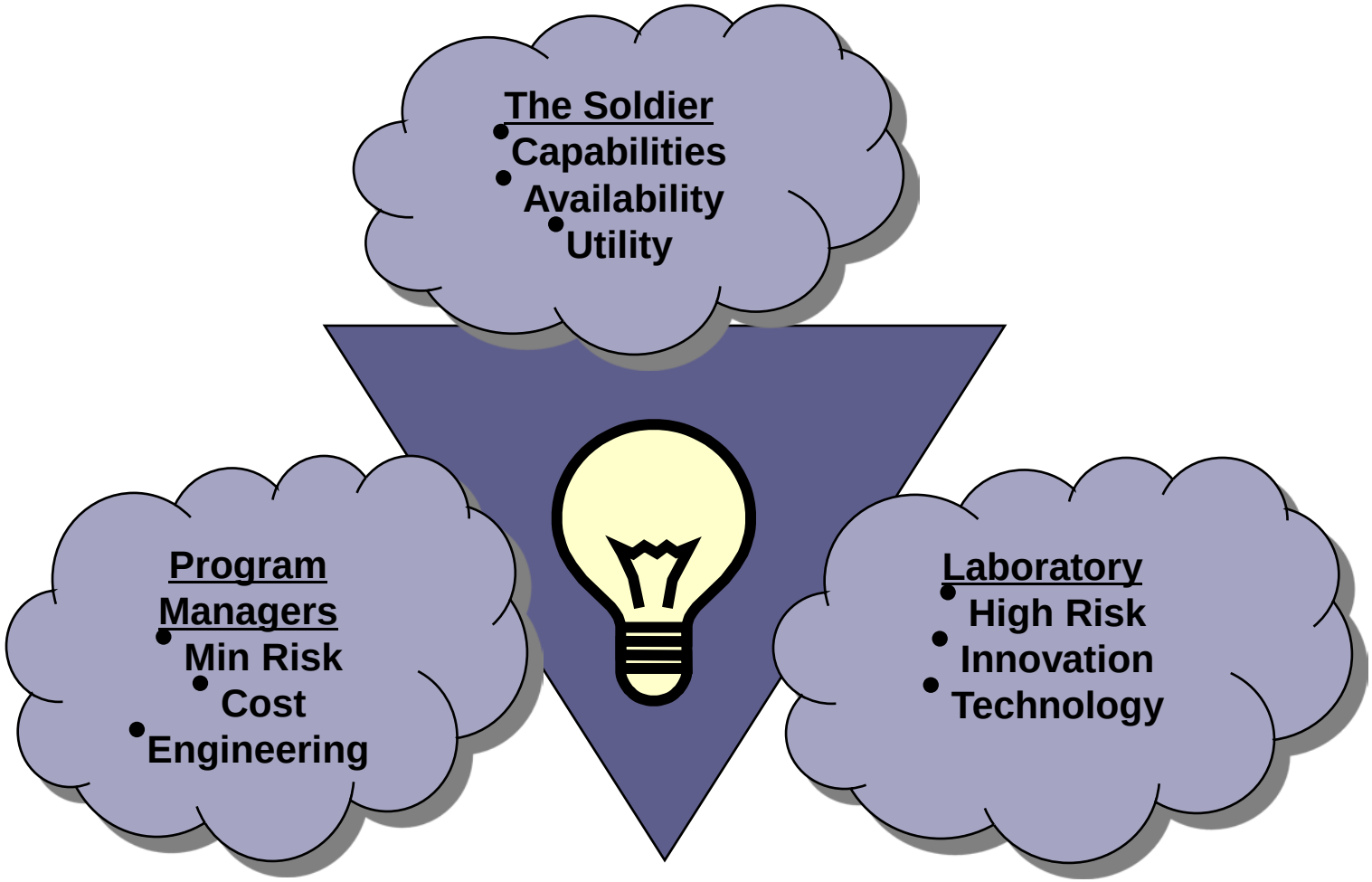
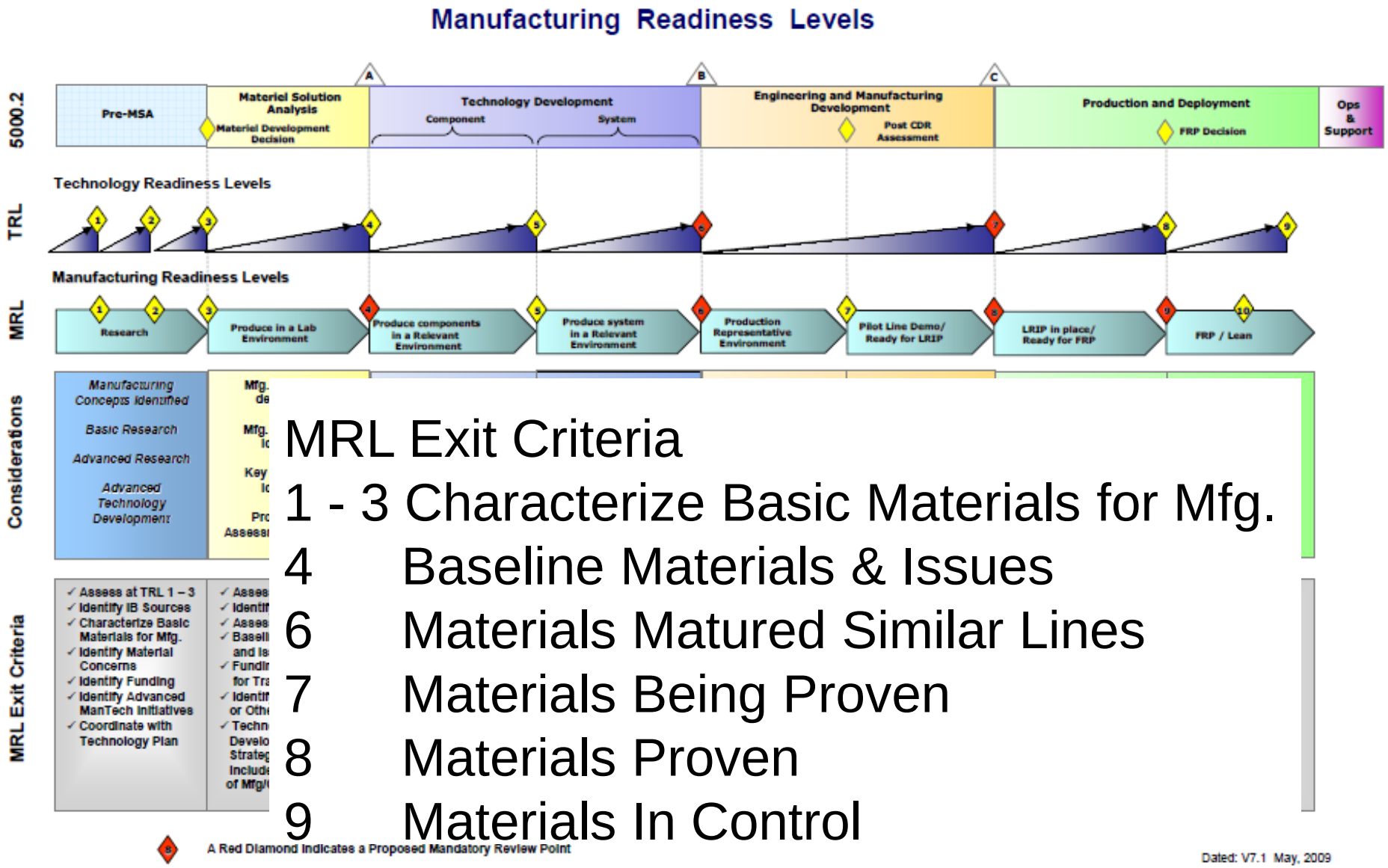
Helps to Resolve Differing, Sometimes Conflicting Perspectives/Values



Materials & Process Information Role in Acquisition Decision-making

- Supports milestone reviews
- Supports alternative selection for potentially restricted materials & process
- Supports economic and environmental assessments
- Enables evaluation of risk management strategies

Materials Impact on Manufacturing Readiness



MRL Exit Criteria

1 - 3 Characterize Basic Materials for Mfg.

4 Baseline Materials & Issues

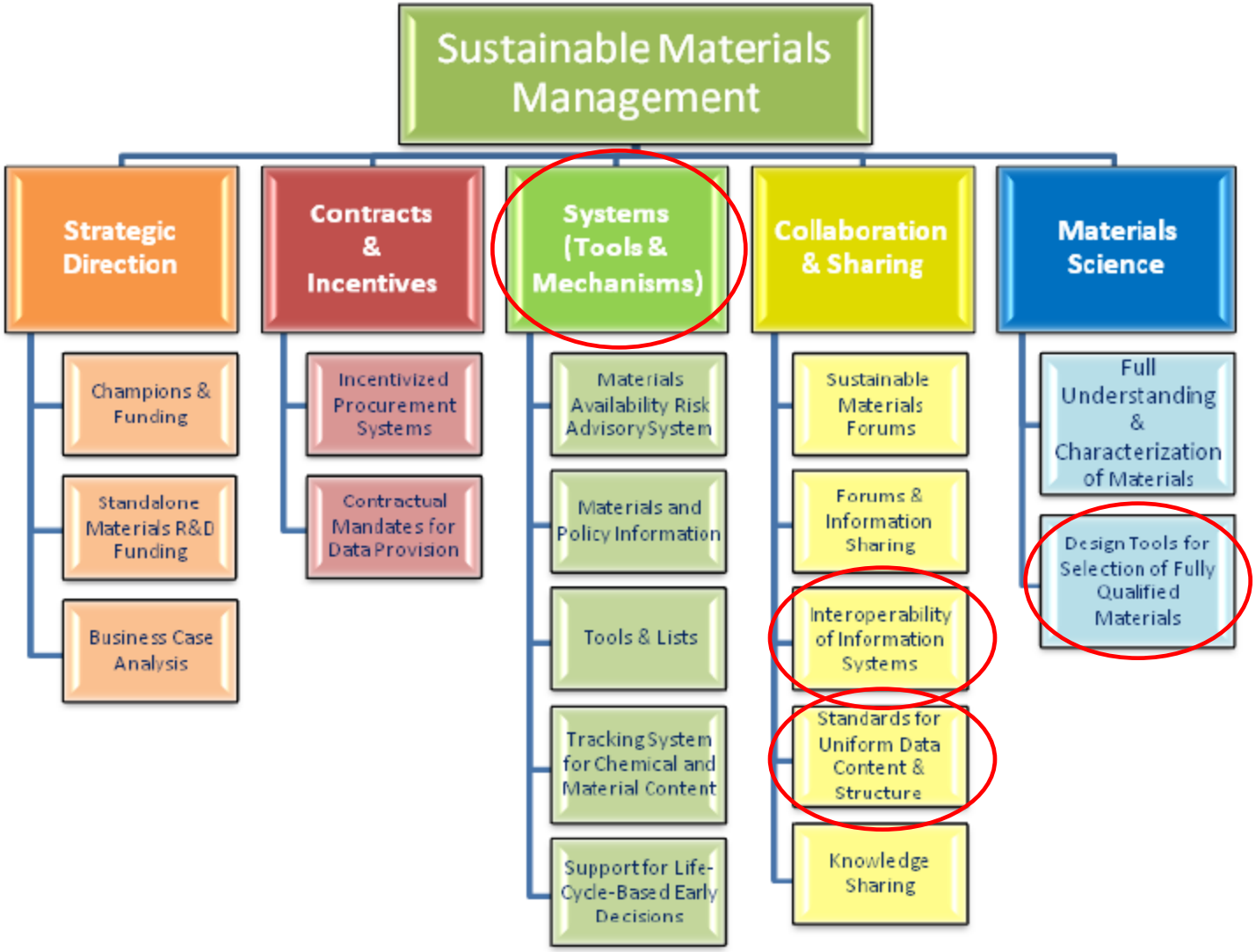
6 Materials Matured Similar Lines

7 Materials Being Proven

8 Materials Proven

9 Materials In Control

Materials & Process Information Role in Sustainment/O&M



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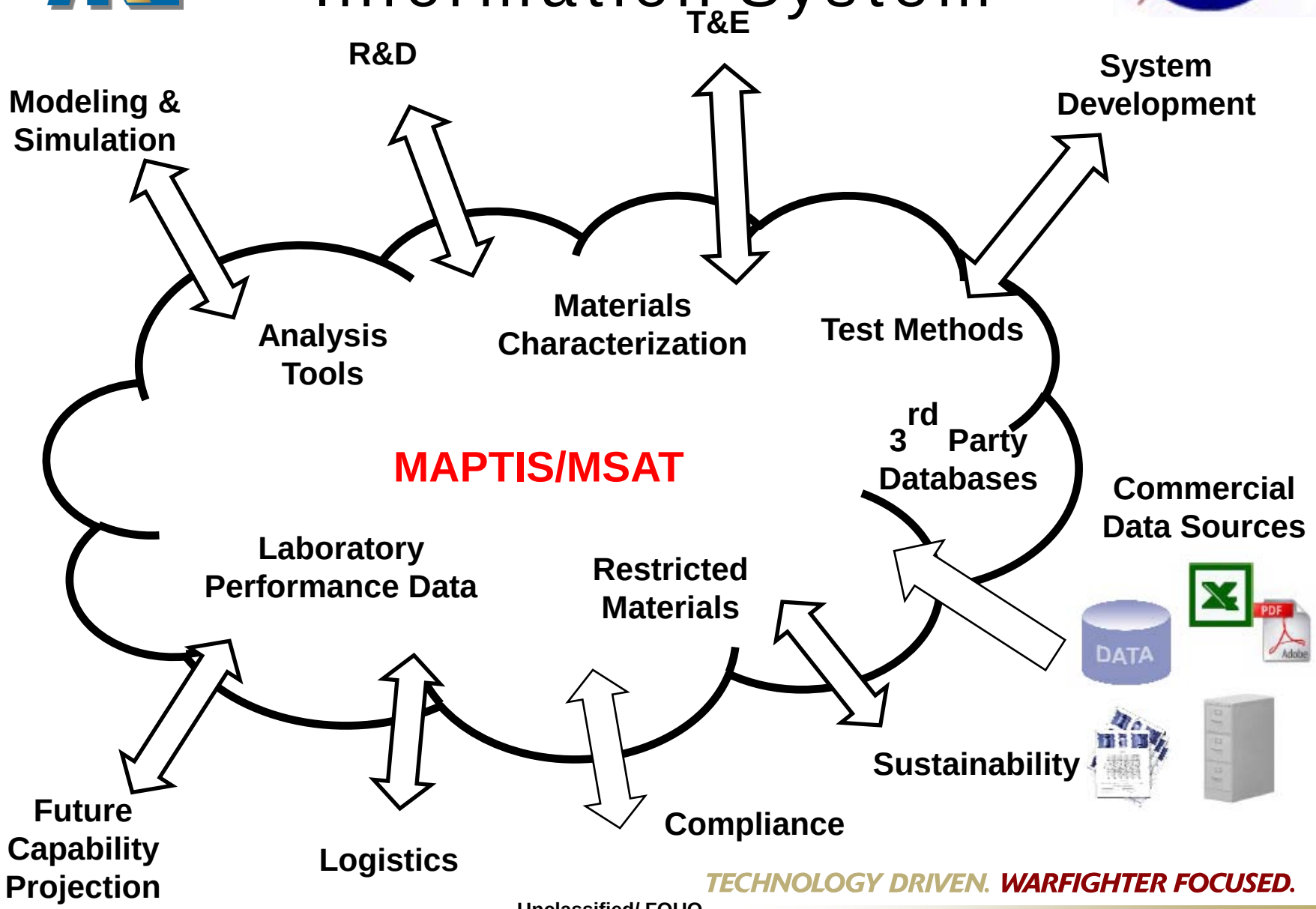
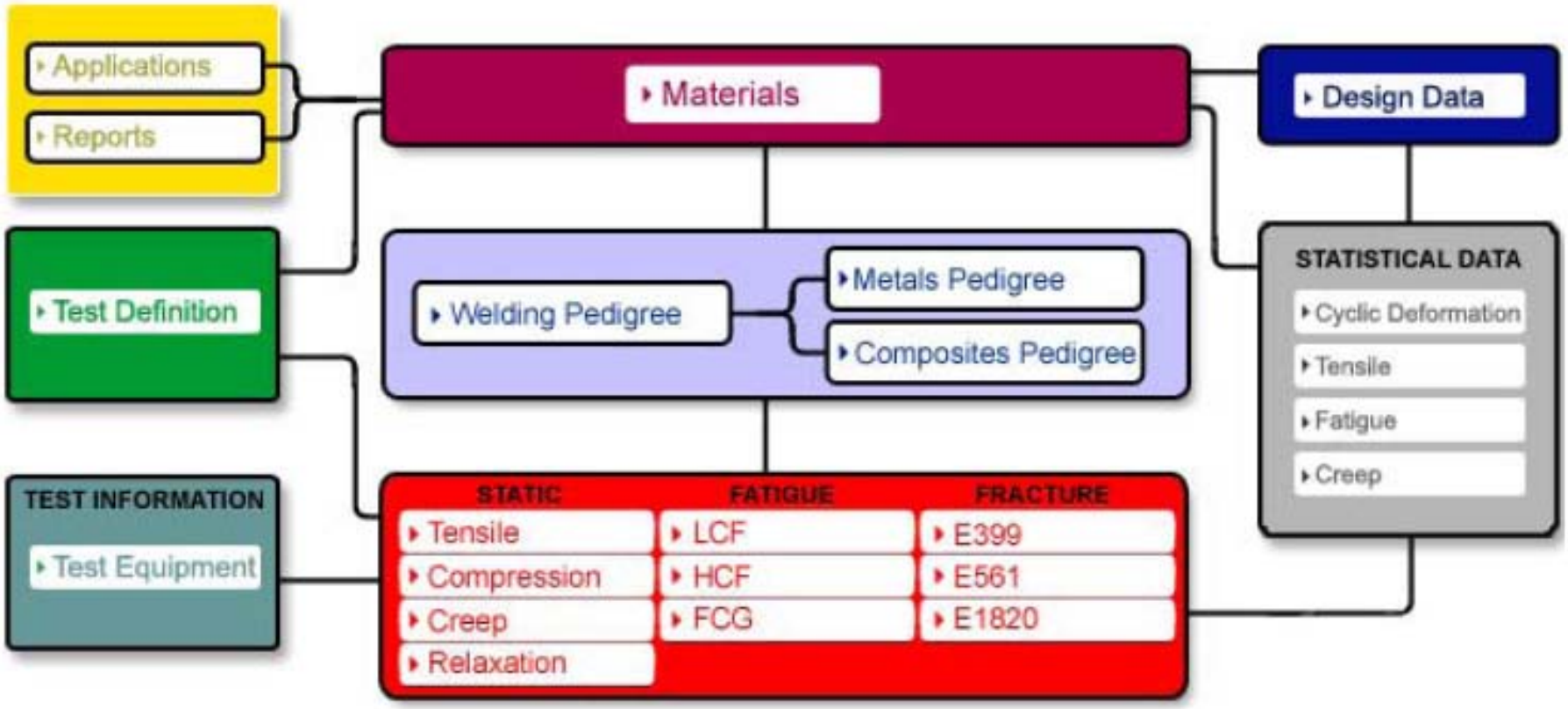
Materials & Process Information Role in O & M

- Supports alternative selection for restricted materials & process
- Tied to TDPs could answer, “Where is it used?”

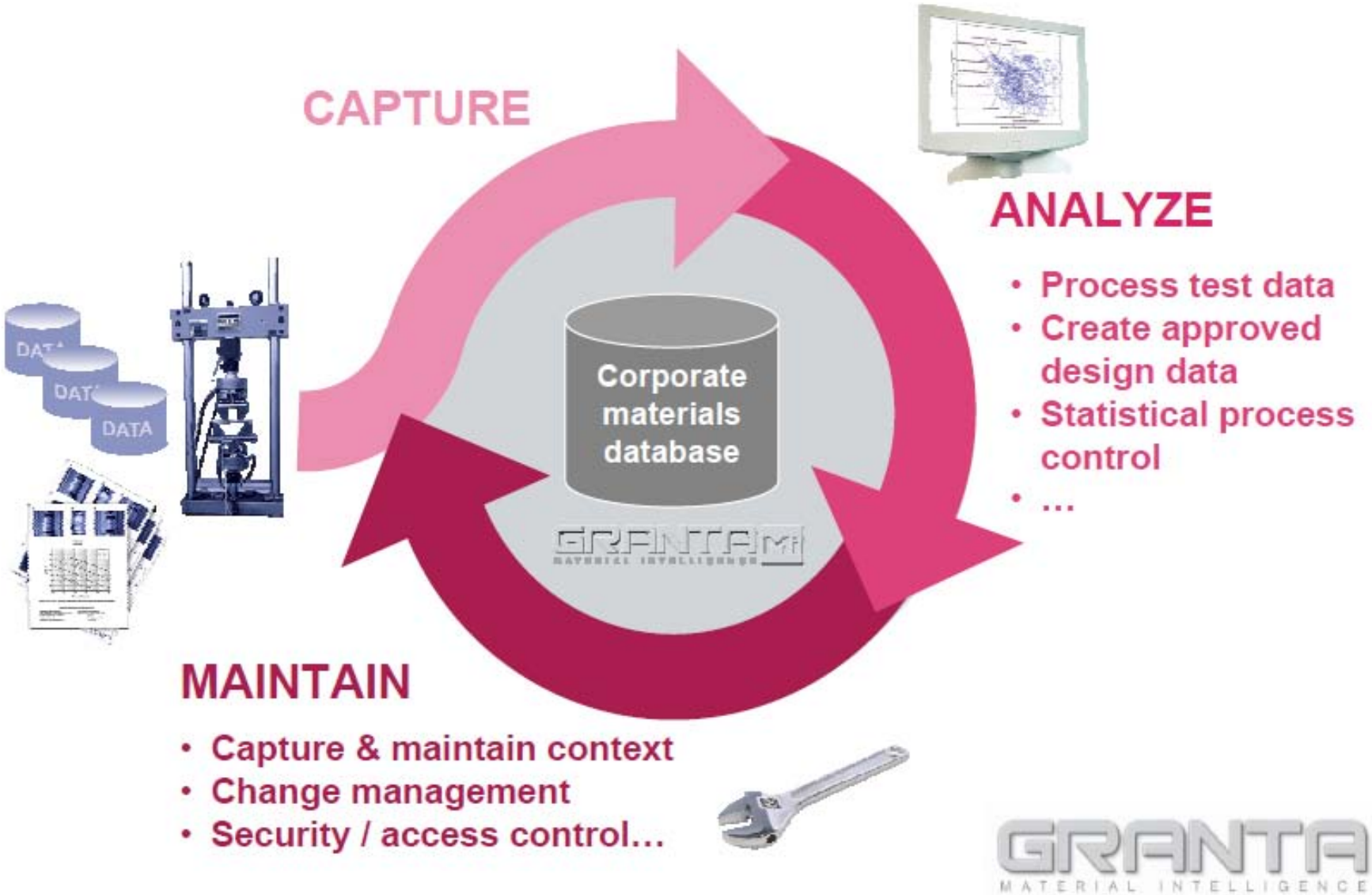
Solution – Distributed Information System



Get the Data Challenge: Information Flow



Manage the Data



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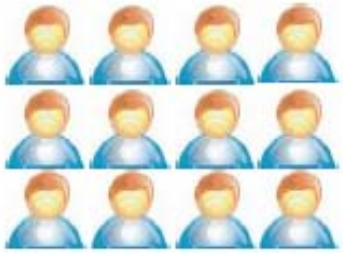
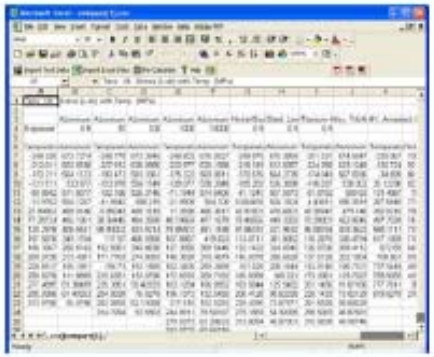
Distribute the Data

Ease of access
Web browser

Fit users' workflows
Plug-in, API



Scalable & robust



Desktop integration
Data to/from Excel

Secure & controlled

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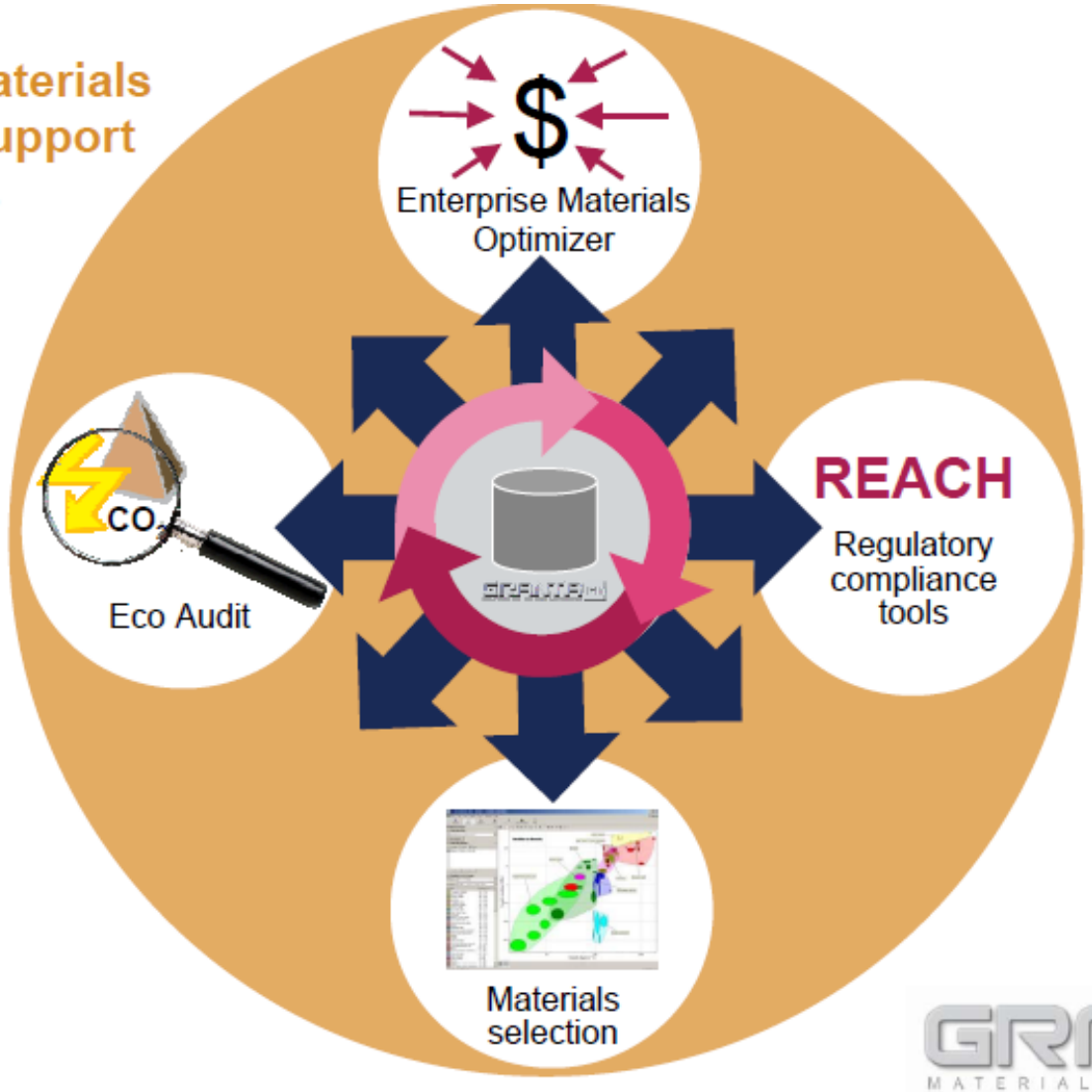
Use the Materials Information

Example materials decision support tools



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Vision

- Single source for Materials & Process Information
- Track data pedigree
- Customized interfaces & tools
- Track materials to components
- Target implementation strategies

Material and Processing Technology Information System (MAPTIS)

http://maptis.nasa.gov

Lab Lead Engineers Office

Materials & Processes Laboratory

MAPTIS

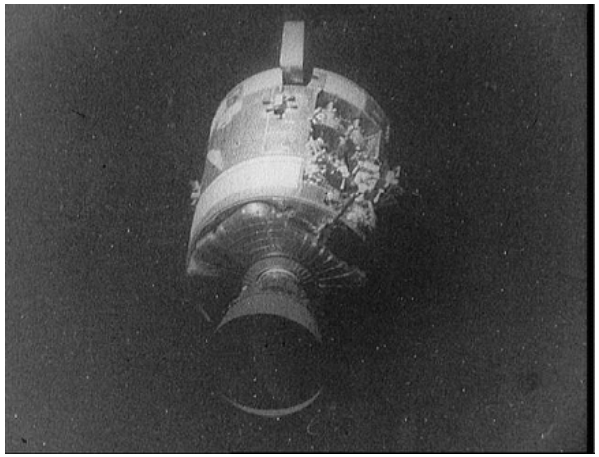
- MAPTIS, developed as a single point source for NASA, for the purpose of acquiring, archiving and disseminating materials information throughout a product life cycle

MAPTIS - History

- **While materials selection has always been an integral part of hardware design, the importance of selection of proper materials in space craft design took on greater importance after the Apollo I accident:**
  - **Finding: "An extensive distribution of combustible materials in the cabin." – *Report of Apollo 204 Review Board, Page 5-12***
  - **Recommendation: "The amount and location of combustible materials in the Command Module must be severely restricted and controlled." - *Report of Apollo 204 Review Board, Page 6-1***

MAPTIS - History

- Apollo13 Service Module LOX tank explosion in 1970 further emphasized need to strengthen materials selection and control Requirements



- Further emphases 1972 "Apollo Experience Report" said SCC most common cause of structural-materials failures in Apollo program

History

- After the Apollo I accident NASA started to look at material compatibilities by developing handbooks
- Several NASA handbooks were brought together into MAPTIS around 1986
  - First “query-able” version with user terminal access was on a VAX 8650
- Today, MAPTIS-II is a web accessible system
- MAPTIS is a central repository for material data for reliability and reusability

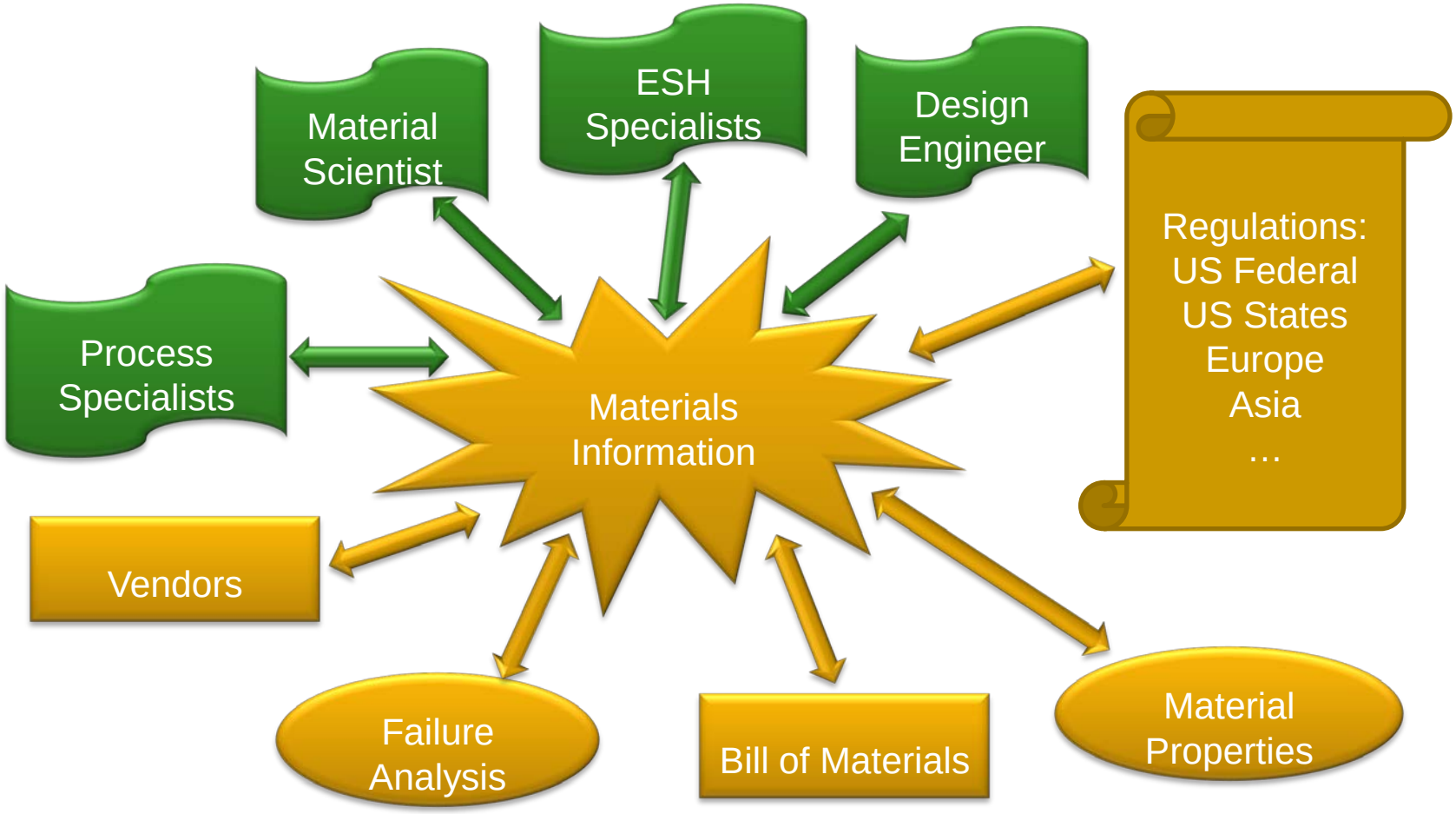
Current User Demographics

- **Current number of register users: 4300+**
- **Average users per month: 500+**
- **NASA Centers (61%)**
  - **Marshall, Ames, Glenn, JPL, Johnson, Kennedy, Langley, White Sands Test Facility**
- **Contractors/Universities (26%)**
  - **Example Contractors: Boeing, Lockheed Martin, Orbital, Ball Aerospace, Hamilton, Honeywell, Goodrich, Raytheon, SAIC**
  - **Example Universities: Texas A&M, University of Colorado, University of Alabama, UCLA, MIT**
- **Foreign Users (13%)**
  - **ESA, JAXA (Japan), Canadian Space Agency, Italian Space Agency, Russian Space Agency**

Features

- 30+ Databases
- Web Accessible
- 24 x 7 hour access
- Live support 7am to 5pm CST
- Search capability to query open material sources
- Flexible System configuration to adapt to our customer needs
- The MAPTIS team provides all IT support along with materials expertise

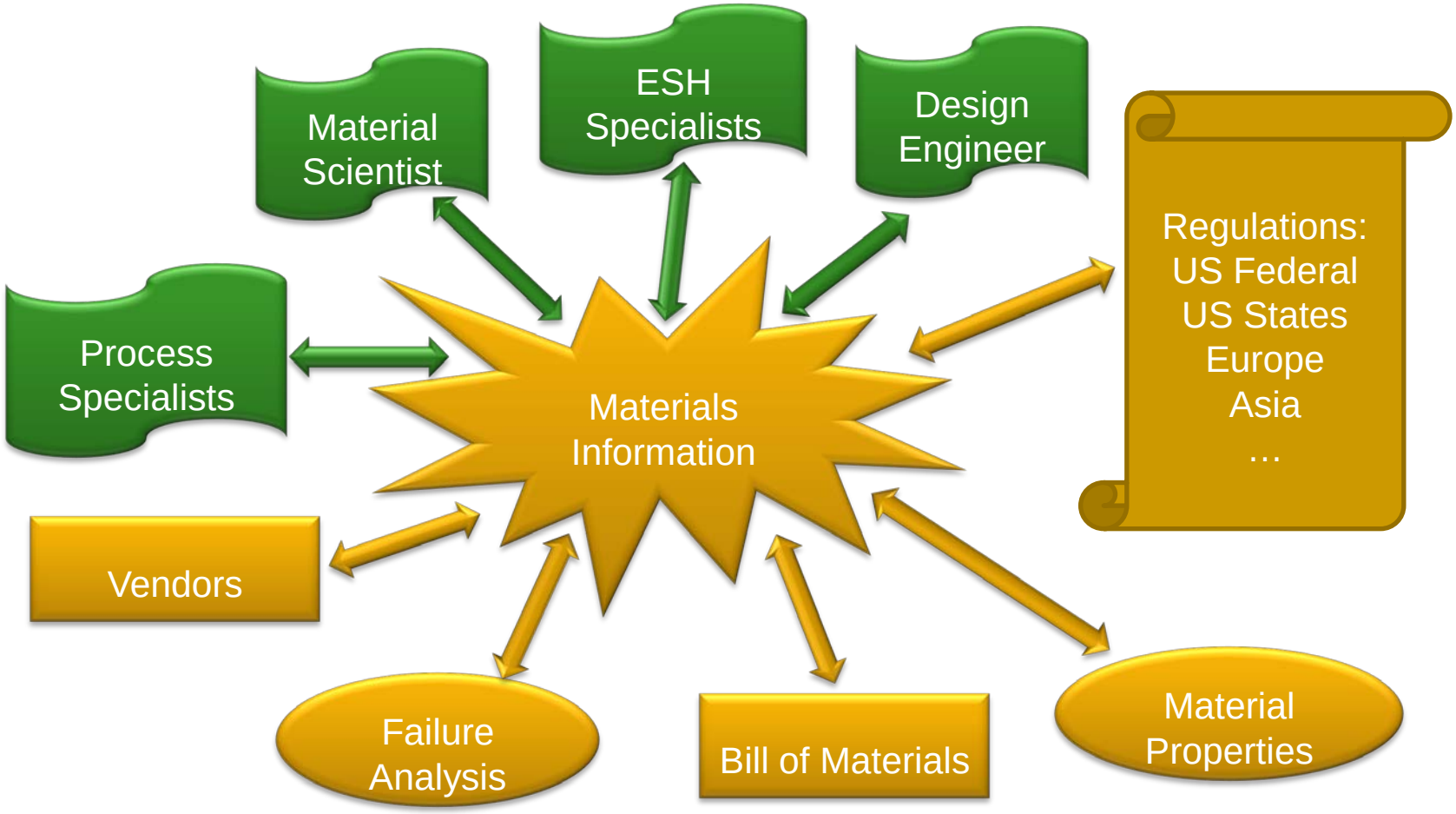
MAPTIS


Material Scientist
ESH Specialists
Design Engineer
Process Specialists
Materials Information
Regulations:
US Federal
US States
Europe
Asia
…
Vendors
Failure Analysis
Bill of Materials
Material Properties

MAPTIS Material Data

- Internal Material Data
  - Test Data is collected from Marshal Space Flight Center, Goddard Space Flight Center, White Sands, Johnson Space Center, Kennedy Space Center, and others
- Internal Material Related Information
- Special Projects
- Commercial Material Data

MAPTIS


Material Scientist
ESH Specialists
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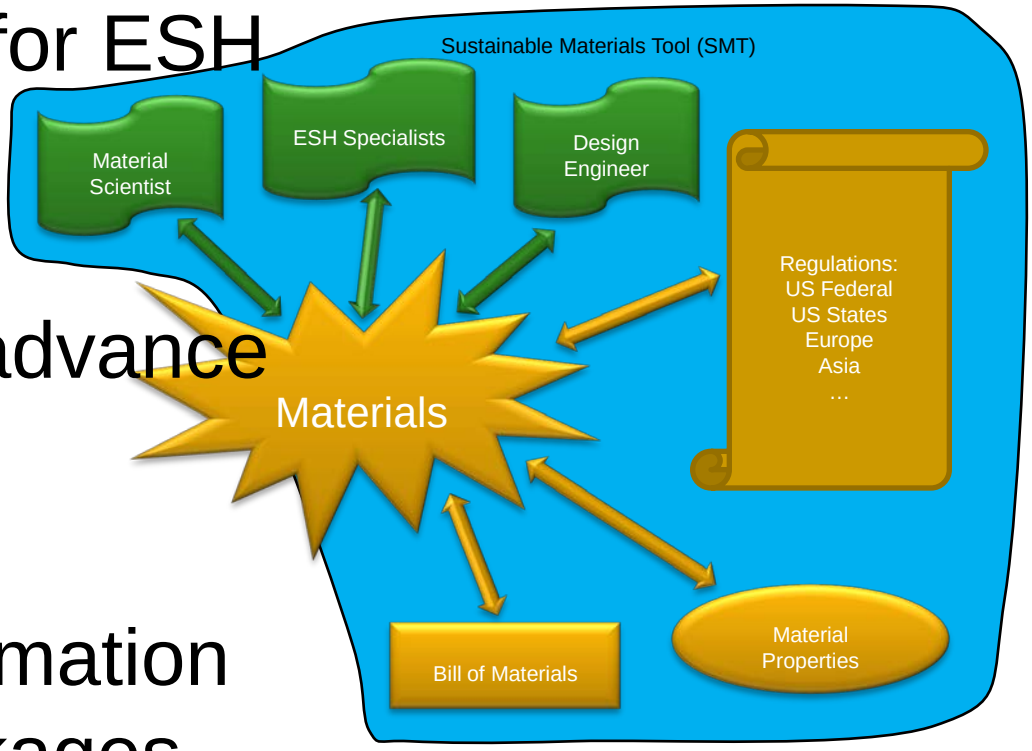
…
Vendors
Failure Analysis
Bill of Materials
Material Properties

Sustainable Materials Tool (SMT)

- Expand Regulations (Domestic & Foreign)
- Improve integration for ESH specialists
- Integrate ESH considerations into advance M&P technology development
- Access to ESH information from CAD/PLM packages

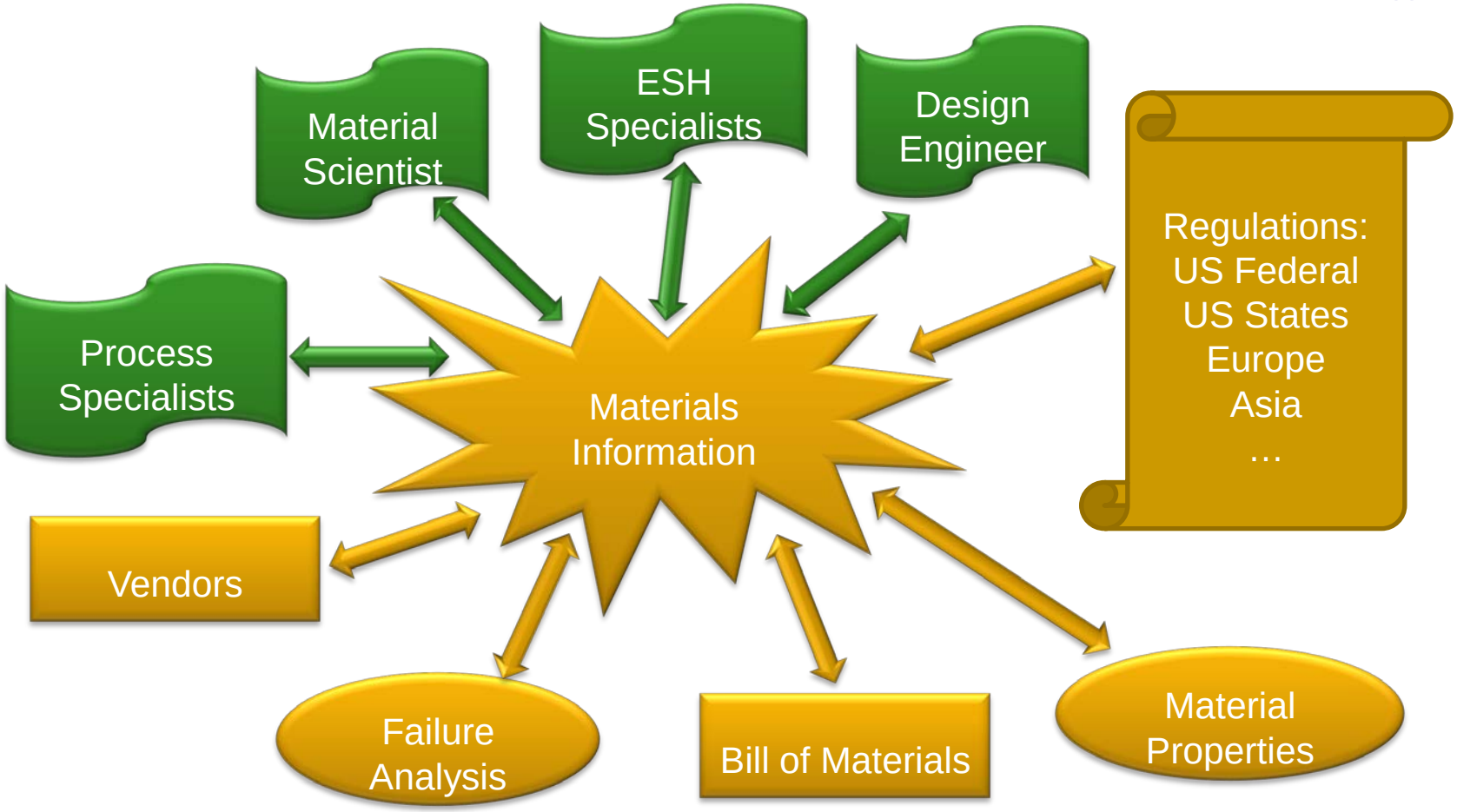


SMT is a 2 year project

SMT

- Enable NASA to minimize the back-end costs of mitigation, changes and retrofits, and hazardous waste disposal associated with the risk of incorrect material selection
- Capability to address institutional risks to mission from material obsolescence, regulatory compliance, disposal costs and environmental liabilities as characterized in Active Risk Management (ARM) #1617

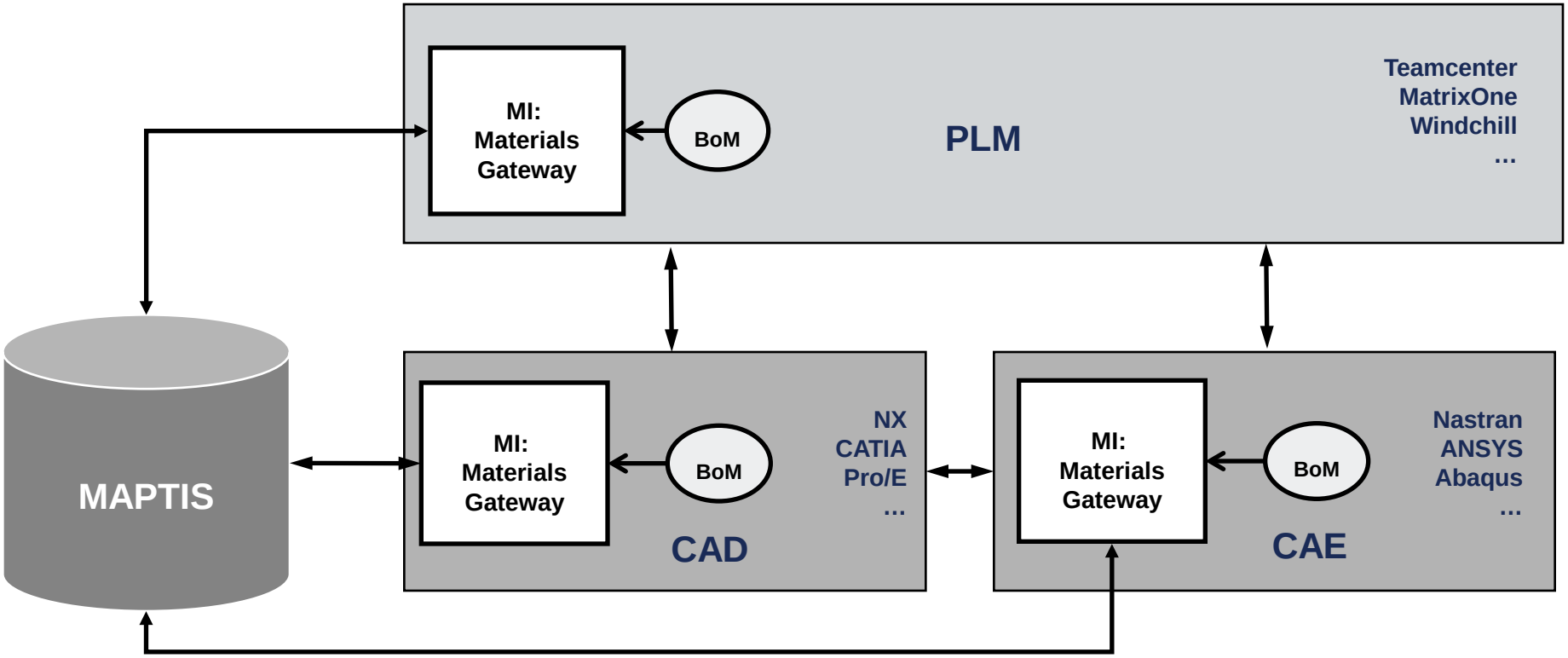
Advance ESH Evaluation



Enable ESH considerations during the materials development or design phase, <u>not after the fact</u>

Interactive access using Gateway “Plug-Ins”

- Manages product structure and lifecycle
- Focus on materials used directly in products



- Manages lifecycle and information on all materials

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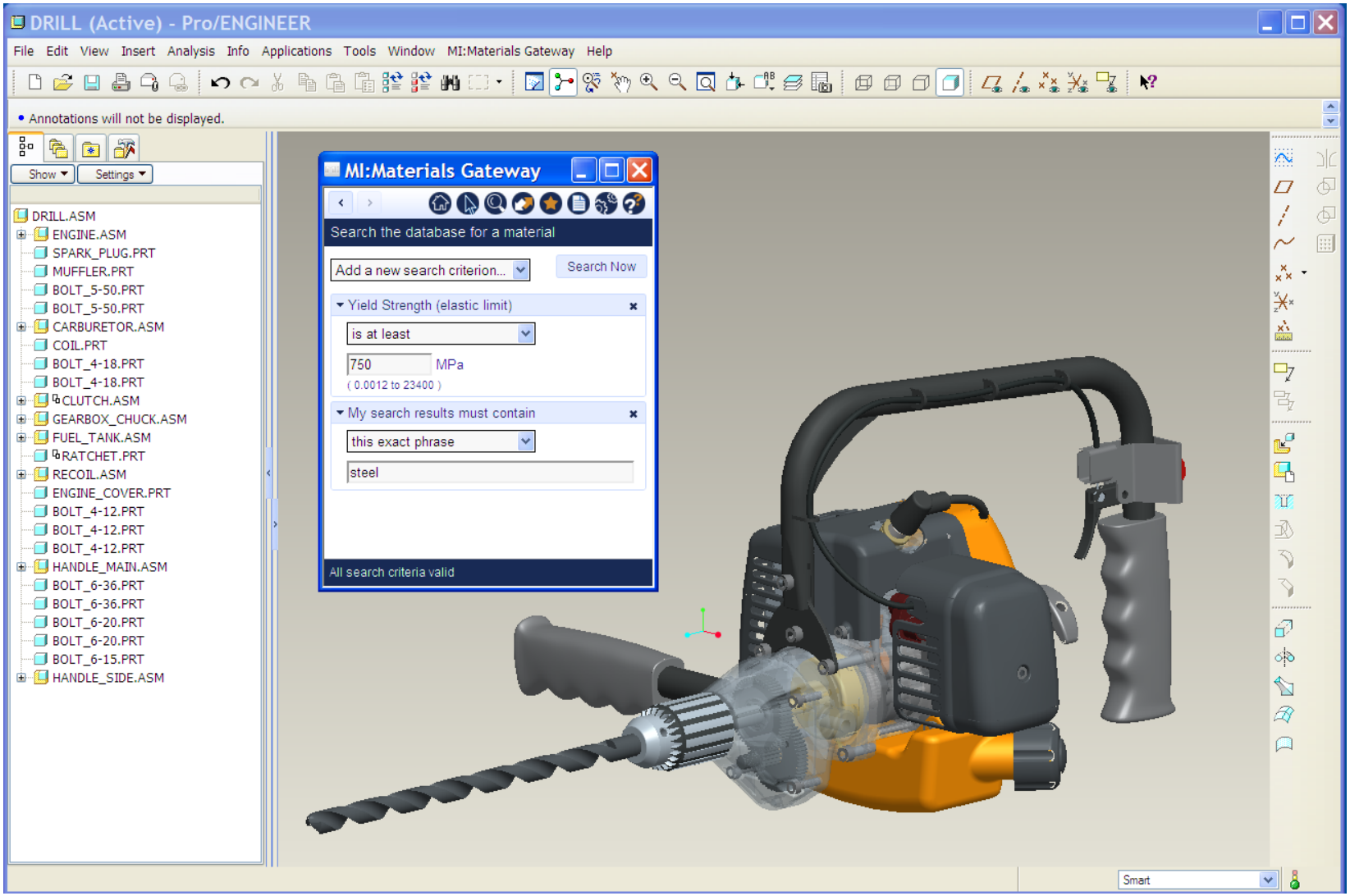
Materials selection in CAD



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Reporting to guide materials selection

In this case guiding eco-design

Pulling data from CAD BoM (part volumes) and from materials system

MI:Materials Gateway

Sustainability Report

Item	Count	Mass (kg)	Material Price (USD)	CO2 Footprint (kg)	Embodied Energy (MJ)	Recyc
– CAM_FOLLOWER	1	0.592	17.45	10.1	161	
– BASE	1	0.425	0.28	0.920	10.9	
● Carbon steel, AISI 1080 (annea…		0.425	0.28	0.920	10.9	✔
– FOLLOWER	1	0.0523	15.36	8.35	134	
– FOLLOWER	1	0.0314	15.30	8.27	131	
● AlBeMet 162		0.0314	15.30	8.27	131	✔
– ROLLER	1	0.0209	0.06	0.0806	2.15	
● ABS (Flame Retarded, Mold…		0.0209	0.06	0.0806	2.15	✔
– CAM	1	0.114	1.81	0.809	16.9	
● PTFE (Unfilled)		0.114	1.81	0.809	16.9	✔

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Project Intergration

UGS Teamcenter

Back · Granta MI

Getting Started | My Teamcenter | *PSE | Granta MI

hter Item ID to Search

Quick Links Customize
- Home
- My Worklist
- My Saved Searches
- My Links

Open Items

History
- A1200/A;1-Rear Assy

- Getting Started
- My Teamcenter
- PSE
- Schedule Manager
- CAE SE
- Validation
- Granta MI
- StructureMap Builder

Granta MI integration for **Teamcenter**

REACH Report

Product structure with materials information

: A1200/A;1-Rear Assy (view) x 1		
: A1100-I/A;1-Wheel Attachment Assy, left (view) x 1		
: A1020-I/A;1-Wheel Assy, left (view) x 1		
: 4851-2/A;1-U-joint x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 4853/A;1-Stub axle x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 2754/A;1-Stub axle pin x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 4354-I/A;1-Stub axle carrier, left x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 5116/A;1-Ball bearing, 5x11x4 x 1	Low alloy steel, AISI 9310 (normalised)	Unregulated
: 1654-1/A;1-Wheel hub x 1		
: 4872/A;1-Wheel x 1	Cast magnesium alloy (AM50)	Unregulated
: 4873-I/A;1-Tyre, left x 1	Nitrile Rubber (NBR)	Regulated
: 1747X/A;1-Nut, 4 x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: A1030/A;1-Upper Camber Rod Assy (view) x 1		
: 2742X-1/A;1-Rod end x 1	Low alloy steel, AISI 4037 (tempered @ 205 C, oil quenched)	Unregulated
: 4841-1/A;1-Upper camber rod x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 2553/A;1-Screw, 3x15 CS M (HD) x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 2742X-2/A;1-Hollow ball x 1	Low alloy steel, AISI 9310 (normalised)	Unregulated
: 4850-I/A;1-Suspension arm, rear, left x 1	Epoxy SMC (Carbon Fibre)	To be phased out
: 4838-2/A;1-Suspension screw, 3x40 x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 4838-1/A;1-Suspension screw, 3x26 x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 4260/A;1-Shock Absorber Assy (view) x 1		
: 3767-1/A;1-Shock Cap x 1	Carbon steel, AISI 1015 (normalised)	Unregulated
: 1765/A;1-Silicone diaphragm x 1	Eccosil 4122 (SIL) - Silicone Elastomer	Unregulated
: 3768-2/A;1-Piston head 2-hole (view) x 1	Wrought aluminium alloy, 2519, T87	Unregulated
: 4262T/A;1-Shock shaft x 1	Low alloy steel, AISI 9310 (normalised)	Unregulated
: 3764A/A;1-Body, Ultra Shock x 1	Carbon steel, AISI 1015 (normalised)	Unregulated
: 3769/A;1-Spring pre-load spacer x 1	Low alloy steel, AISI 9310 (normalised)	Unregulated
: 3768-1-1/A;1-Spring retainer, upper (view) x 1	Low alloy steel, AISI 9310 (normalised)	Unregulated
: 2362/A;1-Shock washers x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 3767-2/A;1-Shock bottom x 1	Carbon steel, AISI 1015 (normalised)	Unregulated
: 4267/A;1-Spring x 1	Low alloy steel, AISI 9255 (annealed)	Unregulated
: 2362/A;1-Shock washers x 1	Low alloy steel, AISI 3140 (normalised)	Unregulated
: 3768-1-2/A;1-Spring retainer, lower x 1	Low alloy steel, AISI 9310 (normalised)	Unregulated
: 1942-1/A;1-Rod end x 1	Low alloy steel, AISI 4037 (tempered @ 205 C, oil quenched)	Unregulated

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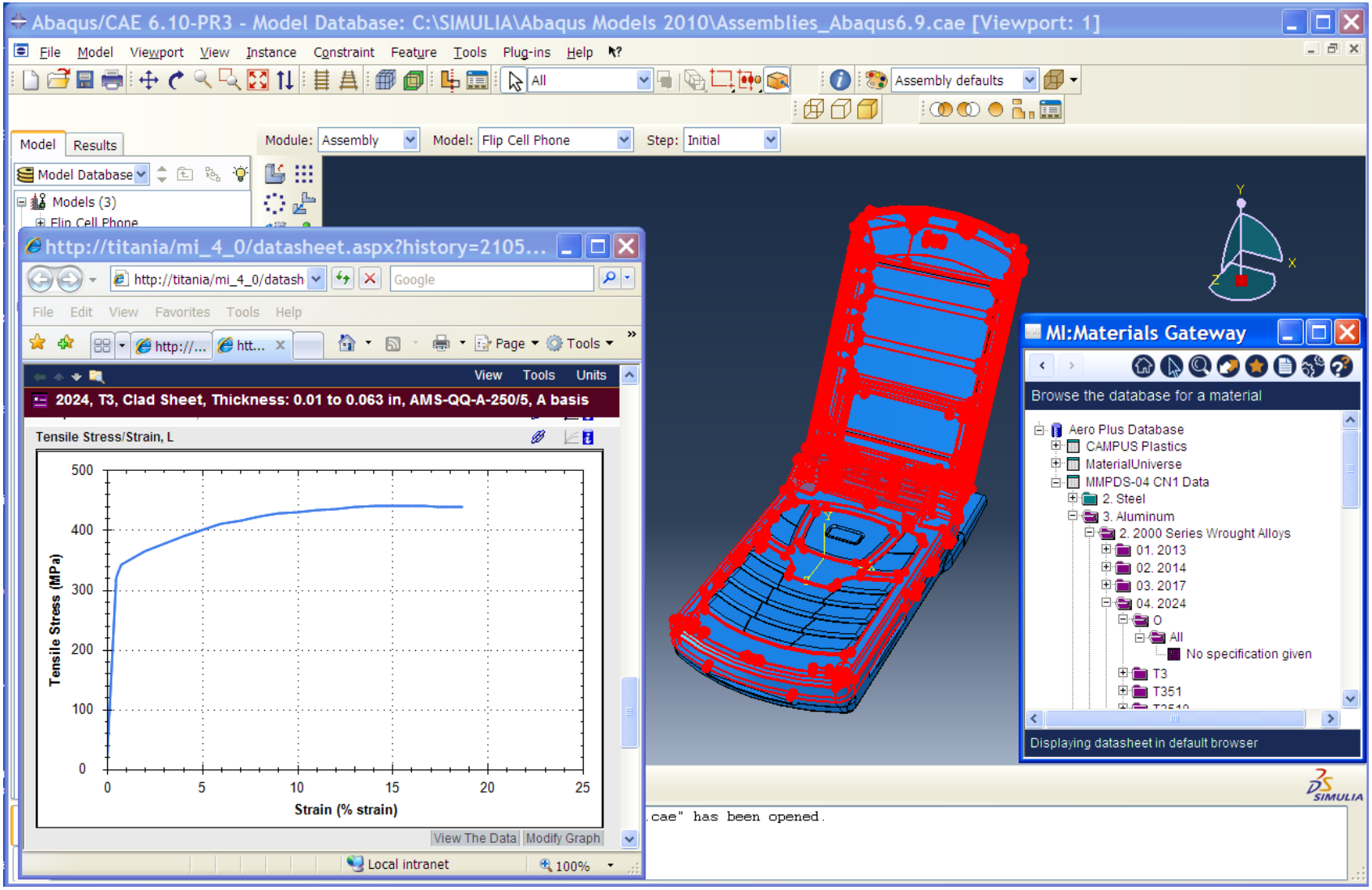
Materials model application in CAE



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Summary

- MAPTIS success has resulted in many data systems/tools that need to be integrated
- MAPTIS goal is to improve the intuitive user experience, reduce efforts, and eliminate redundancy
- Consistent data management system with common data connectivity will improve data quality and accessibility

Vision

- What to use?
- What is it?
- What is the impact?
- Where is it?
- What are RMOs?