

A Proposed Model-Based Approach To Qualification (Formal V&V)

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MBSE – Not Just For Design

- Qualification = V&V!
 - Government systems, formal process
- Many companies have moved to model based design and development
- Some operations – qualification – still document based

Using MBSE tool to track, organize, and finally grant
“Qualified” status to a product can save time and money

Document Based Qualification

- My role: Qualification Engineer for multiple components
- Qualification Plan in MS Word
 - Wide range of parts: tire valve to complex Electro/mech parts
 - Requirements, design, production, Reliability
 - Plan is for Verification; approach works for Validation also
- Required for Government / High Consequence Items

Tracking the work is not doing the work; any reductions through use of a MBSE tool are most welcome

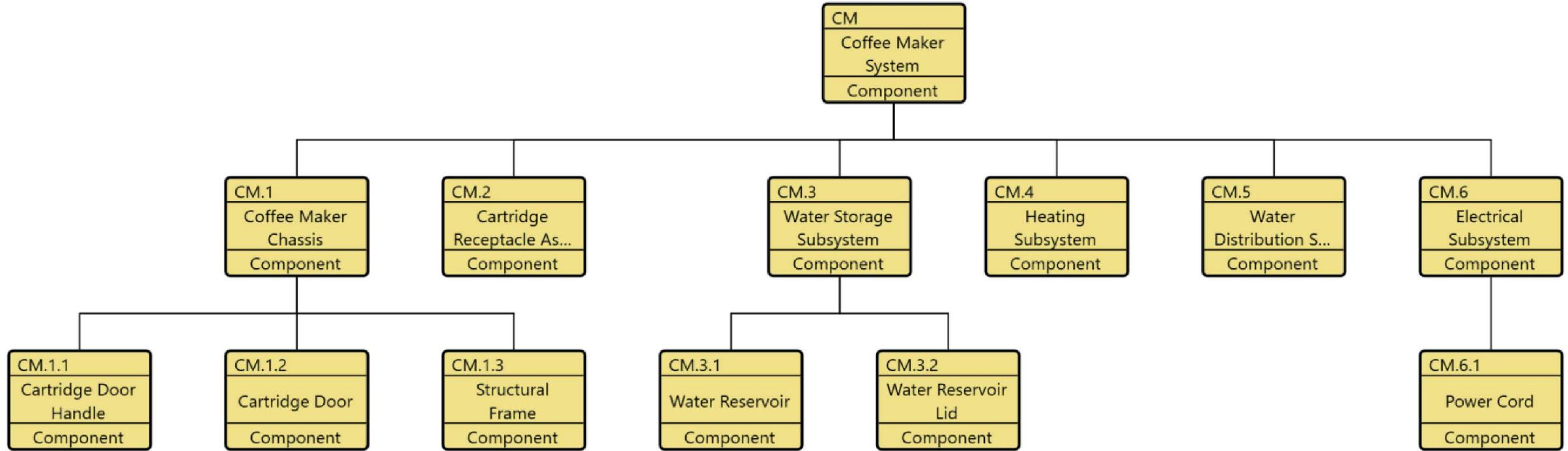
Example: Coffee Pot



Data Elements: Requirements & Design

- Integrated Data as a Foundation of Systems Engr.
- Define data elements!
 - Requirements
 - Functional, Interface, Transport, Environmental, ...
 - Solid drawings / CREO
 - Handling specification
 - Production specifications
 - Programmatic: status reports, SEMP, REMP, V&V plan, ...

Top Level Physical Architecture



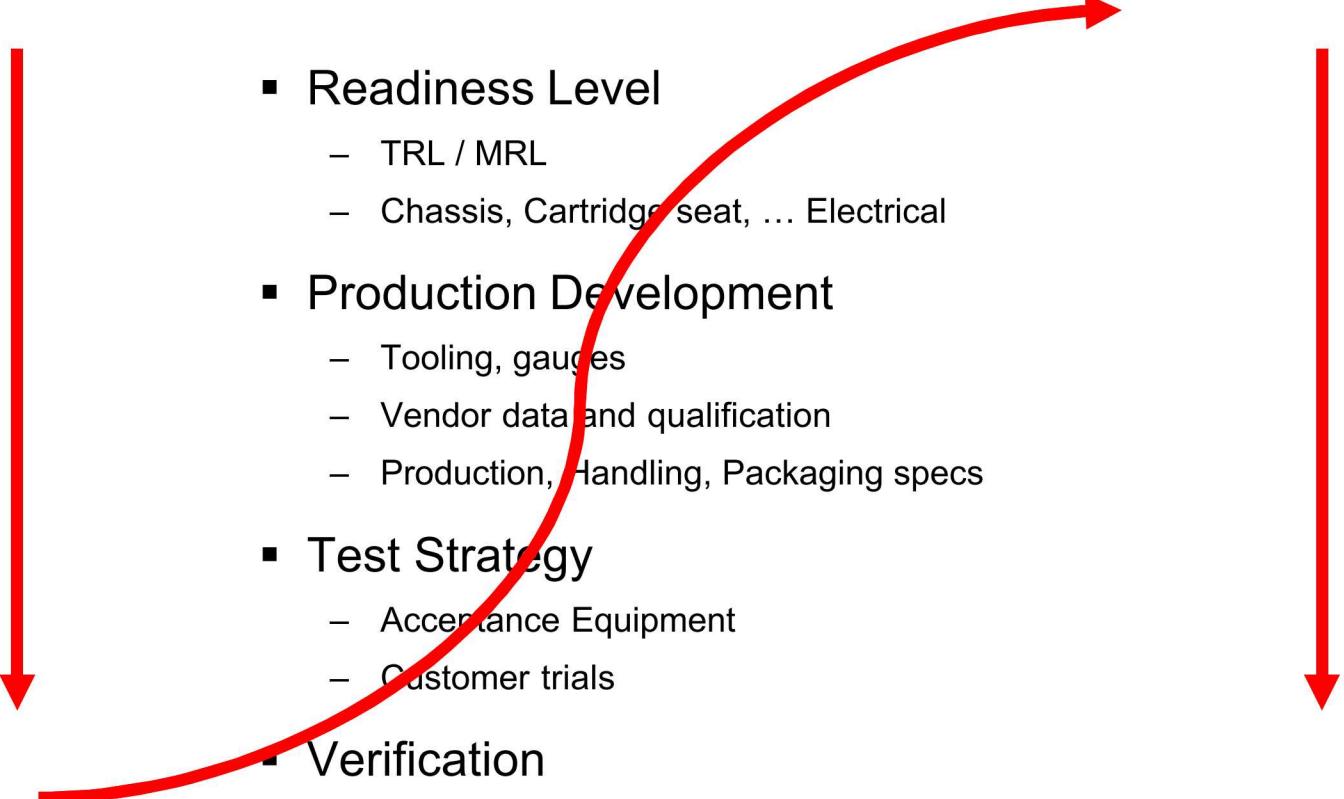
Move to V&V Plan: MS-Word

- Introduction
- Product Information
- Drawing Set
- Qualification Strategy
 - Prototype Builds
 - Status Reports
 - Test Equipment
 - Customer Experience tests
- Requirements Validation
 - Chassis, Cartridge seat, ... Electrical
- Design Qualification
 - Prototype Build 1, 2, 3
 - Chassis, Cartridge seat, ... Electrical
- Readiness Level
 - TRL / MRL
 - Chassis, Cartridge seat, ... Electrical
- Production Development
 - Tooling, gauges
 - Vendor data and qualification
 - Production, Handling, Packaging specs
- Test Strategy
 - Acceptance Equipment
 - Customer trials
- Verification
 - Data repository
- Final Acceptance

Hard to access specific data quickly

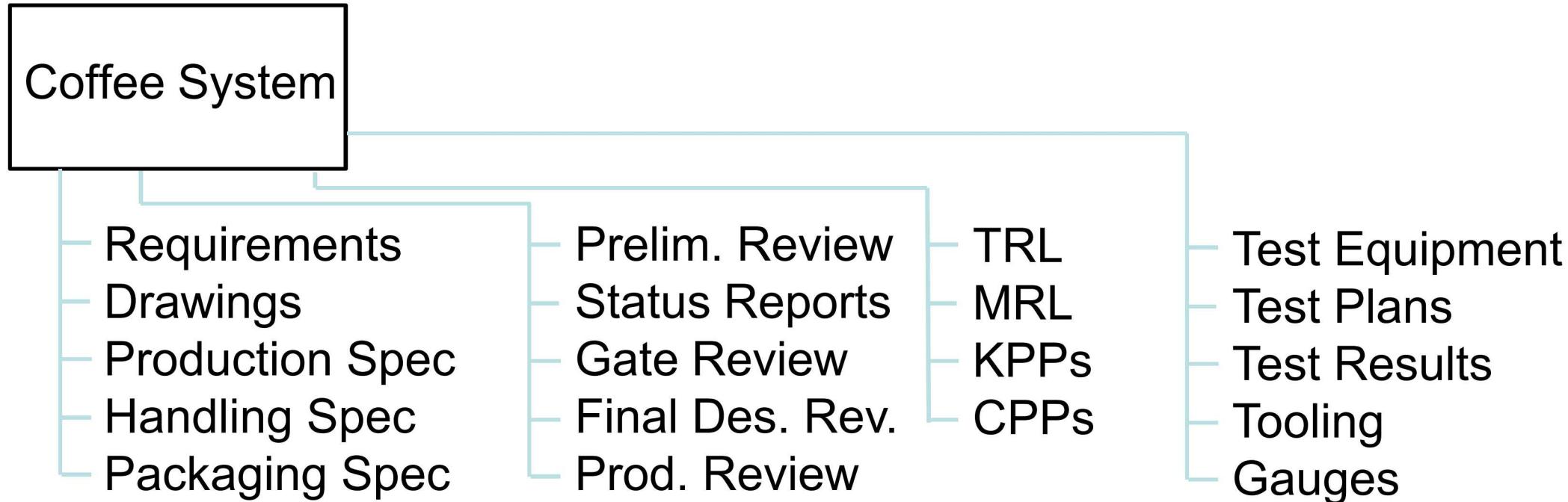
Very Linear! Read Top-to-Bottom

- Introduction
- Product Information
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- Qualification Strategy
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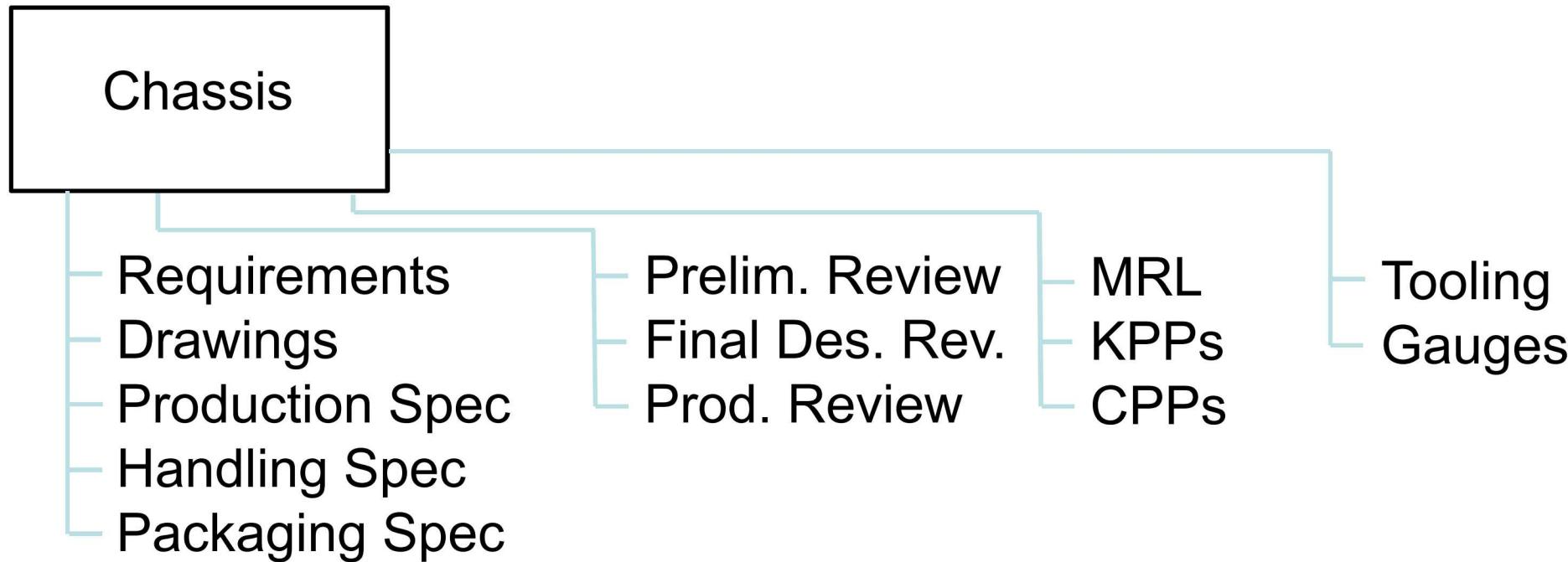
The MS-Word approach is “One-dimensional up and down the page. It’s all there, but hard to access specific data quickly

New Approach: Model Based



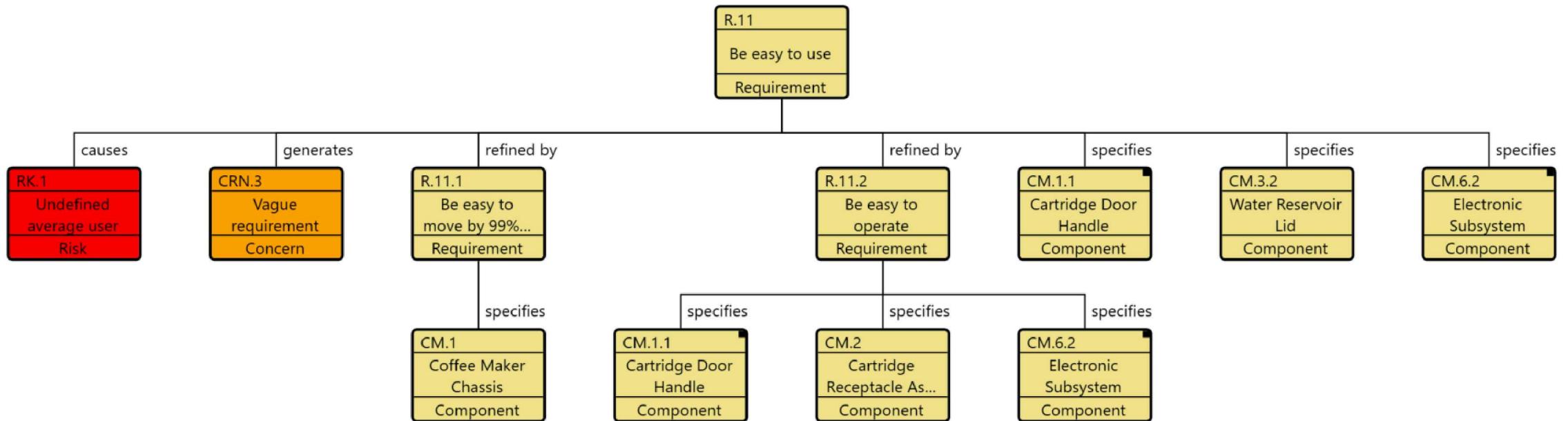
Each physical item's data is more accessible than buried in a MS Word document

Recursive



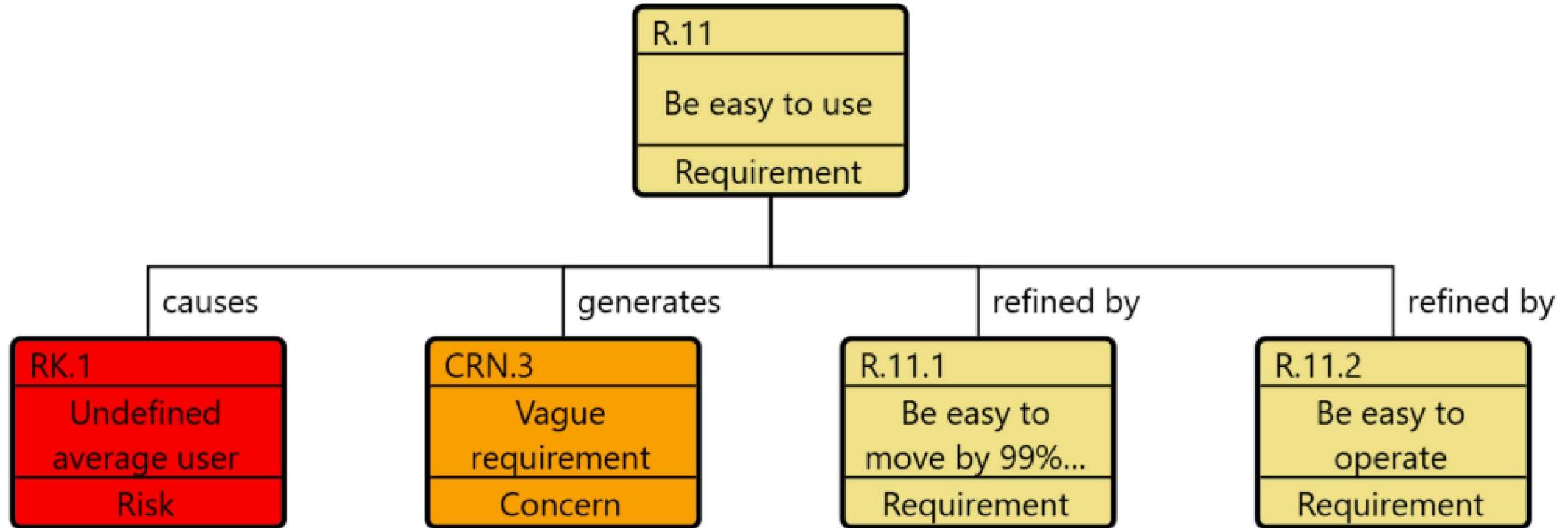
Model allows flexible and recursive approach

MB Qualification – What Information Ties to a Requirement?

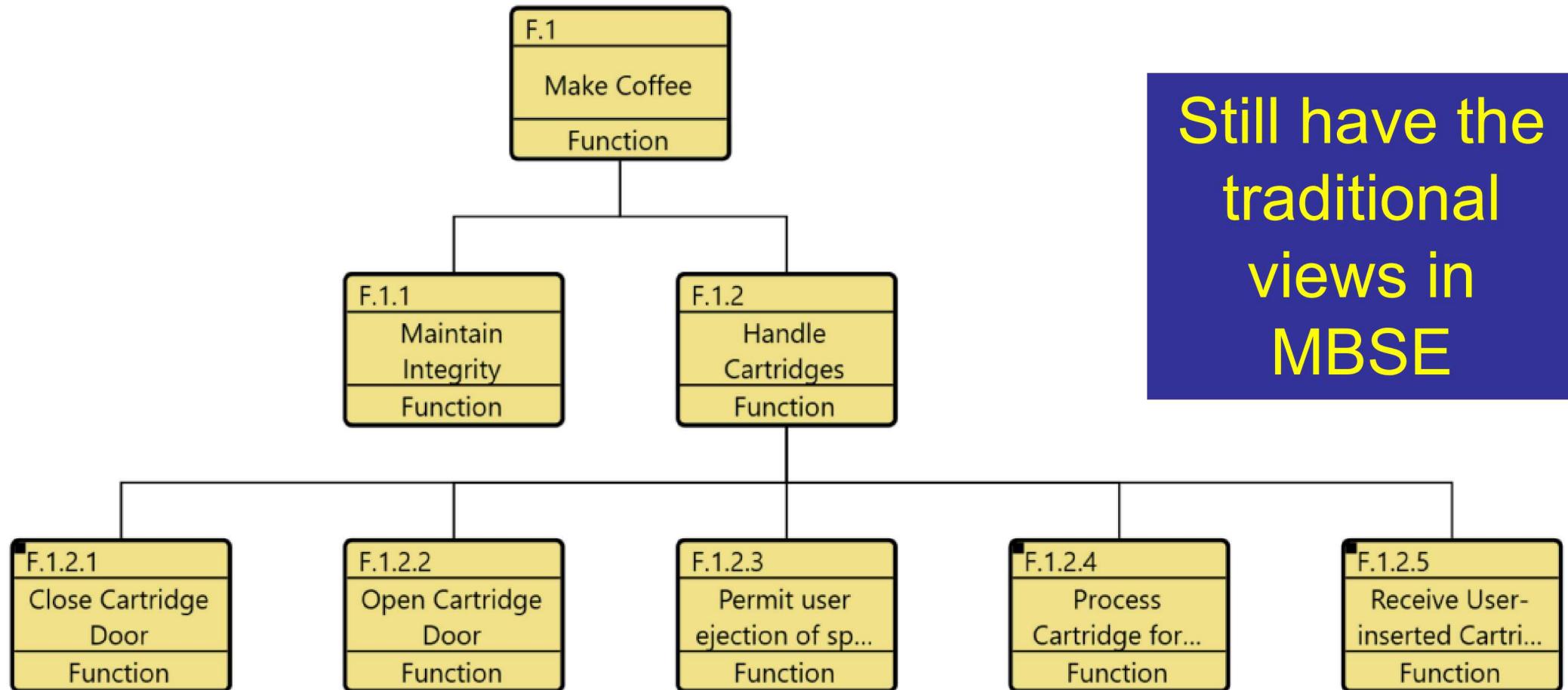


This view very helpful for formal V&V

Risks and Concerns – Side by Side with Child Requirements

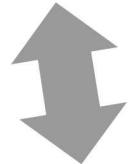


Functional Architecture - Excerpt



Can Link other Data Elements ...

Functions:
Make coffee
Be elec. Safe
Hold Water
....



Requirements:
Req 1
Req 2
Req 3



Tests:
Repeatability
Taste
User Interface



Product Def'n:
Part 1, ver. A
Part 2, ver. B
Part 3, ver. B

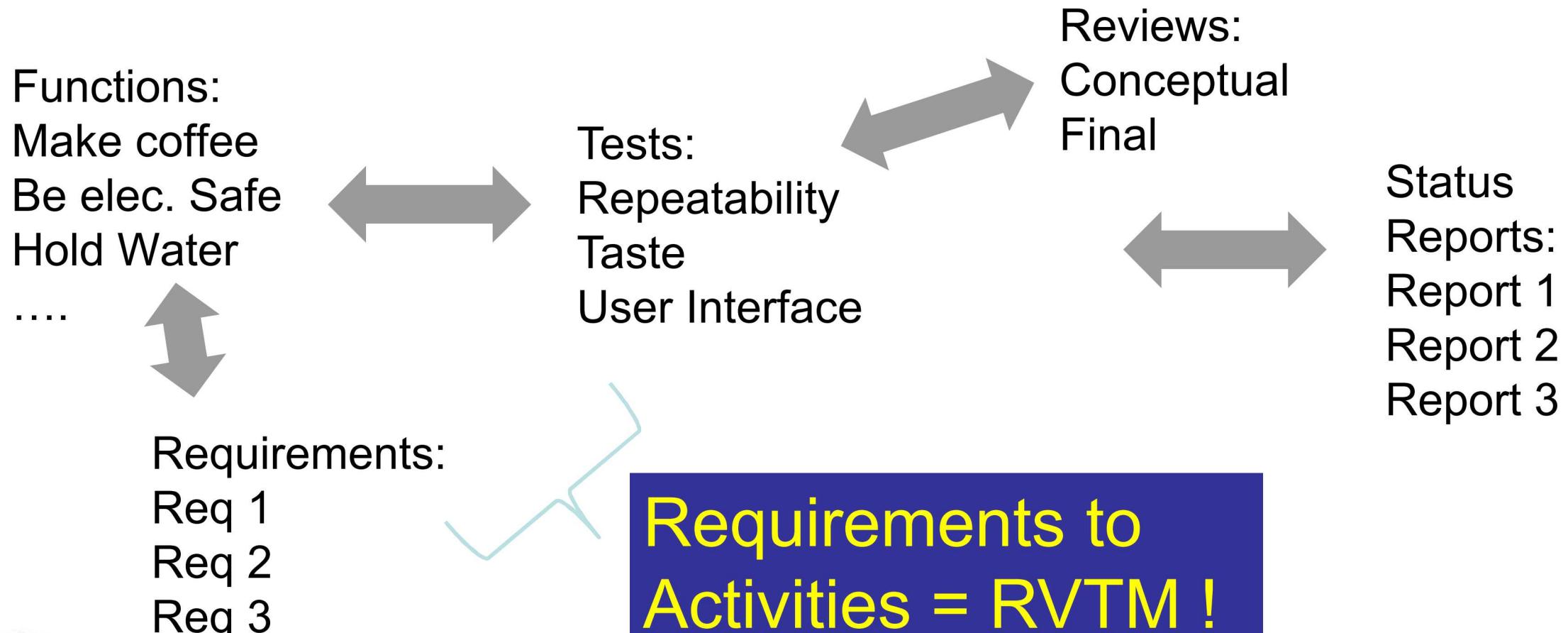


Reviews:
Conceptual
Final



Status Reports:
Report 1
Report 2
Report 3

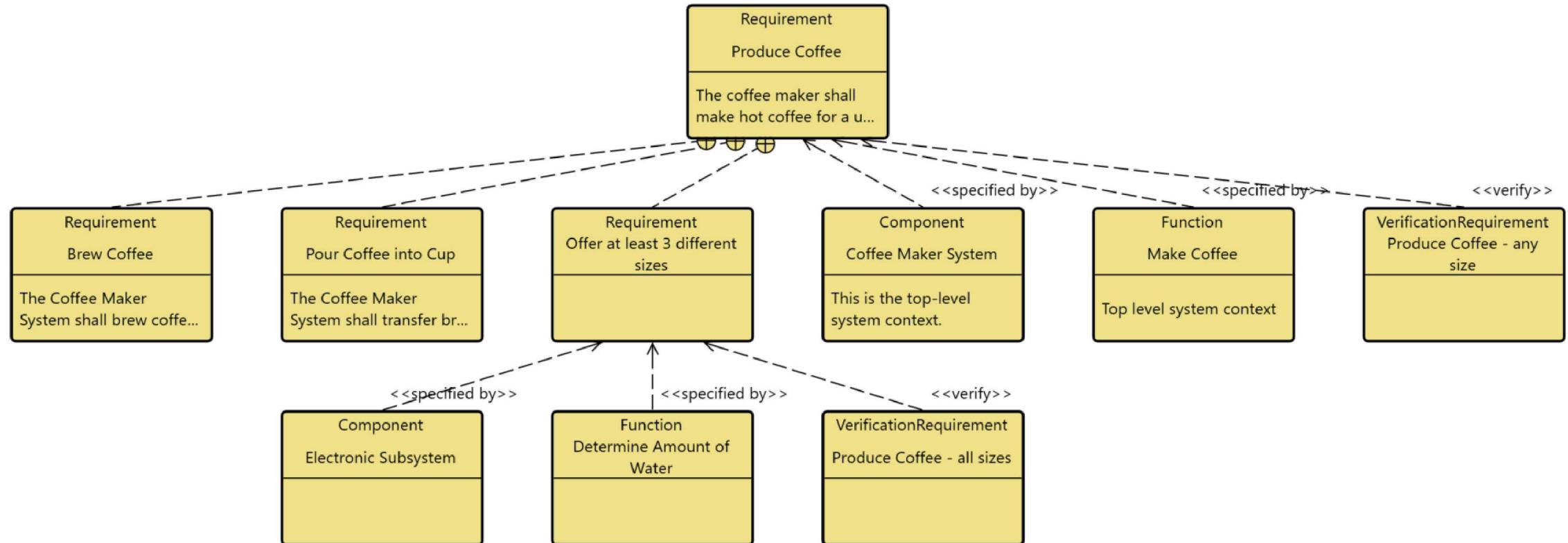
... to Produce the Traceability Matrix



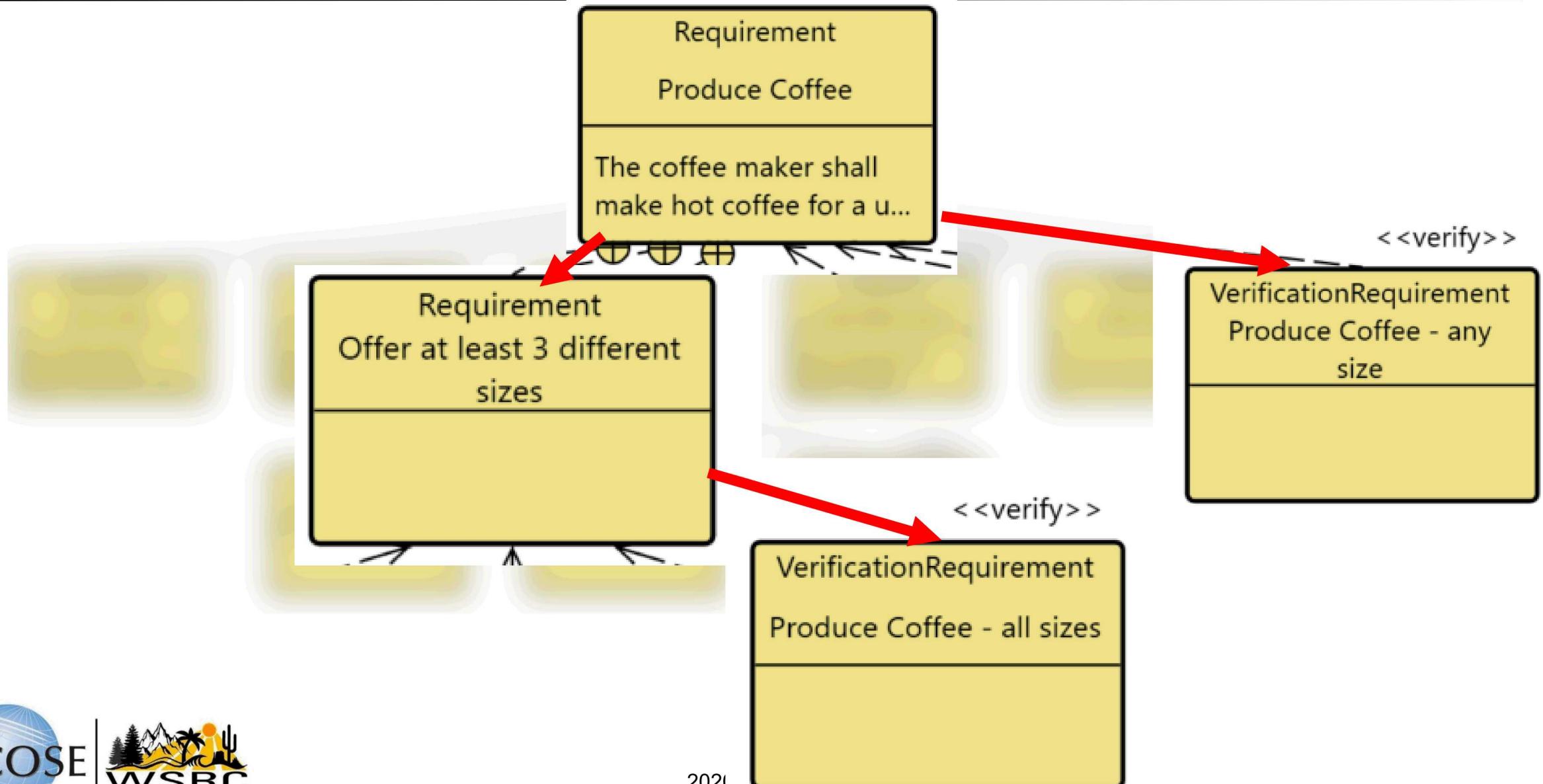
Example RVTM Matrix – Combined with Up/Down Traceability

Require- ment	specifies	refines	refined by	verified by (verif.)
	(components, functions)	(parent)	(child)	Reqmt
	<i>Component</i> CM Coffee Maker System			
R.1 Produce Coffee	<i>Function</i> F.1 Make Coffee		R.1.1 Brew Coffee R.1.2 Pour Coffee R.1.3 Offer => 3 sizes	Verif. Reqmt Produce Coffee - any size
R.1.1 Brew Coffee		R.1 Make Coffee		
R.1.2 Pour Coffee		R.1 Make Coffee		
R.1.3 Offer => 3 sizes		R.1 Make Coffee		

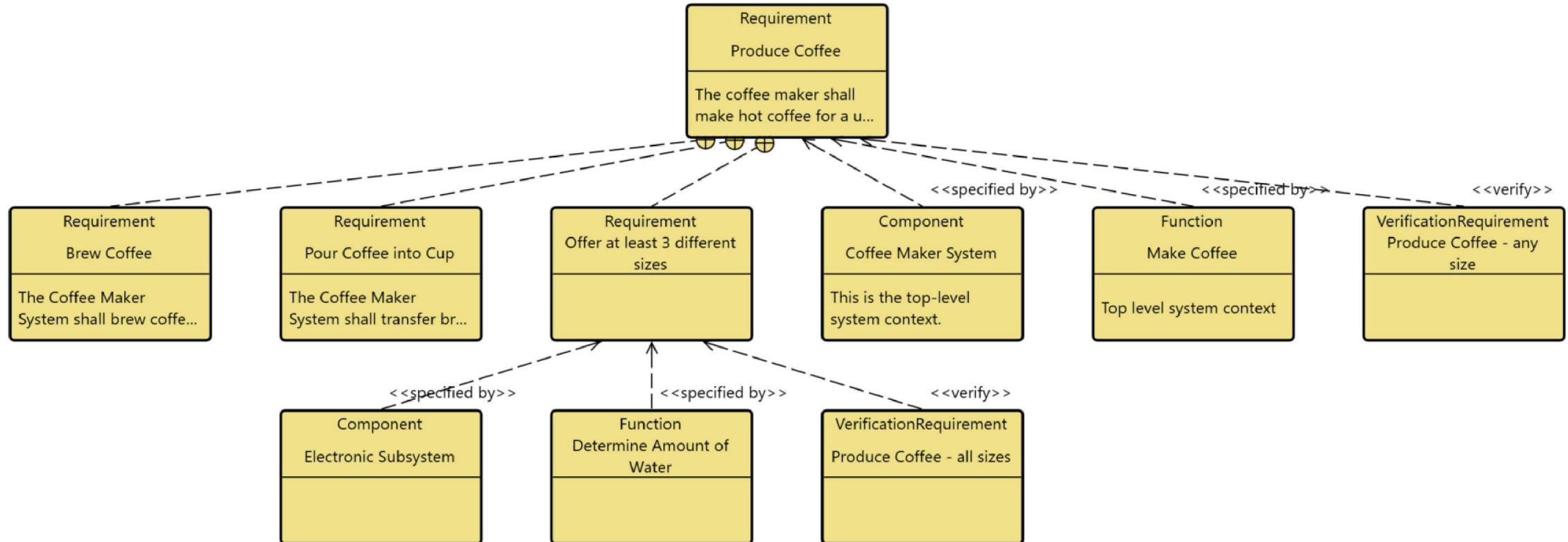
Can Show Same Info, and More, in the MBSE Tool



Has Graphical Trace to Verification!



Has Graphical Trace to Verification!



Each Block is “Clickable” – to Reveal Specifics

“Details”
for each
block, one
double-
click away

Browser

R.1 Produce Coffee

R.1.1 Brew Coffee

R.1.2 Pour Coffee into Cup

R.1.3 Offer at least 3 different sizes

R.1.4 Coffee tastes good

R.1.5 Coffee made in less than 60 sec

R.2 Provide water throughout system

R.2.1 Deliver water to heater

R.2.2 Deliver hot water to cartridge

R.2.3 Force water through cartridge

R.3 Remain Safe

R.3.1 Remain Electrically Safe

R.3.2 Do Not Burn User

R.4 Store 1.5 l Water

R.5 Receive Standard Cartridge

R.6 Heat Water

R.7 Remain Mechanically Sound

R.8 Allow user input

R.8.1 User-selectable brew start

R.8.2 User-selectable size

R.9 Provide Power

R.9.1 Use standard 110V power

R.9.2 Use standard 220 V power

R.10 Support cleaning by user

R.10.1 Reservoir easy to clean

R.11 Be easy to use

R.11.1 Be easy to move by 99% of user

R.11.2 Be easy to operate

R.11.2.1 Easily insert and remove cart

Produce Coffee as PropertySheet

Name: Produce Coffee

Number:

Description: The coffee maker shall make hot coffee for a user in a user provided cup, upon power-up of the CMS, selection of the size of cup and a positive indication from the user to commence brewing.

Doc. PUID:

Title:

Type: Functional

Key Performance Parameter:

Performance Parameter Type: nil

True False

Relationships:

- (all relationships)
- augmented by
- basis of
- categorized by
- causes
- classified by
- documented by
- elicited by
- establishes

Targets & Attributes:

- elicited by UseCase Brew Cup of Coffee
- refined by Requirement R.1.1 Brew Coffee
- refined by Requirement R.1.2 Pour Coffee into Cup
- refined by Requirement R.1.3 Offer at least 3 different sizes
- specifies Component CM Coffee Maker System
- specifies Function F.1 Make Coffee
- verified by VerificationRequirement Produce Coffee - any size

V&V Data Much More Accessible

- Requirements, mapped to:
 - Functions, Physical architecture, Testing, equipment, tooling
- Adaptable to changes
 - Edit a MS Word doc -> now we edit the Model.
- Verification & Validation now far smoother
 - Test activities, pointers to artifacts (plans, reports) linked.
 - RVTM can be produced automatically
 - May still want to enter linking into a RM database such as DOORS

Can still produce typical Sys Engr. artifacts

Clarifications

- Not a replacement for a RM system such as DOORS
- Not performing engineering design
 - May find interfaces
 - Could hang off of a design MBSE system
- Requires maintenance, tool support
- Not for change control, or workflow management

All of these are workable! MB approach still recommended

Proposed: Worth the Front End Effort

- Easier for Qualification Engineer to perform job
 - Built-in Context Diagram
 - Scalable: can drill-down to part (or function) in question
- Can easily pass on work to successor, mid-project
- Government acceptance can be Model-Based
 - Reviews can walk through the model, vs. a Word doc.
- Can spot gaps, hidden interfaces more easily
 - Early on is best, but can see gaps at any time

Higher Quality Product, Lower Cost

- Time (hours, salary) spent on qualification effort reduced
- Visual approach, easier to spot interface V&V gaps
- Increase customer confidence, satisfaction
 - Some government customers, very concerned about transparency
 - Some like to ‘drill down’.

Up-front investment in MBSE V&V infrastructure is worth it

Questions

Q/A Session

