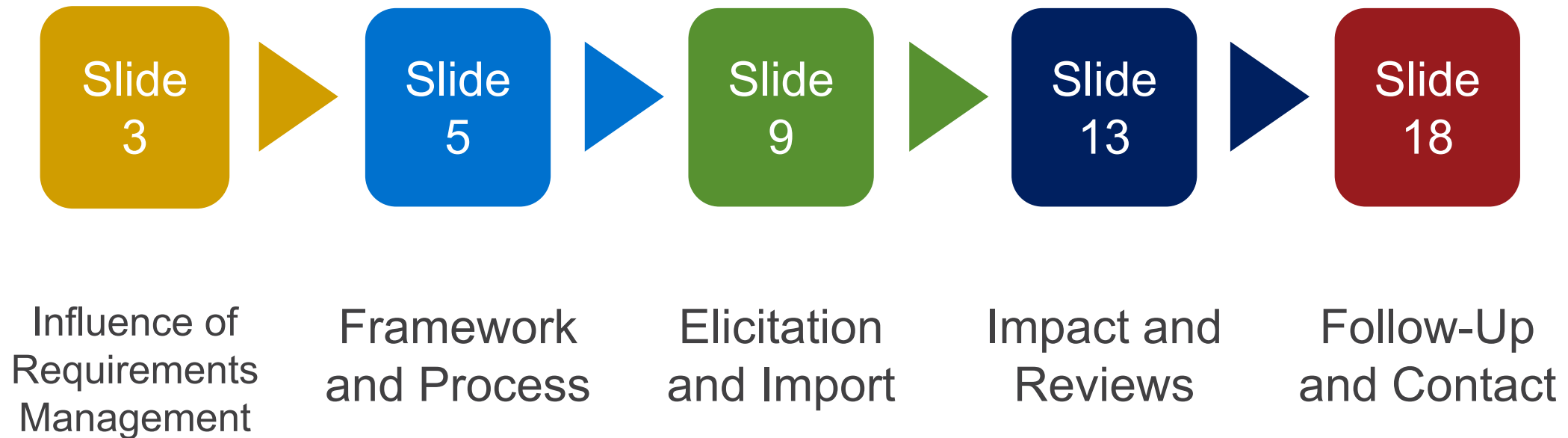Max Franklin & Enoch Lee, INVENSITY Inc.

Requirements Management Framework for program RFQ phase

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Agenda

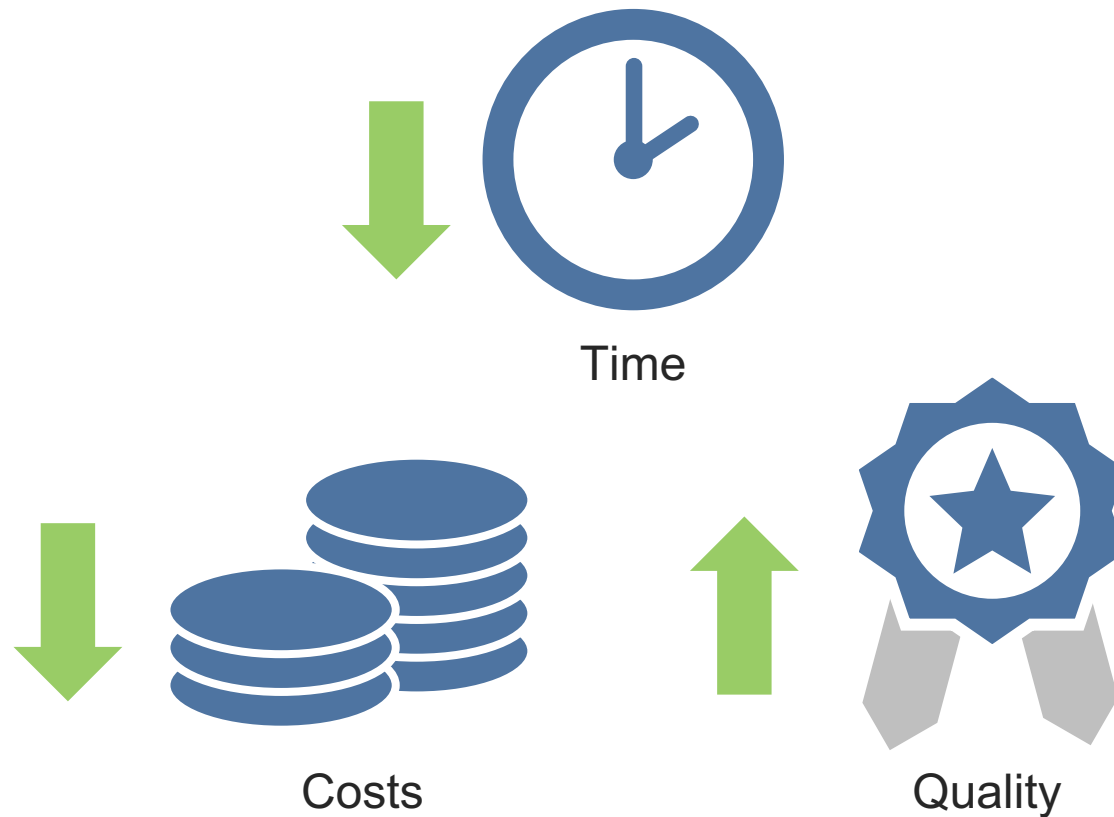| Slide 3	Slide 5	Slide 9	Slide 13	Slide 18
Influence of Requirements Management	Framework and Process	Elicitation and Import	Impact and Reviews	Follow-Up and Contact

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Requirements Management can be leveraged by the development team to influence the key drivers of successful product development

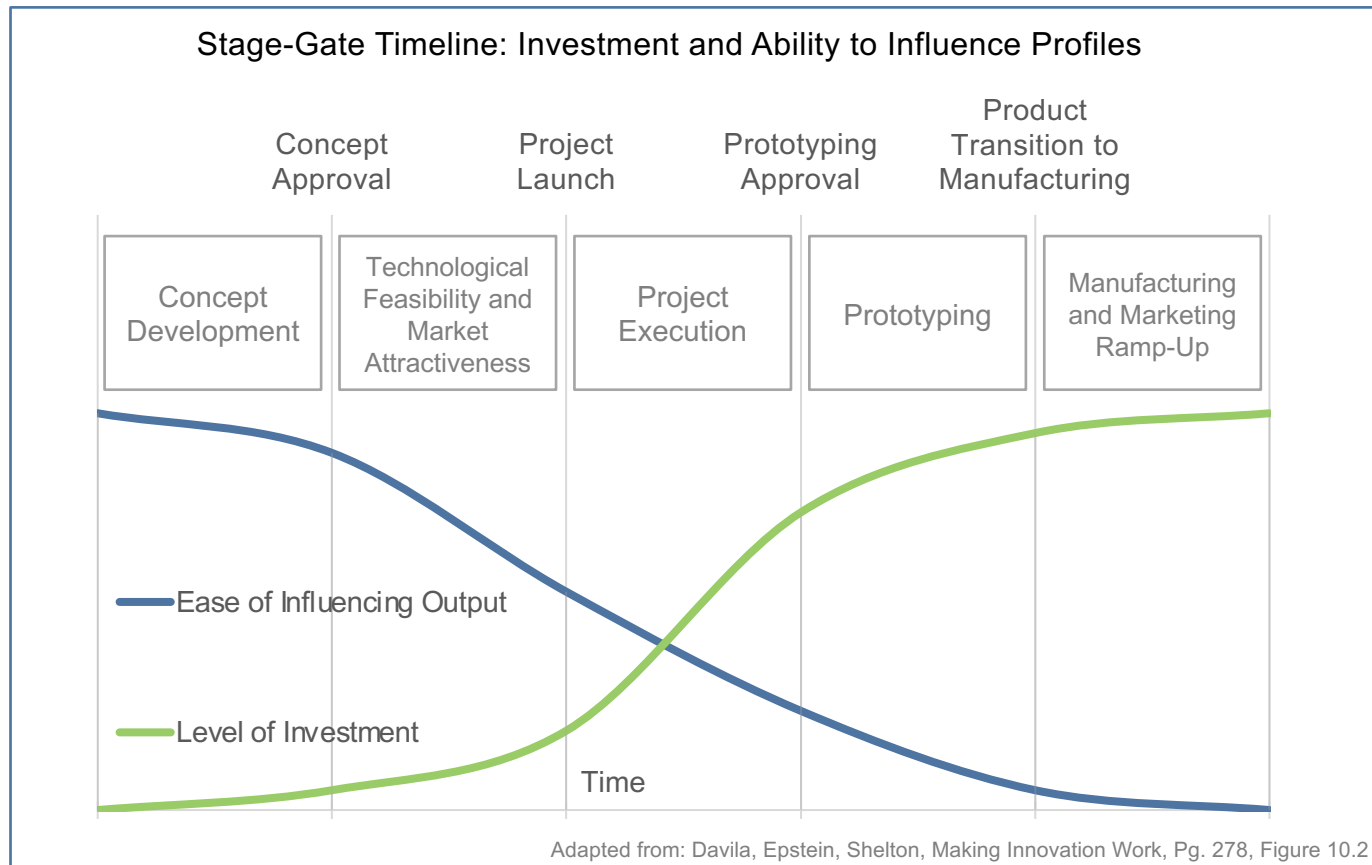## The Project Management Pyramid

Time

Costs

Quality

- These common issues usually stem from ineffective strategy, management, and execution of requirements

  - Mis-identified customer wants and needs (CWN)
  - Under-specified product or system requirements
    - Won't meet customer needs
    - Re-engineering and re-validation needed
  - Over-specified system or component requirements
    - Excess time and resources spent in development

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Make an early impact – the associated effort and cost to fix engineering errors greatly increases as project maturity progresses

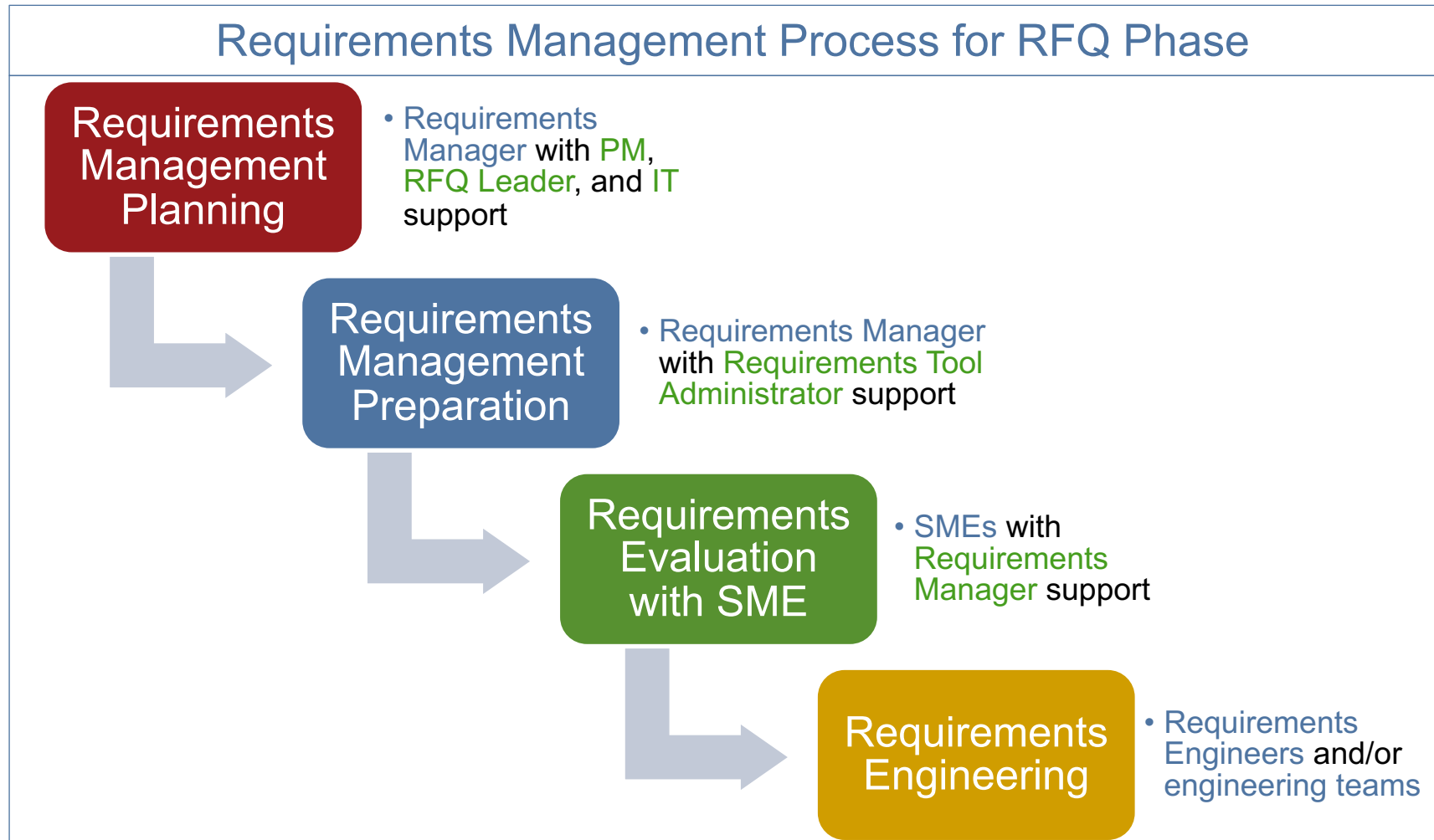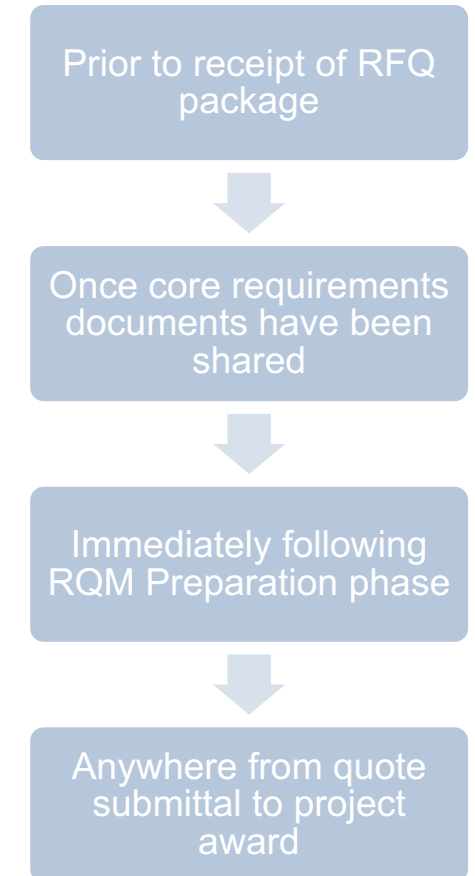Technical flexibility decreases while change costs rise as the project proceeds

Stage-Gate Timeline: Investment and Ability to Influence Profiles

Concept Approval	Project Launch	Prototyping Approval	Product Transition to Manufacturing	
Concept Development	Technological Feasibility and Market Attractiveness	Project Execution	Prototyping	Manufacturing and Marketing Ramp-Up

— Ease of Influencing Output

— Level of Investment

Time

Adapted from: Davila, Epstein, Shelton, Making Innovation Work, Pg. 278, Figure 10.2

Typical fault correction costs during:	
Concept	$ 1,300
A-Sample	$ 4,550
B-Sample	$ 5,200
C-Sample	$ 7,800
PV Series	$ 84,500
Production	$ 104,000
Post-Production	$ 117,000

Source: HIS (Audi, BMW, Daimler, Porsche, VW) presented by Method Park Software, IBM Automotive Engineering Symposium, 10/24/2013, Slide 10

The supplier's Requirements Management Process and timeline are streamlined when starting with the RFQ phase

Requirements Management Process for RFQ Phase

Requirements Management Planning
- Requirements Manager with PM, RFQ Leader, and IT support

Requirements Management Preparation
- Requirements Manager with Requirements Tool Administrator support

Requirements Evaluation with SME
- SMEs with Requirements Manager support

Requirements Engineering
- Requirements Engineers and/or engineering teams

Potential Phase Start

Prior to receipt of RFQ package

Once core requirements documents have been shared

Immediately following RQM Preparation phase

Anywhere from quote submittal to project award

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The Requirements Manager leads the RQM Planning phase and can complete these activities prior to receipt of the RFQ package

	Requirements Management Planning		
Process Steps	Establish RQM Milestones, Baselines, and Due Dates in the Project Schedule with the RFQ Leader	Identify Subject Matter Experts (SME), Feature Owners, and System Owners, and clarify decision makers	Initiate Requirements Management Strategy including tailored RQM procedures and setup of RQM Project in the Requirements Management Software Tool
Work Packages	❑ RFQ Phase RQM Schedule	❑ RFQ Phase Project Roster / RASIC ❑ Product Breakdown Structure (working copy) OR ❑ Project Org. Chart	❑ Requirements Management Strategy (RMS) ❑ Project (in the tool) with Roles and Permissions
Proposed Timeline	~ 1 week	~ 1 week (concurrent with step 1)	~ 2 weeks (after completion of steps 1-2)

The Requirements Manager leads the RQM Preparation phase and can execute as soon as requirements documentation is shared

	Requirements Management Preparation		
Process Steps	Create and populate List of Requirement Sources including primary, supporting/reference, and missing documents	Define structure in RQM Tool: project and artifact/item types, attributes/fields, link strategy, preferred views, filters, dashboard, and KPIs	Import all Requirement sources into RQM tool (plus pre-formatting of all LRS documents to enable import) and baseline imported requirements
Work Packages	❑ List of Requirement Sources (LRS) with links to the documents	❑ Import Template ❑ Link Strategy ❑ KPI Metrics	❑ LRS formatted for import ❑ LRS in RQM tool ❑ Published baseline(s)
Proposed Timeline	~ 2 weeks (after receipt of RFQ documentation package)	~ 1 week (finalize after completion of step 4)	~ 1-2 weeks (after completion of step 5)

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SMEs evaluate their assigned requirements after each module is baselined, and then re-evaluate after customer negotiation

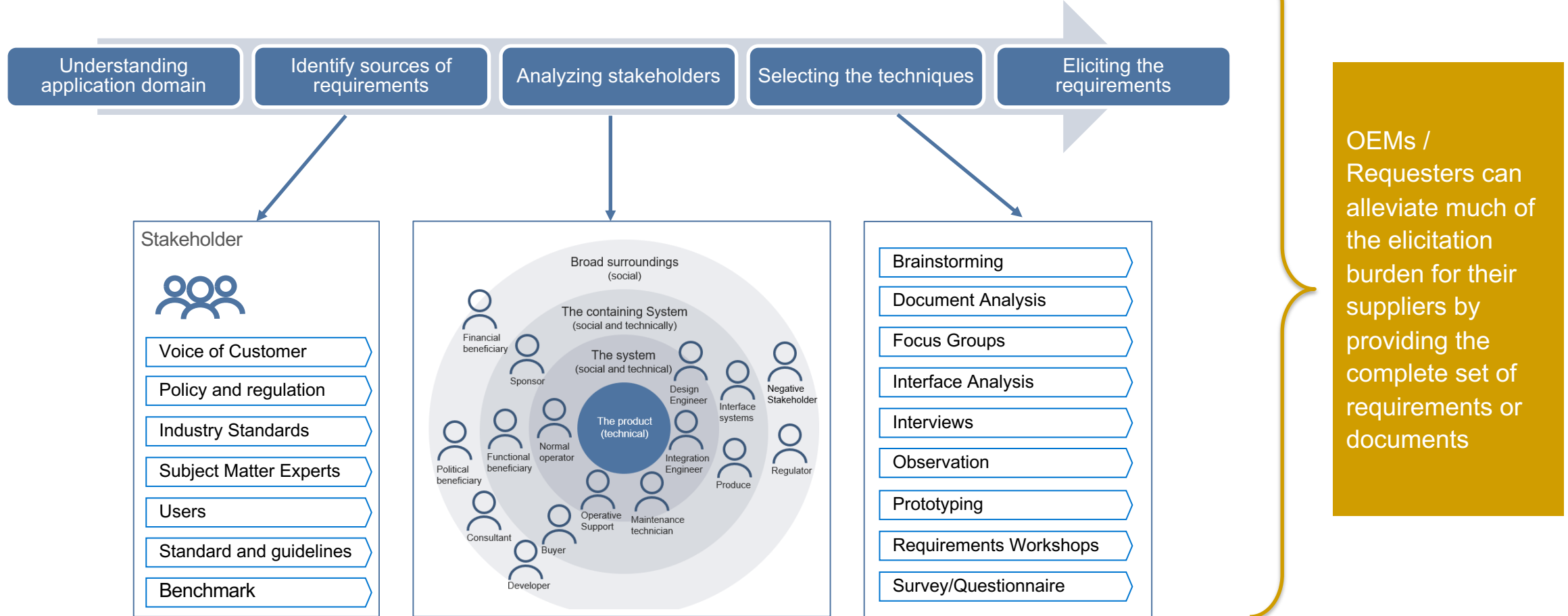|	Requirements Evaluation with SME		
Process Steps	Internal stakeholder analysis of customer requirements – Requirement Type, Allocation, Complexity/Maturity, and Agreement	Plan required engineering and test resources, budget, and timing for production project based on Requirement Type and Complexity	Support interim negotiations with customer based on Agreement status. Re-analyze updated requirements.
Work Packages	❑ RQME Training for SMEs ❑ Classified requirements in Requirements Management Tool (new baseline) ❑ Open Points (LOP) shared with customer	❑ Project resource estimates (by product breakdown or organization)	❑ Updated requirements in Requirements Management Tool (new baseline) ❑ Updated project resource estimates
Proposed Timeline	~ 4-8 weeks with dedicated SME support (assumed requirements mix w/reference docs readily available)	~ 1 week (after completion of step 7)	~ 2-3 weeks (after feedback from customer)

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Requirements elicitation aims to gather, process, and track evolving stakeholder needs and requirements throughout the project lifecycle

Typical activities of the requirements elicitation process can be divided into 5 steps

Understanding application domain	Identify sources of requirements	Analyzing stakeholders	Selecting the techniques	Eliciting the requirements

Stakeholder

- Voice of Customer
- Policy and regulation
- Industry Standards
- Subject Matter Experts
- Users
- Standard and guidelines
- Benchmark

Broad surroundings (social)

The containing System (social and technically)

The system (social and technical)

The product (technical)

Financial beneficiary
Sponsor
Design Engineer
Interface systems
Negative Stakeholder
Political beneficiary
Functional beneficiary
Normal operator
Integration Engineer
Regulator
Consultant
Buyer
Operative Support
Maintenance technician
Produce
Developer

- Brainstorming
- Document Analysis
- Focus Groups
- Interface Analysis
- Interviews
- Observation
- Prototyping
- Requirements Workshops
- Survey/Questionnaire

OEMs / Requesters can alleviate much of the elicitation burden for their suppliers by providing the complete set of requirements or documents

Elicited documents are tracked in the List of Requirement Sources (LRS) plus a Missing Documents log

LRS exists as a summary of all received and reviewed documents

- can also live in the tool and be tracked via dashboard

	ID	No.	Name	Reference	Status	Source
1	Proj_387	CUS. 21A	Customer Requirements Specification for MY27 Z654		In-progress	CUS Application Doc.
2	Proj_405	ISO 26262-4	Road vehicles – Functional safety – Part 4: Product development at the system level	CUS. 21A, Sec. 5.4	Analyzed	CUS Referenced Doc.

Missing Documents log facilitates the acquisition of all requirement sources

	No.	Name	Ref.	Relevant Sections	Status
1	IEC 98765	End-of-life directive	CUS 21A	Ch. 2, 5	Obtained
2	CUS-T 1492	Customer Environmental Test Procedures	CUS 131B		Missing

➤ Priority and assignment should exist in both lists – enable the team to focus on the highest impact items relevant to their skillset

The formatting and import process can hinder or accelerate the evaluation activity depending on incoming requirements quality

- For spreadsheets, fields/attributes of the incoming file must align with that of the configured modules in the requirements tool
  - Different tools have different restrictions around sequence, completeness, discrepancy of entries, etc.
- Importing from text files effectively guarantees the reviewer will have to classify all fields for every requirement, either one-by-one (for disorganized specs) or through batch edits

Attributes in this import template must align with those in the import target defined in the software tool

The attribute "Requirement Type" here has the defined entries of "Undefined", "Design", "Behavioral", "Performance", "Safety", and "Process". Therefore, these are the only viable entries in the import template. The same rule applies to all attribute of any artifact.

OEMs / Requesters can alleviate much of the importing burden for their suppliers by providing:
- ReqIF files
- Pre-formatted files for import
- Partially modifiable files
- Requirements separated by type

In early-stage development, alternative allocations and tool structures are often necessary to enable effective reviews

function-oriented development

product(ion) structure
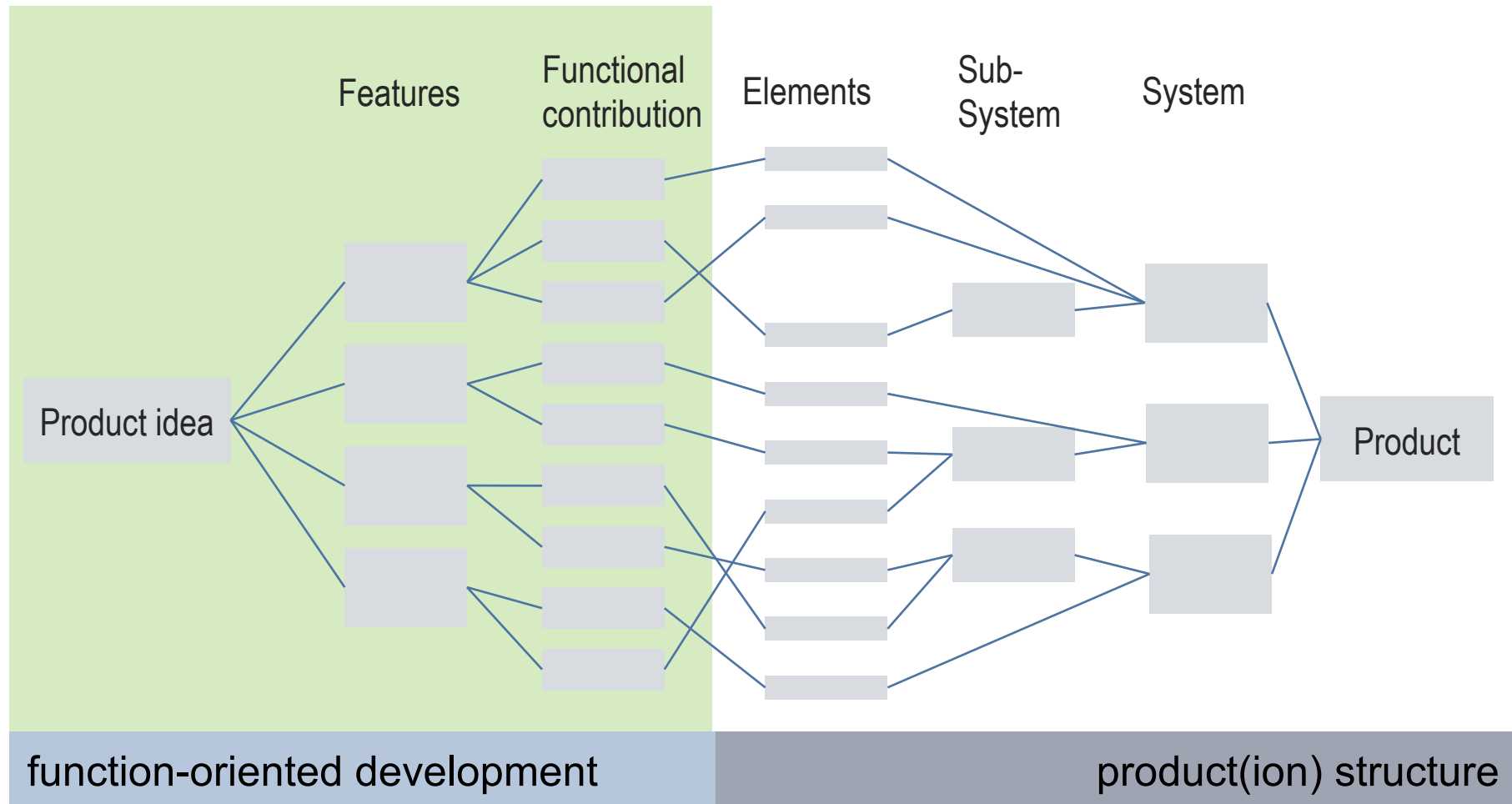
Each of the 3 primary types of requirement analysis review is used at a different stage of the requirements management lifecycle

Classification & Evaluation Review (Impact Analysis)

- Performed on incoming requirements
  - Shared by a customer, partner, or supplier
  - Allocated from a different level
  - Decomposed

- A qualified reviewer classifies various aspects of the requirement – including source, target object, stakeholder, requirement type, feasibility, verification method – to maximize comprehension and ensure the proper next steps can be taken

- Evaluation from subject matter experts (SMEs) where needed
  - Technology maturity and the novelty of the task to the team
  - Complexity to execute the requirement by the team
  - Agreement, clarification, or disagreement to the requirement
    - The requirement recipient should reject the requirement with justification as early as possible in the process
- Once classified and evaluated, each requirement's impact on the project can be determined

- Priority, timing, and resources can then be allocated for each requirement or set of requirements, and the project overall

Verification Review

- Performed on your own requirements to check the quality and completeness of sets of requirements and each requirement within
- Results in a correct set of requirements that can then be executed – implemented, verified, decomposed

Confirmation Review

- Performed on verified requirements to check the traceability of each requirement
  - Upstream traceability to the requirement source
  - Downstream traceability to decomposed requirements
  - Test coverage and traceability

Classification by requirement type, while less straightforward at the stakeholder level, is crucial to prioritize and assign requirements
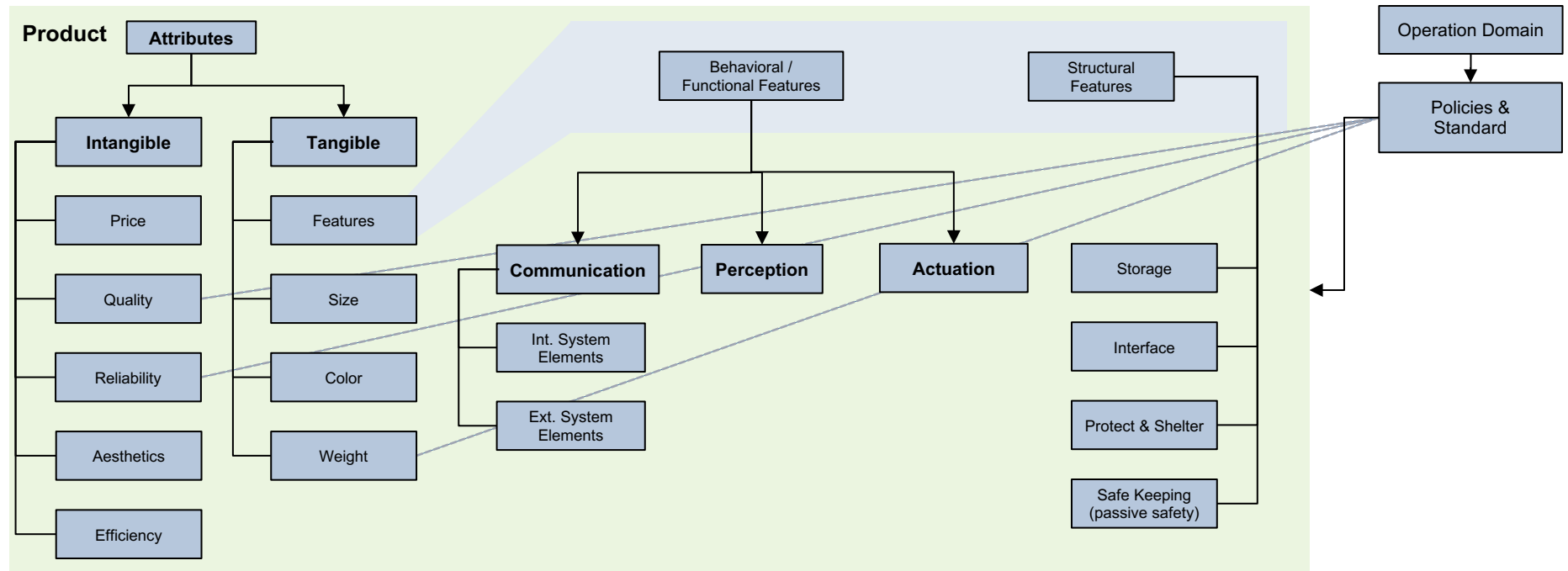
- Each organization should have a taxonomy that works for them – and is potentially streamlined during RFQ phase

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Requirements can now be evaluated and classified based on readiness level and effort needed for implementation/development

Field:	Allocation	Complexity	Maturity	Acceptance	V&V Method
Values:	Allocation Open (Default)	Complexity Open (Default)	Maturity Open (Default)	Acceptance Open (Default)	V&V Open (Default)
	Product Breakdown Domains, System Architecture Elements, or Functional Allocation	Reuse	Mature	Accepted	Analysis
		Adaptation	Immature	Accepted pending change	Simulation
		Development	Benchmarked	Clarification Required	Functional Test
		Innovation	New Market	Rejected	Destructive Test
		Not Feasible	New Application		Vehicle Test
Alternatives:	Subject Matter Expertise	TRL / Team Capability	TRL / MRL	Agreement	Integration / Qualification Level

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Software tools have multiple options for reviewing completed requirements, but often none is ideal for analysis and completion of incomplete requirements – the Requirements Manager must tailor the process to the project and team

Reviews: Entire Module

↑ Modules (requirement specifications) where one SME (or a single team of SMEs) is responsible for the entire module, regardless of requirement type

↓ Tool does not differentiate between a single requirement having been reviewed and an entire module having been reviewed

Artifact View: Line-by-line

↑ The entire module is visible to the reviewer, who can read in order and see all headings and supporting information

↑ SME team can easily split requirements amongst themselves

↑ Can easily batch edit attributes of multiple requirements, or edit line-by-line in the table view

↓ Relies on manual tracking of the review status (e.g., dashboard, filtered counts) using attributes in each artifact (e.g., comments)

Reviews: Selected Artifacts

↑ SMEs who have a specific responsibility, with a few requirements spread across multiple modules

↑ Review of each requirement is tracked individually, and overall status is reflective of percentage of requirements reviewed

↓ Need to open each artifact in a new tab and edit one-by-one to complete classification

↓ Onus on requirements manager to track that all incoming requirements have been reviewed

Artifact View: Filtered View
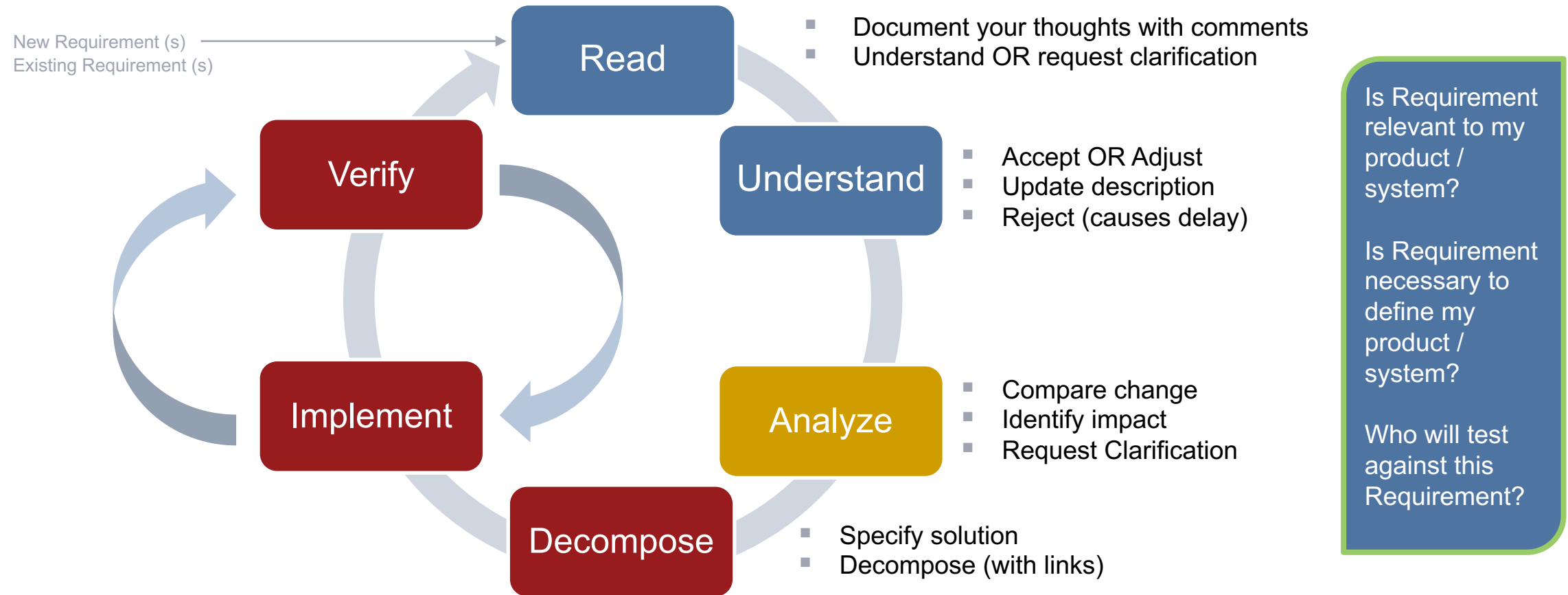
↑ Single team responsible for one module, with a clear split in responsibility amongst SMEs (e.g., requirement type)

↓ SMEs must un-filter the view to see supporting information or similar requirements

↓ Relies on manual tracking of the review status (e.g., dashboard, filtered counts) using attributes in each artifact (e.g., comments)

To successfully execute the requirements activities within the timeframe, key project stakeholders must be qualified in the process

Requirements Engineering cycle with modifications for RFQ phase

New Requirement (s)
Existing Requirement (s)

Read
- Document your thoughts with comments
- Understand OR request clarification

Understand
- Accept OR Adjust
- Update description
- Reject (causes delay)

Analyze
- Compare change
- Identify impact
- Request Clarification

Decompose
- Specify solution
- Decompose (with links)

Verify

Implement

Is Requirement relevant to my product / system?

Is Requirement necessary to define my product / system?

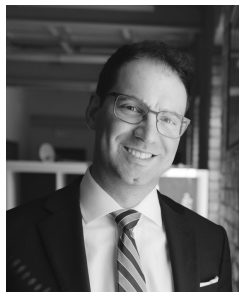Who will test against this Requirement?

Reflections and next steps

Evolution of the framework

❖ Develop organizational metrics based on this phase of the process

– OEM/requester evaluates suppliers based on their ability to process requirements and respond appropriately during RFQ phase

– Suppliers rate requesters based on the quality and usability of the requirements packages they provide

❖ The language of negotiation shifting from requirements to models

– Acceleration of the MBSE used during system integration to the RFQ phase

Refinement of the framework

o Data-driven prioritization of requirements classification

– Primary negative drivers

• Complexity? Type? Allocation?

– Consistent drivers from program to program? Team to team? Company to company? Industry to industry?

o Applicability of the framework and timelines to different industries

➢ Interaction and shared data from breadth of proposals and programs

Feel free to reach out with questions and feedback

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