26th annual INCOSE international symposium
Edinburgh, UK
July 18 - 21, 2016

Using Visual Diagrams and Patterns for Consistent and Complete Requirements

David Lempia (Rockwell Collins (RC)), Bill Schindel (President ICTT Systems Sciences), Terry Hrabik (RC), Stewart McGill (RC), Mike Graber (RC)





Have you ever:

1. Misunderstood a requirement?
2. Struggled to know what goes in a good requirement?
3. Wondered if you have all of the requirements you need?

Review of Historical Practices and Literature

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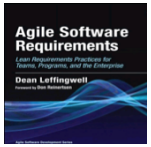
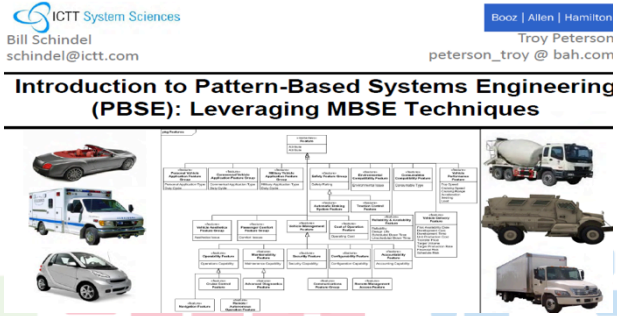
Literature

- Four Variable Model (Parnas and Madey 1991)
- Traditional Requirements - (Ivy Hooks 1993)
- Problem Frames (Jackson 2000)

- Agile Requirements (Leffingwell 2011)

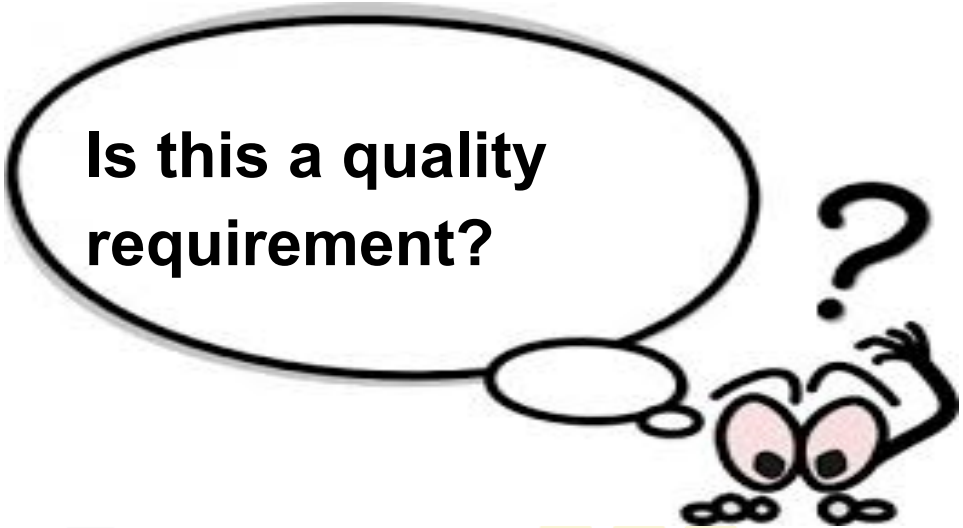


- Textual Requirements Grammatical Patterns (Carson 2015)
- An S*Model is any MBSE model that satisfies the S*Metamodel, S*Pattern is an S*Model of a system family (product line, platform) (Peterson and Schindel 2013; Schindel 2011)



Requirements

The Rover shall Calculate Commanded_Motor_Speed in <= 10ms after receiving Steering_Command and Throttle_Command while in the Operating state.



Writing Good Requirements

(A Requirements Working Group Information Report)

Ivy Hooks
Compliance Automation, Inc.
17629 Camino Real, Suite 207
Houston, Texas 77058

System Context

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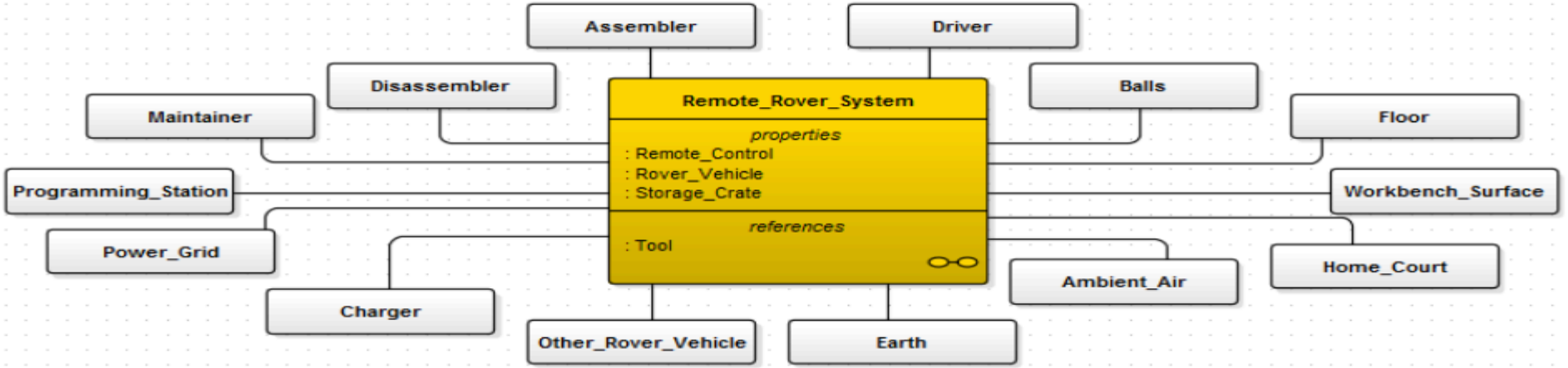
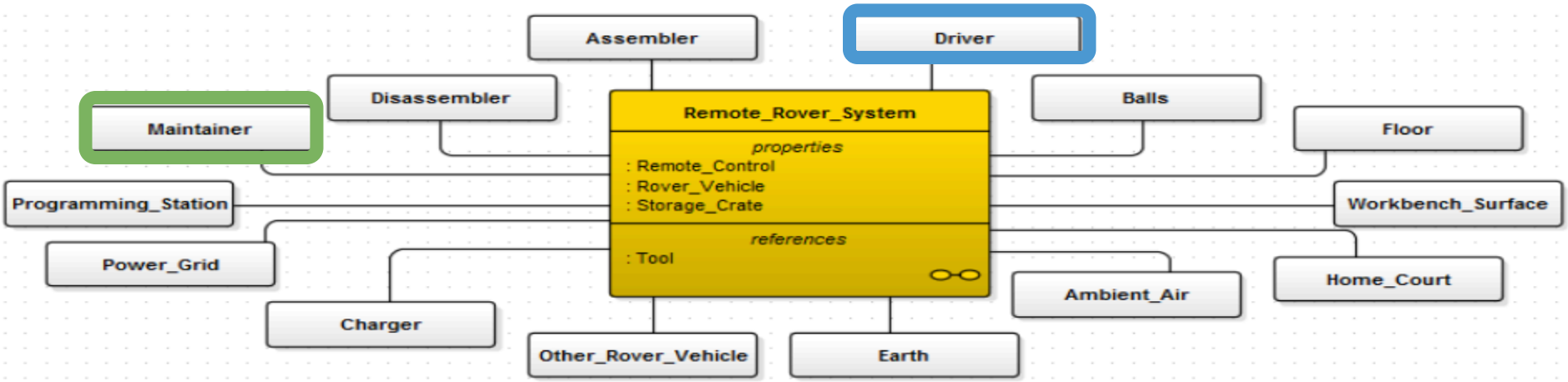
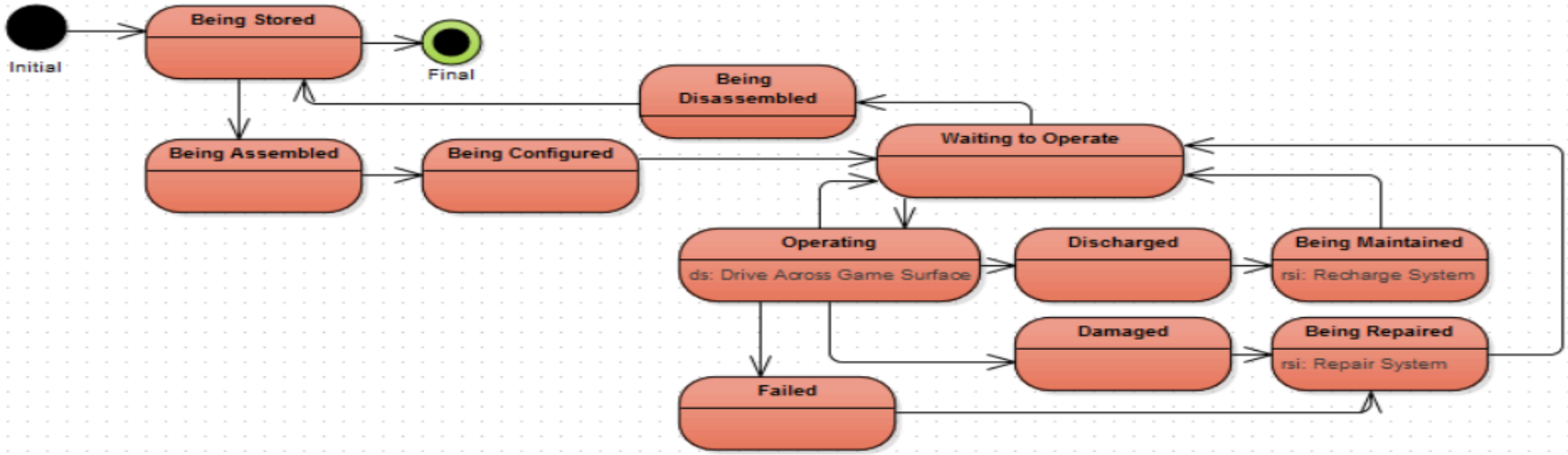


Features

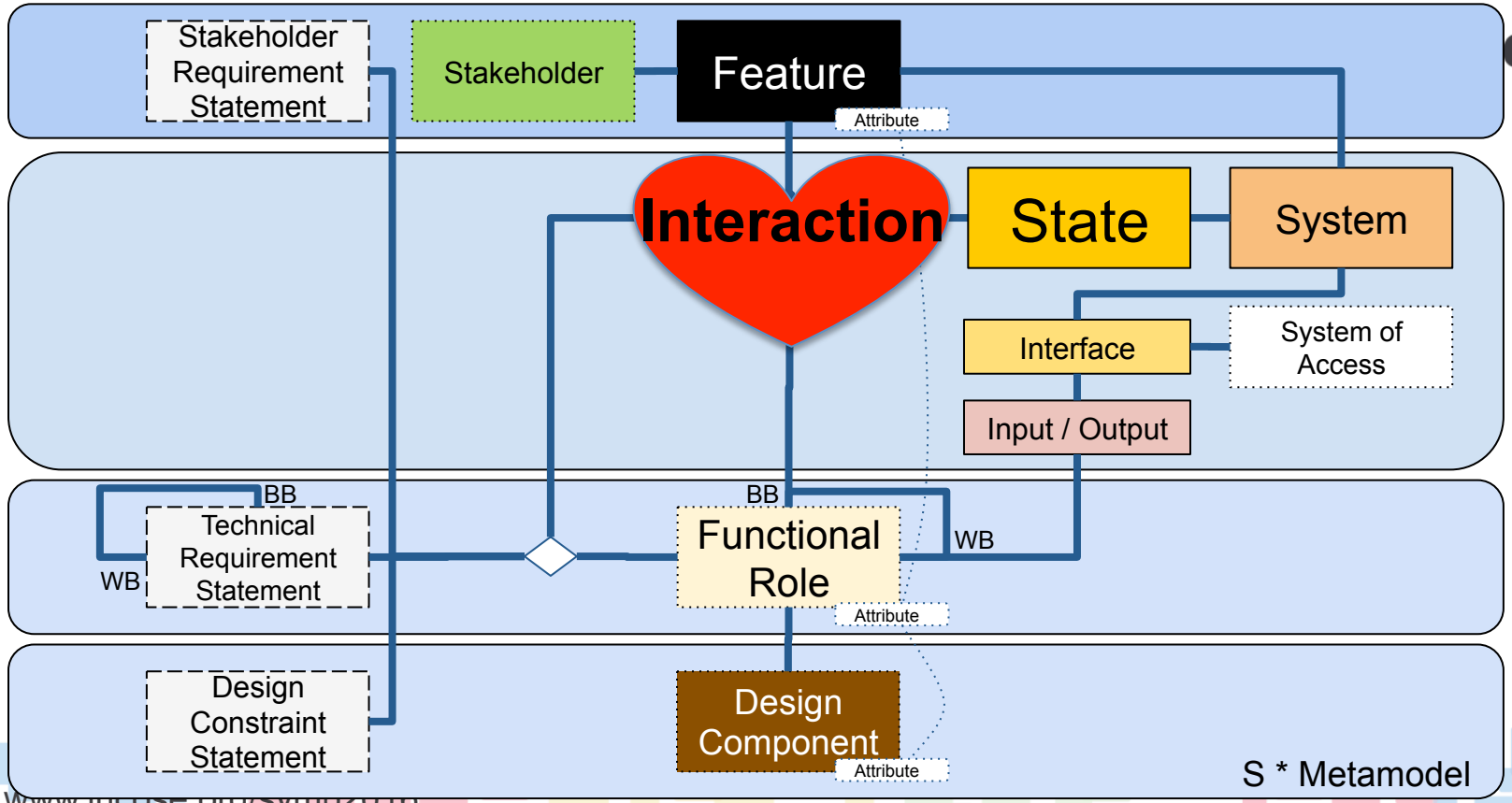
Game Feature
Rechargeable Feature



State


Initial
Being Stored
Final
Being Disassembled
Being Assembled
Being Configured
Waiting to Operate
Operating
ds: Drive Across Game Surface
Discharged
Being Maintained
rsi: Recharge System
Damaged
Being Repaired
rsi: Repair System
Failed

The Smallest Representation of a System



Interactions

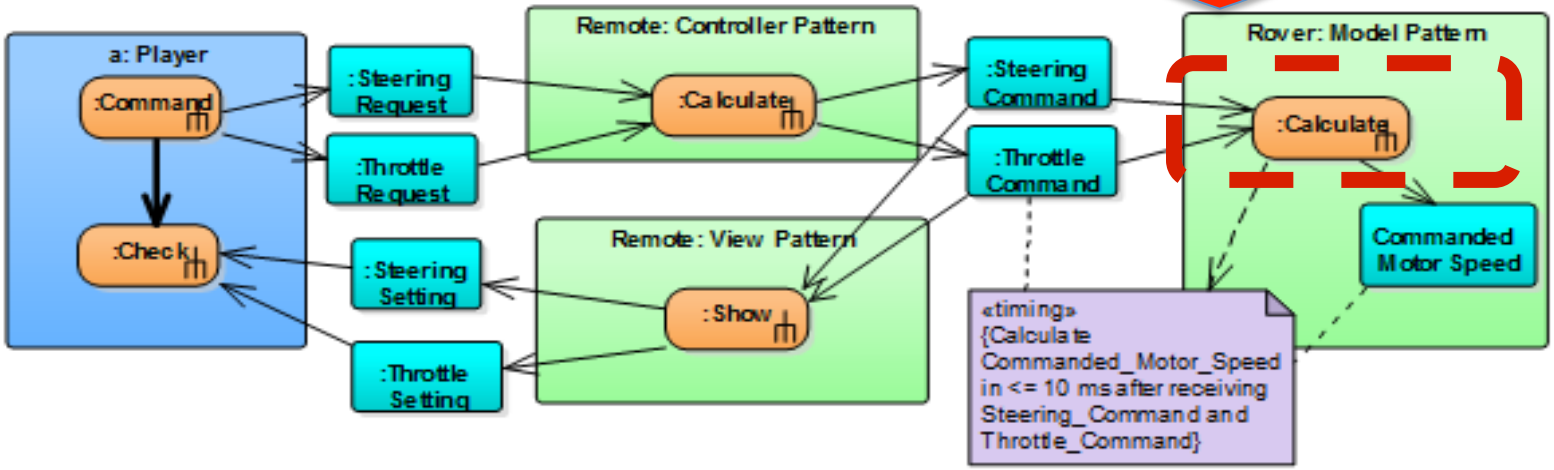
All requirements can be modeled as an interaction.

The Interactions model the exchange of:

1. forces,
2. energy,
3. mass flows, or
4. information

between two or more objects in the system.

Drive Across Game Surface **Interaction**



- The Rover shall Calculate Commanded_Motor_Speed in <= 10ms after receiving Steering_Command and Throttle_Command while in the Operating state.

Textual Requirements Pattern

Textual requirements can be generated from an interaction using a pattern

If [TRIGGER],
the OBJECT shall BEHAVIOR
[(OUTPUT_DATA with the OUTPUT_DATA_ATTRIBUTE(s))(s)]
[PERFORMANCE_CONSTRAINT]
[using (INPUT_DATA with the INPUT_DATA_ATTRIBUTE(s))(s)]
[while in STATE state].

Recharge System Interaction

Visually representing interactions supports completeness

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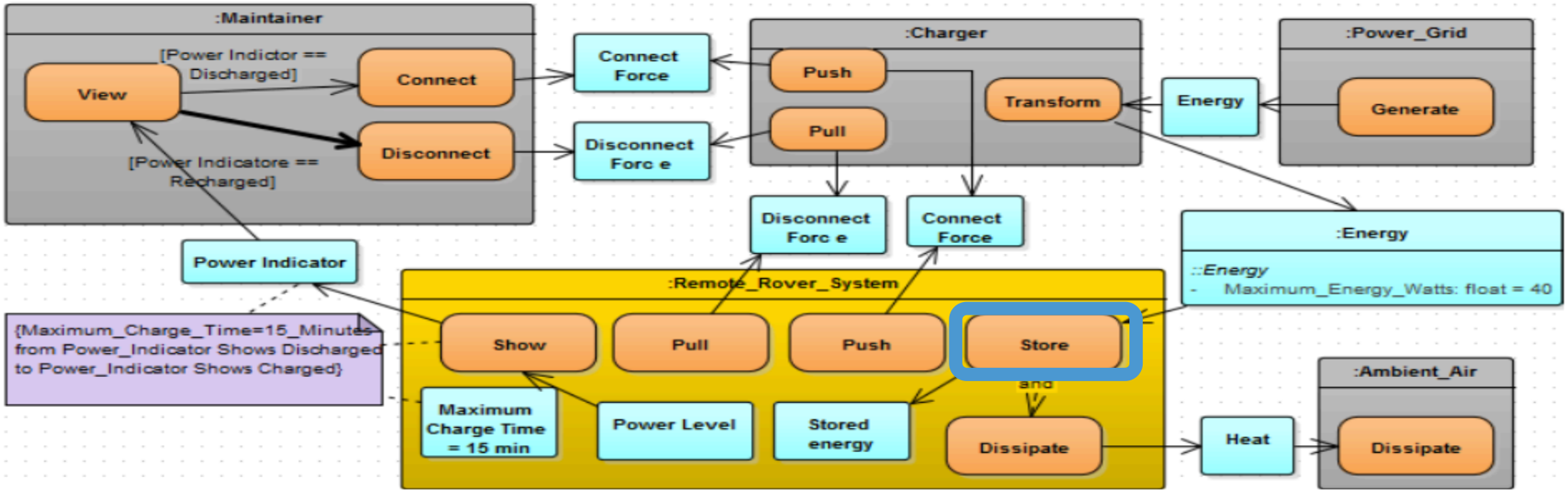
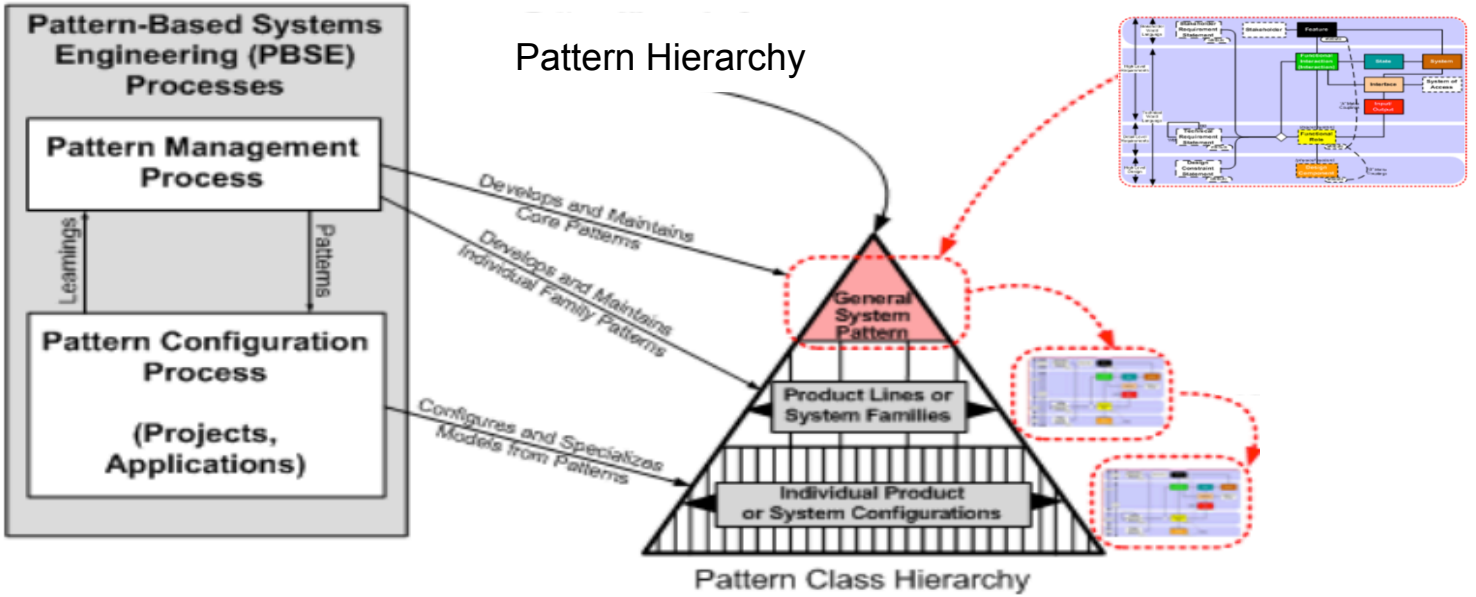


The **Remote_Rover_System** shall **Store Stored_Energy** with the **Maximum_Energy_Watts**=40 while in **Being Maintained** state.

Product Line Requirements



Organizational Learning is captured in patterns

Configure Stakeholder Features

	D	E	H	K	N	O	P	Q
5	**Mandatory, Optional, or Other Configuration Rule**	**Populate? (YES/NO)**	**Feature Name**	**Feature Attribute Primary Key (PK) Attribute Name**	**Feature Attribute PK Value #1**	**Feature Attribute PK Value #2**	**Feature Attribute PK Value #3**	**Feature Attribute PK Value #4**
6								
7	Mandatory	YES	**Game Feature**	Game Capability	Sense Ball	Navigate	Pick Up Ball	Release Ball
8	Optional	NO	**Rechargeable Feature**	--				
9	Mandatory	YES	**Durability Feature**	Threat Type	Drop Impact	Operational Wear & Tear	Collision	
10	Mandatory	YES	**Ease of Use Feature**	Use Challenge	Steering Control	Ball Handling Control	Learning Time	Help Aids
11	Optional	YES	**Environmental Compatibility Feature**	Environmental Issue	Storage Temperature	Storage Humidity	Water Resistance	Sunlight Tolerance
12	Mandatory	YES	**Maintainability Feature**	Maintenance Capability	Fault Diagnostics	BIST	Part Replacement	
13	Mandatory	YES	**Reliability Feature**	--				
14	Optional	YES	**Storage Feature**	Storage Type	Home Closet	Outdoor	nvas Cover	
15	Mandatory	YES	**Producability Feature**	--				
16								
17								
18								
19								
20								
21								

Home Closet
Outdoor
Canvas Cover

Using Features/Attributes configures variability in product families

Configure Technical Requirements

	A	B	C	D	E
1	**Feature**	**Interaction**	**Functional Role**	**Requirement ID**	**Requirement**
24	Rechargable Feature	Recharge System	Remote Rover System	RRS-201	The **Remote_Rover_System** shall **Store Stored_Energy** with the **Maximum_Energy_Watts**=40 while in **Being Maintained** state.
25	Rechargable Feature	Recharge System	Remote Rover System	RRS-202	The **Remote_Rover_System** shall **Show Power Indicator** with **Maximum_Charge_Time_Minutes**=15 from **Power_Indicator** Shows **Discharged** to **Power_Indicator** shows **Charged** using **Power_Level** while in **Being Maintained** state.
26	Rechargable Feature	Recharge System	Remote Rover System	RRS-203	The **Remote_Rover_System** shall **Transmit_Push Connect_Force** with **Maximum_Connect_Force_lbs**=0.5.
27	Rechargable Feature	Recharge System	Remote Rover System	RRS-204	The **Remote_Rover_System** shall **Transmit_Pull Disconnect_Force** with **Maximum_Disconnect_Force_lbs**=0.5.
28	Rechargable Feature	Recharge System	Charger	CRG-301	The **Charger** shall **Transform AC_Electrical_Energy**=110VAC to **DC_Charging_ Voltage**=5.0 V and **Charging_Current**=0.2A.
29	Rechargable Feature	Recharge System	Power_Grid	PGD-151	The **Power_Grid** shall **Generate AC_Electrial_Energy**=110VAC.

When we started I asked if you have you ever:

1. Misunderstood a requirement?
2. Struggled to know what goes in a good requirement?
3. Wondered if you have all of the requirements you need?

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Can you:

1. Better understand your requirements?
   - Interactions lead to conversations and improved understanding
2. Put the right information in your requirements?
   - Interactions exchange forces, energy, mass flow and information
   - Template (pattern) show and describe the information needed in a good requirement
3. Have a more complete set of requirements?
   - Interactions bring up natural questions that lead to complete requirements
   - Visual diagrams show gaps

Discussion Time

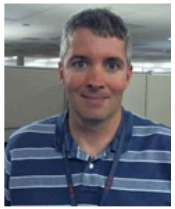
Biography

David Lempia is a Principal Systems Engineer in the Engineering Infra-structure & Integrity (EI&I) organization of Rockwell Collins with over 20 years of experience in systems development. He is currently leading Agile Transformation across Rockwell Collins. He is an author of papers on Requirements Engineering Management, Model Based Development, Agile, and Lean.

Bill Schindel is president of ICTT System Sciences. His engineering career began in mil/aero systems with IBM Federal Systems, included faculty service at Rose-Hulman Institute of Technology, and founding of three systems enterprises. Bill co-led a project on Systems of Innovation in the INCOSE System Science Working Group, co-leads the Patterns Working Group, and is a member of the lead team of the INCOSE Agile Systems Engineering Life Cycle Discovery Project.

Terry Hrabik is a Principal Systems Engineer in the Engineering Infra-structure & Integrity (EI&I) organization of Rockwell Collins. He has over 20 years of experience in systems engineering and engineering management, including positions at Tellabs Operations and the MITRE Corporation. For the past 15 years, he has supported several DoD programs in many different roles including Integration and Test Lead, Lead Systems Engineer, and Chief Architect. He is currently the Systems Engineering Lead for the Rockwell Collins School of Engineering.

Mike Graber is a Sr Systems Engineer in the Engineering Infra-structure & Integrity (EI&I) organization of Rockwell Collins. He has over 20 years of experience in systems/software development/testing and project management which includes MCI. He is currently leading the Engineering Project Leadership area for the School of Engineering across Rockwell Collins. Over the last 12 years, he has led several successful projects within the Government Systems business unit as a Technical Project Manager involving Systems, Software, and Hardware disciplines.



Stewart McGill is a Principal Systems Engineer in the Engineering Infra-structure & Integrity (EI&I) organization of Rockwell Collins. He has over 20 years of experience in mechanical/systems engineering and engineering management, including positions at Honeywell, Inc. and the United States Marine Corps. He is currently the Systems Engineering Lead for Strategic Development and Transformation for Engineering Tools.