2019
Annual **INCOSE**
international workshop
Torrance, CA, USA
January 26 - 29, 2019

Requirements Working Group

Lou Wheatcraft

- Senior Product Manager for [Seilevel](#)/[Requirements Experts](#) (RE)
- Has taught over 190 requirement seminars over the last 19 years.
- 22 years in the US Air Force
- Worked in the Astronaut Office at Johnson Space Center for 6 years.
- Works with both government and industry clients in multiple domains: Space systems, medical devices, etc..
- Chair of the INCOSE Requirements Working Group
- Member of PMI, the Software Engineering Institute (SEI), the World Futures Society, International Institute of Business Analysis (IIBA), and the National Honor Society of Pi Alpha Alpha.
- Has a BS degree in Electrical Engineering, MA degree in Computer Information Systems, MS degree in Environmental Management, and has completed the course work for an MS degree in Studies of the Future
- Author of numerous papers and presentations concerning requirement development and management
- Is the primary contributor to RE's blog on requirements best practices. The blog can be assessed at: http://www.reqexperts.com/blog .

Requirement Working Group

Chair: Lou Wheatcraft; Requirements Experts/Seilevel, USA
Co-Chair: Mike Ryan; University of New South Wales in Canberra, Australia
Co-Chair: Jeremy Dick, Costain, UK
Co-Chair: Kathy Baksa, Pratt&Whitney, USA
Co-Chair: Rick Zinni, Harris Corporation, USA
Co-Chair: Jason Baker; Transocean, USA

INCOSE Connect address:
https://connect.incose.org/WorkingGroups/Requirements/Pages/Home.aspx

Number of Members: 524 (392 IW2018) (largest and fastest growing WG)
Agile (367) (293)
MBSE Initiative (354)(274)
Lean (349) (323)
Transportation (244) (218)

Number of Members Participating in IW2018: 120 (87 Last IW)

Charter

(1) **Purpose**
The purpose of the Requirements Working Group (RWG) is to advance the practices, education and theory of requirements development and management and the relationship of requirements to other systems engineering functions.

(2) **Goal**
Expand and promote the body of knowledge of requirements and its benefits within the systems engineering community

(3) **Scope**
Activities relating to best practices for requirements development and management throughout the product lifecycle including:

Elicitation	Analysis	Allocation	Traceability
Elaboration	Management	Change Management	
Expression	Verification	Validation	

All IW presentations and associated materials are available on the RWG Connect web site:

https://connect.incose.org/WorkingGroups/Requirements/Pages/Home.aspx

Click on the "RWG sessions at IW2019" link on the left, then select "documents"

Published Products

- *Guide for Writing Requirements – 2017 version*

- *Guide for Writing Requirements Summary –* 2017 version

- Whitepaper*: Integrated Data as a Foundation of SE*

  - *Published in March 2019*

- Web tutorials to support *Guide for Writing Requirements (need to be updated to reflect 2017 Guide)*

Planned Activities for 2019

- Active participation in IS 2019

- Maintain the RWG public and Connect web sites

- Support the SE Tools Database development efforts

- Support the update to the INCOSE SE Handbook

Planned Work Products for 2019

- Update the INCOSE "Guide for Writing Requirements"
  - Update and peer review complete
  - Submitted to IPC for publication
- Develop draft "Guide for Managing Requirements"
- Develop draft "Guide to Verification and Validation"
- Update current webinar-based training for the Guide for WR with new on-demand training

To join the Requirements Working Group (RWG) :

1. Login to your INCOSE Membership account at INCOSE.ORG
2. Click on the "Profile Home" link at the top of the page.
3. Scroll down to "My committees/Working Groups and click on the link "Browse/Join a Working Group"
4. This will result in a list of Working Groups. (For some reason the page says "Browse Committees". I guess the page developers view Working Groups as Committees)
5. Scroll down until you see "Requirements" and then on the right-hand column, click on the (view) link.
6. This will result in a roster of current WG members.
7. Scroll down to the bottom of the list and under "Committee Tasks" click on "Join this Committee

That's it.   Welcome to the RWG!

Agenda for IW 2019

"The role of requirements in an MBSE world"

Saturday January 26 Location: **Pier 5**

08:00 -10:00	Opening Plenary
10:00 -10:30	Break
10:30 -11:00	Closed session to discuss IW 2019 Agenda
11:00 -12:00	RWG kick-off, Welcome, 2018 in review
12:00 -13:00	Lunch
13:00 -15:00	Overview to the *Guide to Writing Rqmts* and whitepaper *Integrated Data as a Foundation of SE* – Lou Wheatcraft (MBSE Related)
15:00 -15:30	Break
15:30 -17:00	Key Insights into Developing Requirements for the 21stCentury"– Lou Wheatcraft (MBSE Related)
17:30 - ?????	**RWG member dinner/social - location TBD**

Sunday January 27 Location **Pier 5**

08:00 - 09:00	"Augmenting requirements with models" – Stéphane Bonnet (MBSE Related)
09:00 - 10:00	"Managing the risks of requirement uncertainty"- Robert Bordley
10:00 - 10:30	Break
10:30 - 12:00	Work on developing the *Guide to Developing & Managing Requirements* – Kevin Orr (MBSE Related)
12:00 - 13:00	Lunch
13:00 - 17:00	Joint meeting with the TIMLM WG on the SE Tools Database (SETDB) – Tool Vendor Questionnaire

Monday January 28   Location: **Pier 5**

08:00 - 09:00	"Applying MBSE to Reduce Development Time" – Mary Compton, Marissa Conroy, (MBSE Related)
09:00 -10:00	"Actionable Requirements Definition Using an EARS OOPM" – Brenan Hall, (MBSE Related)
10:00 - 10:30	Break
10:30 - 11:30	"Requirements Efficiency: External Questionnaire Results" – Celeste Drewien (MBSE Related)
11:30 - 12:00	Ask the experts/Other topics as they evolve
12:00 - 13:00	Lunch
13:00 - 15:00	Joint meeting with the IV&V WG on developing the *Guide to Validation & Verification* – Lou Wheatcraft & Jim Armstrong
15:00 - 15:30	Break
15:30 - 16:30	Joint mtg with Oil & Gas WG: "Sharing requirements – a case study using REQIF" – Ray Climacosa (MBSE Related)
16:30 – 17:00	Managing Structured Requirement Content – Use Case - Pawel Chadzynski

Tuesday January 29   Location: **Pier 5**

08:00 - 10:00	Discuss updates to the *Guide for Writing Requirements* – Mike Ryan
10:00 - 10:30	Break
10:30 - 11:30	"Model-Based Requirements Engineering" – Jose Fuentes (MBSE Related)
11:30 - 12:00	Closed Session – work on IW MIS, 2019 planning
12:00 - 13:00	Lunch
13:00 - 14:00	"Improving Requirement Quality using MBSE - Matsuaki Kato
14:00 - 14:30	Ask the experts/Other topics as they evolve
14:30 - 15:00	Break
15:00 - 16:00	Closing Plenary
16:00 - 18:30	Closing Reception & WG Market Place

Five key insights from RWG IW 2019 sessions

- The concept of "duality" as applied to requirements and models.

- Requirements don't just happen – they are a transformation from a set of needs, that was transformed from a set of concepts that address a feasible solution to a problem.

- The quality of the requirements is directly proportional to the quality of the set of stakeholder needs from which they were transformed.

- Preliminary conceptual and physical design architectural models are both the source of the stakeholder needs and resulting requirements (design inputs) as well as the tools used to implement those same sets of needs and requirements in the form of the design and the engineered system of interest (design outputs).

- 20th century SE methods and practices are often not adequate to address the challenges of increasingly complex, software centric systems of the 21stcentury!

Insight 1:

- The concept of "duality" as applied to requirements and models.
  - Requirements are important and can not be replaced by diagrams/models
  - Diagrams/models are also important and can not be replaced by text-based requirements

Both are different sides to the same SE coin!

Why use the Textual Form of Requirements?

- For many ideas and concepts that need to be communicated; well-formed, text-based needs and requirements have been proven to be the most effective form.

- Communication
  - There is still (arguably, there will always be) a very sizeable audience who cannot interpret, do not understand, or who are not willing to work with, diagrammatic or other non-textual representations of needs or requirements.

- Power of Expression
  - There is a wide variety of types of needs or requirements that must be expressed.

- Accessibility
  - SE tools (including requirement management tools (RMT)) and modeling languages used to create and view the data and information represented by the model's dataset are not readily available and assessable to all stakeholders.

Reference: INCOSE Guide for Writing Requirements, 2019 version

Why use the Textual Form of Communication?

- Attributes
  - Both the need and requirement expressions include attributes that can be used to manage them as well as the system under development across all life cycle process activities.

- Formal, binding agreement
  - Text-based requirement statements are more easily understood in a formal agreement or contract-based system development effort by a wider, and often, non-technical set of stakeholders including business management, project management, configuration management, contract administrators and legal support.

- System verification and validation
  - Most formal agreement (contract) based product development and management processes include system verification and validation as formal processes that must occur prior to system acceptance and use.

Reference: INCOSE Guide for Writing Requirements, 2019 version

Requirements are the common thread that ties all life cycle activities and artifacts together.
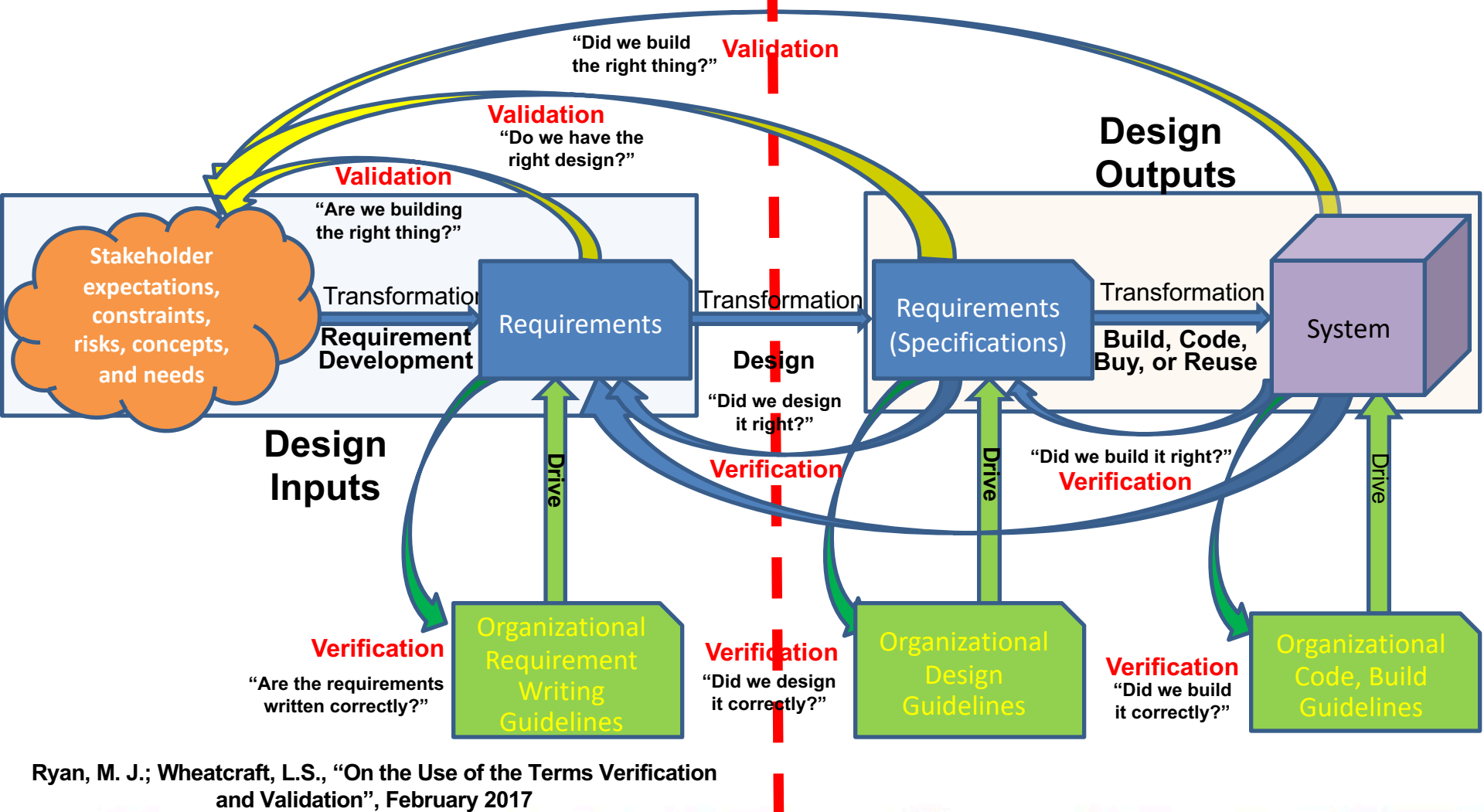
Ryan, M. J.; Wheatcraft, L.S., "On the Use of the Terms Verification and Validation", February 2017

Benefits of Diagrams & Models

- Models and diagrams are excellent methods for defining and maturing a feasible concept
  - Provide context for requirements
    - Helps ensure correctness, completeness, and consistency
  - Make complex systems and processes easier to understand
  - Facilitate communication
    - Picture is worth a thousand words……………..
  - Identify interdependencies
- Models and diagrams are excellent methods for transforming a conceptual model (design inputs) to a physical model (design outputs)
  - Allows modeling of interdependencies
  - Allows simulations

Insight 1:

- The reality is that the textual form of needs and requirements are not only useful, they are necessary.

- Operational scenarios, use cases, diagrams, and other types of models are also useful and necessary.

- Each of these forms represents a specific visualization and both need to be represented in an integrated data and information model of the SOI.

- With this approach, the underlying data and information model captures not only the needs and requirements but also their relationships to each other and to other artifacts represented within the data and information model.

- This enables stakeholders to view the data in whichever form is best for what they are trying to communicate or achieve.

- Therefore, it is important to understand which form and media is best to communicate specific ideas and concepts to a given audience over time.
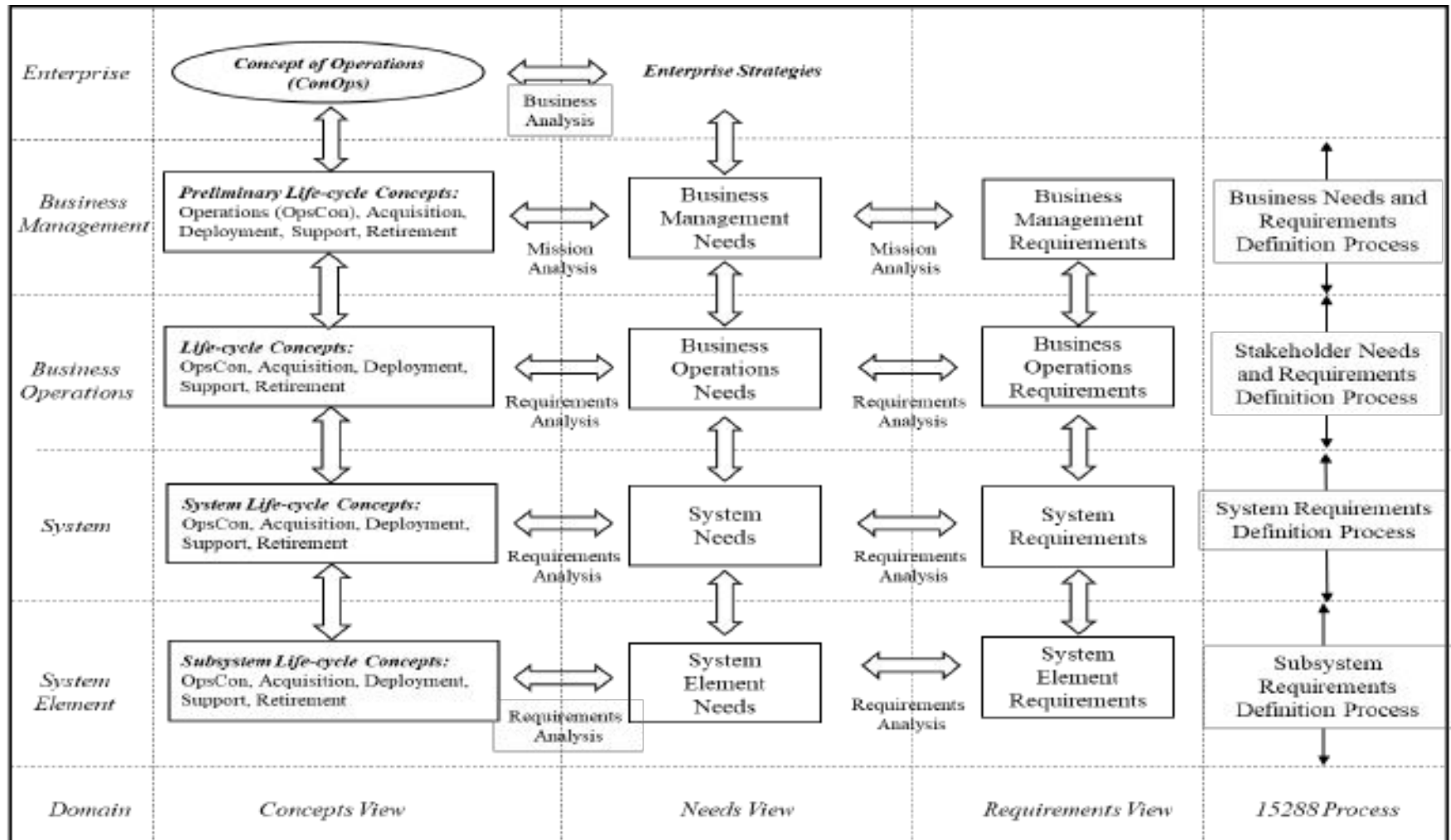
Reference: RWG "Integrated-data as a Foundation of SE

Insight 2:

- Requirements don't just happen –
  - they are a transformation from a set of needs,
  - that were transformed from a set of concepts that address a feasible solution to a problem.

Transformation of concepts into needs into requirements (based on Ryan, 2013)

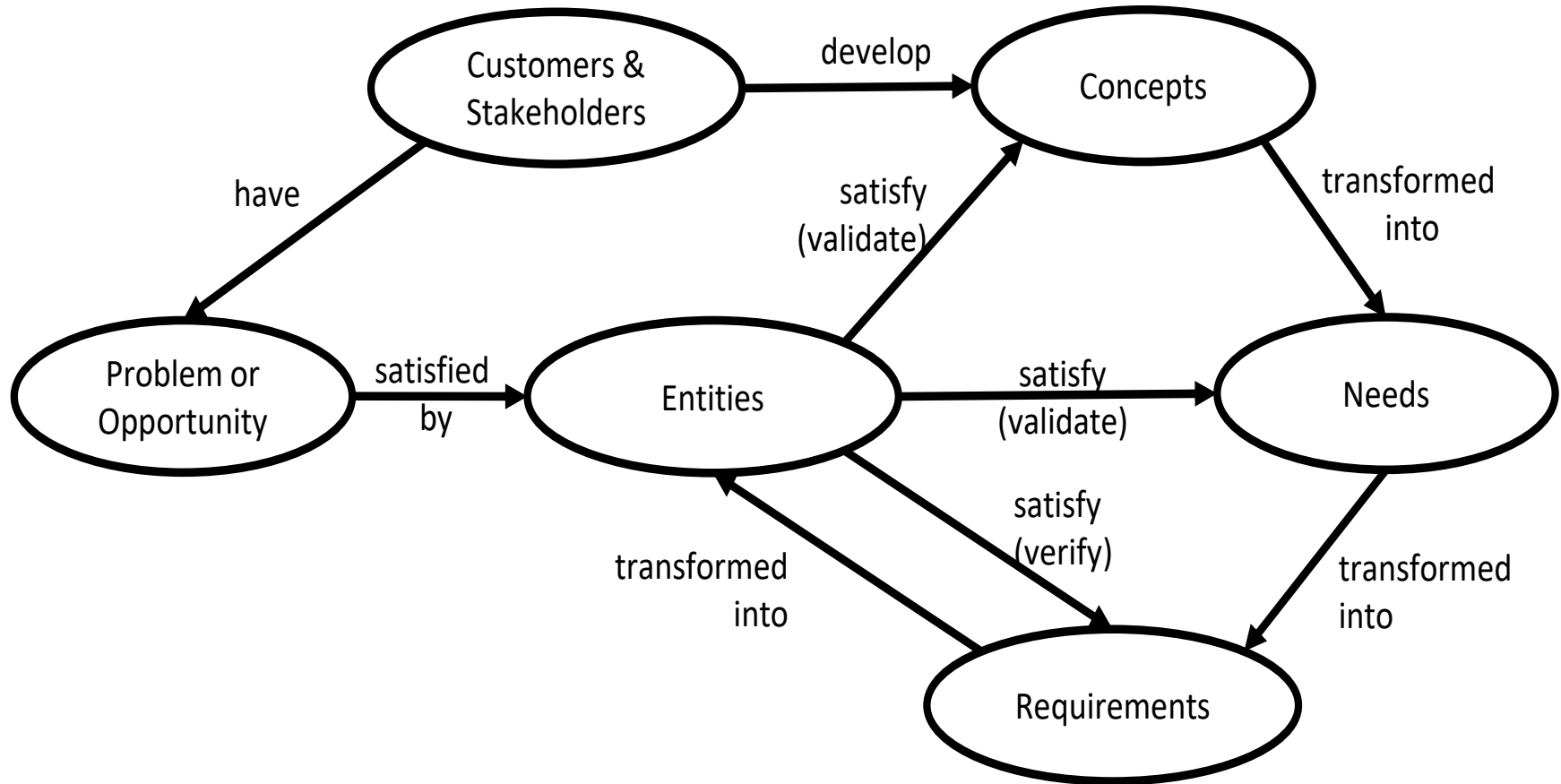Reference: INCOSE Guide for Writing Requirements, 2019 version

Definitions

- *An **entity** is a single thing to which a concept, need or requirement applies: an enterprise, business unit, service, system, or system element (which could be a product, process, human, or organization).*

- *A **concept** is a written or graphic representation that concisely expresses how an entity will satisfy the problem or opportunity it was defined to address within specified constraints with acceptable risk.*

- *A **need statement** is the result of a formal transformation of one or more concepts into an agreed-to expectation for an entity to perform some function or possess some quality (within specified constraints with acceptable risk).*

- *A **requirement statement** is the result of a formal transformation of one or more needs or parent requirements into an agreed-to obligation for an entity to perform some function or possess some quality (within specified constraints with acceptable risk).*

Reference: INCOSE Guide for Writing Requirements, 2019 version

Entity-relationship diagram for customers, concepts, entities, needs and requirements terms (based on Ryan and Wheatcraft, 2017)

Reference: INCOSE Guide for Writing Requirements, 2019 version

Insight 3:

- The quality of the requirements is directly proportional to the quality of the set of stakeholder needs from which they were transformed.
- Likewise, the quality of the set of needs is directly proportional to the quality and quantity of the work done to
  - Identify the problem
  - Define "Need", goals, & objectives
  - Understand the stakeholder expectations
  - Identify drivers, constraints, and risks
  - Define a feasible logical and physical concept (model) based on this information prior to documenting the needs (and resulting requirements)
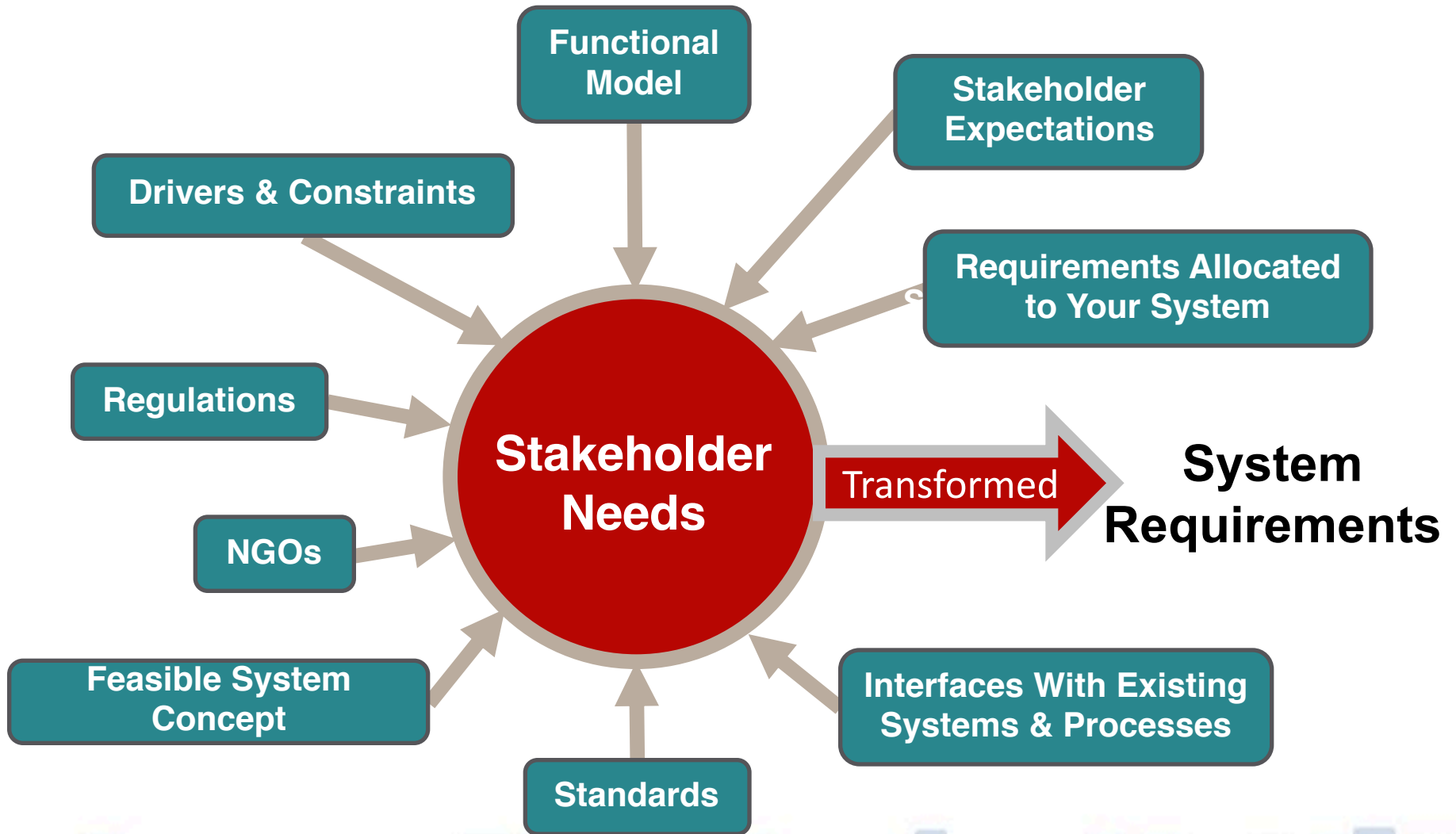
Define Scope to ensure that the technical team has defined a feasible concept that has been agreed to by the stakeholders before documenting stakeholder needs and transforming them into requirements.

Components of Scope Definition
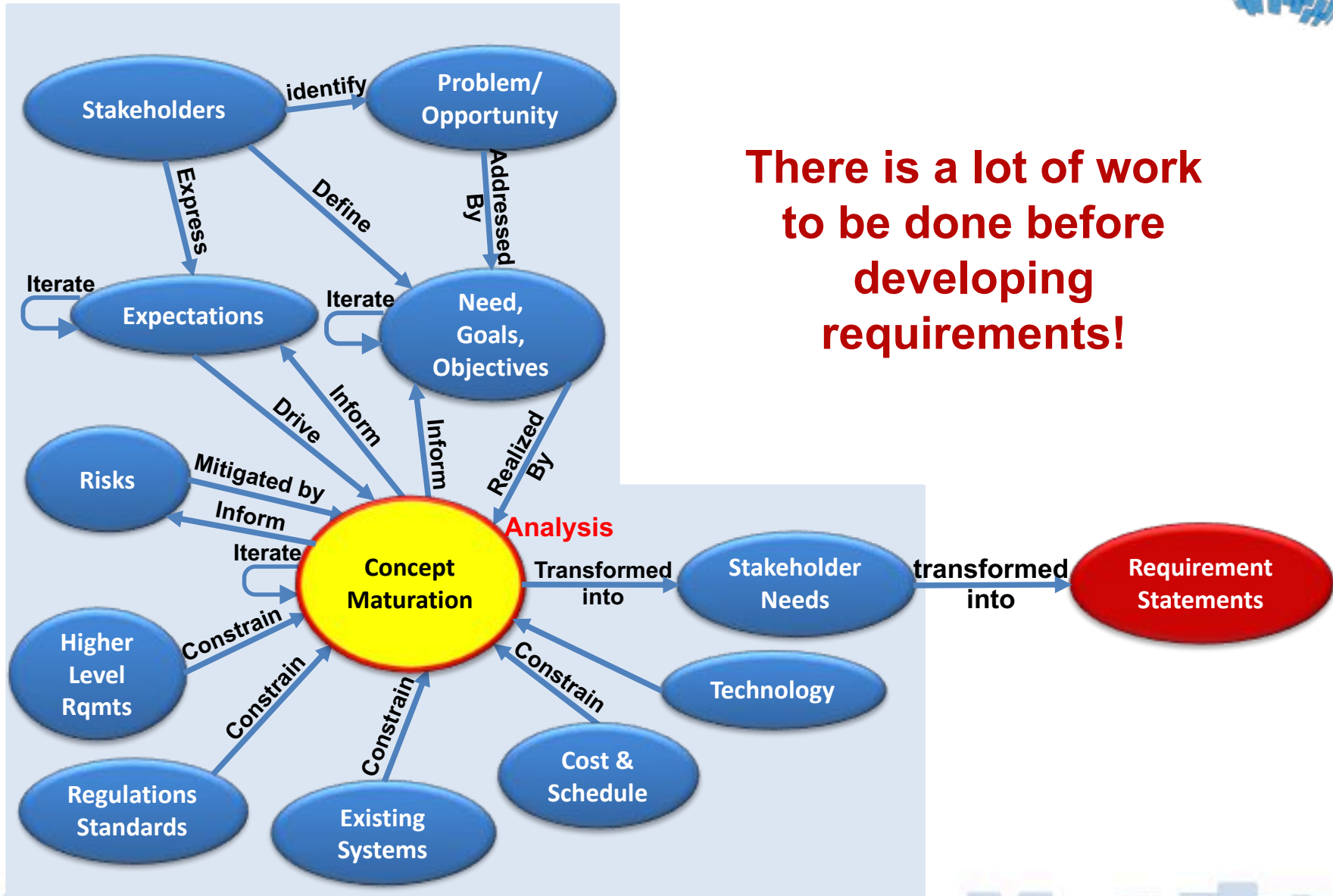
There is a lot of work to be done before developing requirements!

Stakeholder Needs are the Result of the Scope Definition Activities

Functional Model

Stakeholder Expectations

Drivers & Constraints

Requirements Allocated to Your System

Regulations

Stakeholder Needs

Transformed

System Requirements

NGOs

Feasible System Concept

Interfaces With Existing Systems & Processes
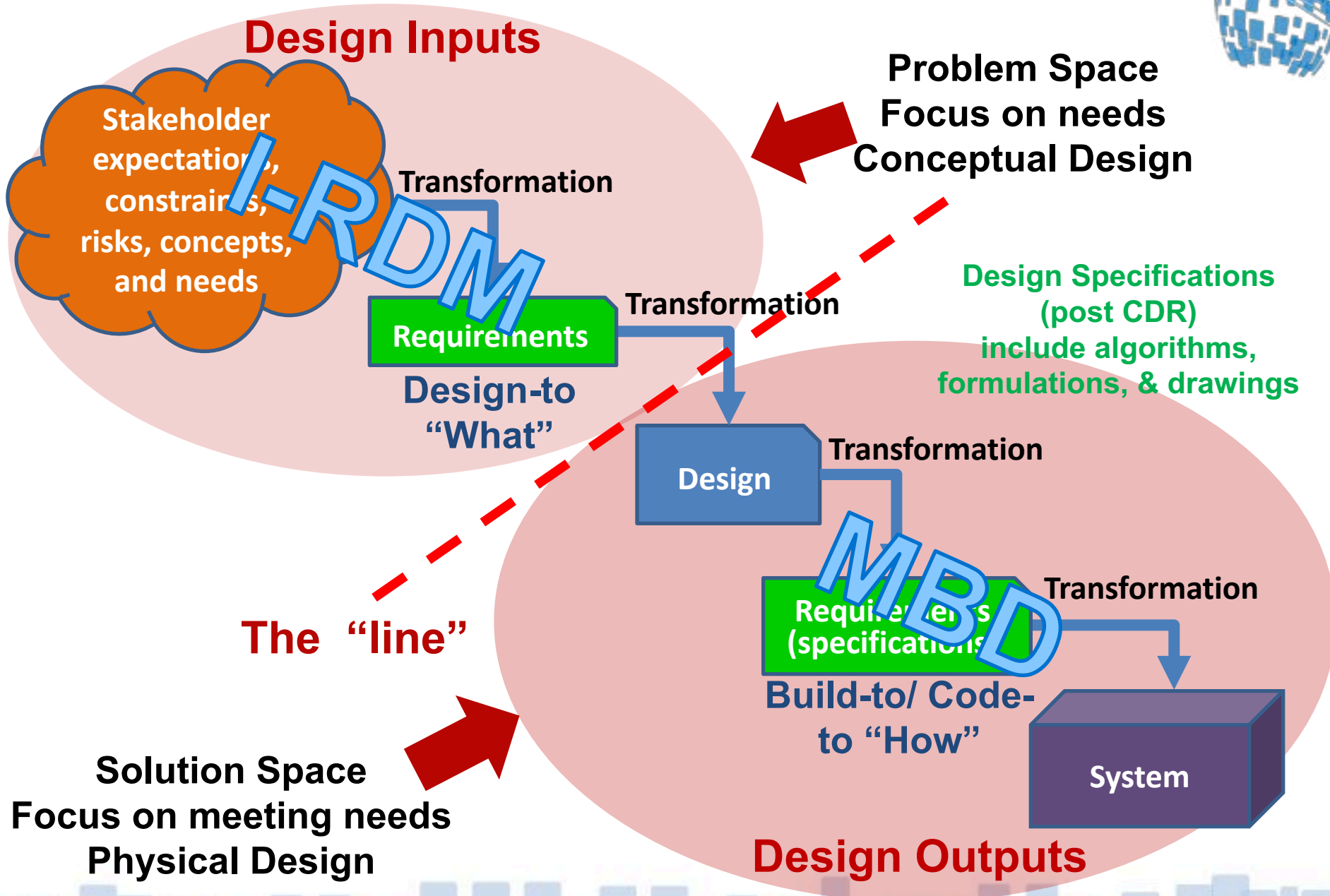
Standards

Insight 4:

- Preliminary conceptual and physical design architectural models are

  - both the source of the stakeholder needs and resulting requirements (design inputs)

  - as well as the tools used to implement those same sets of needs and requirements in the form of the design and the engineered system of interest (design outputs).

Models Throughout the System Life Cycle

Design Inputs

**Problem Space
Focus on needs
Conceptual Design**

Stakeholder expectations, constraints, risks, concepts, and needs

I-RDM

Transformation

Requirements

Design-to "What"

Transformation

**Design Specifications
(post CDR)
include algorithms,
formulations, & drawings**

Transformation

Design

Transformation

MBD

Requirements (specifications)

Build-to/ Code-to "How"

Transformation

System

The "line"

**Solution Space
Focus on meeting needs
Physical Design**

Design Outputs

Putting it all together

Information-based Requirement Development & Management

Physical Baseline

Scope Definition
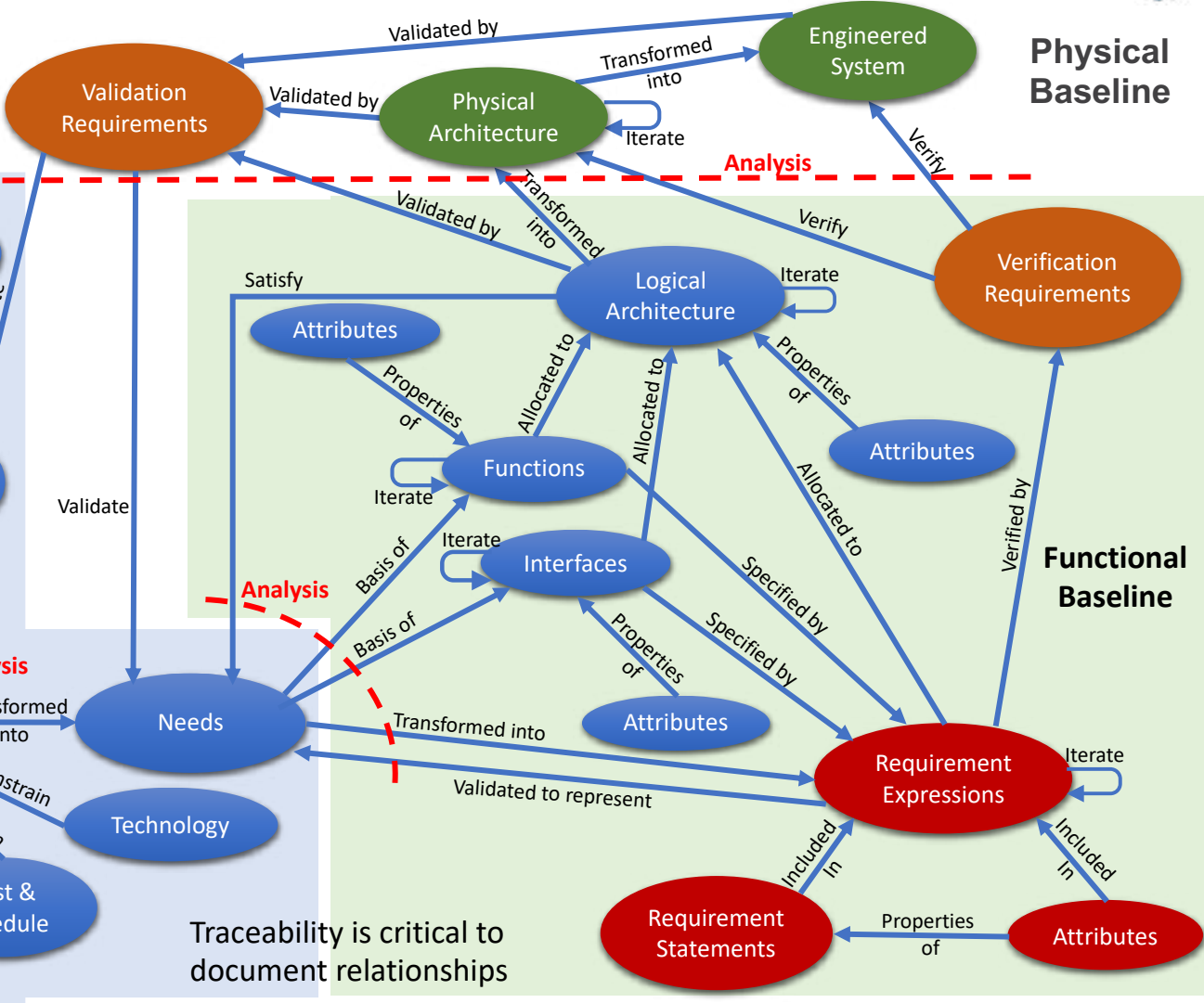
Traceability is critical to document relationships

Functional Baseline

Insight 5:

- 20th century SE methods and practices are often not adequate to address the challenges of increasingly complex, software centric systems of the 21st century!

Insight 5:

- Today's system development environment presents many key challenges as a result of increases in:
  - complexity
  - role software has in the system architecture
  - dependencies between key parts of the system
  - oversight
  - competition
  - program/project risks
  - development risks
  - operational risks
  - number of programs that are over budget
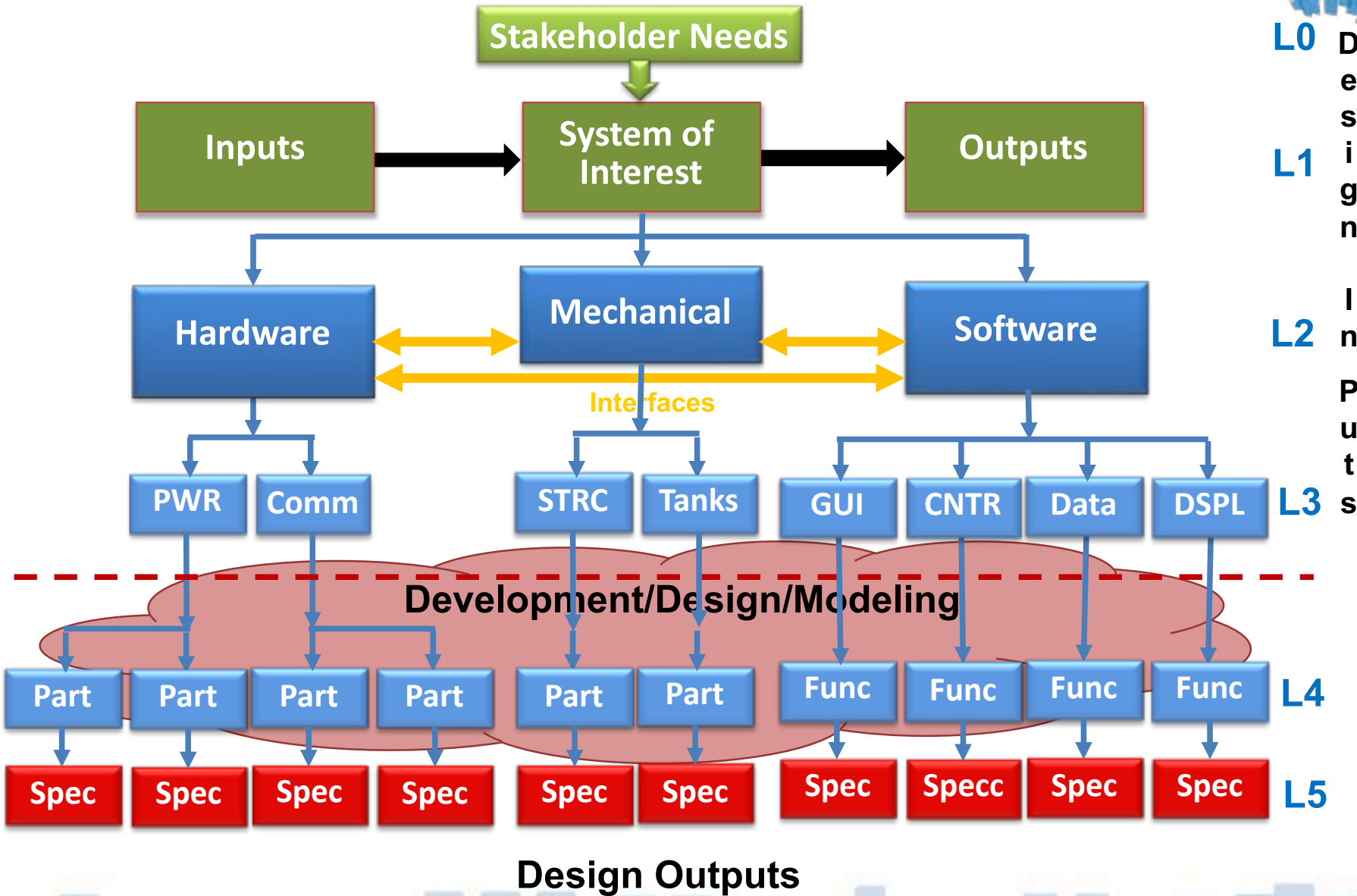 - number of programs whose schedule keeps slipping

One Answer: Better Systems Engineering

Approaches to address these challenges

- Incorporate systems thinking into all phases of product development
  - Systems must be managed at the systems level
  - Focus on interdependencies of the parts that make up the system
  - May have to sub-optimize the subsystems to optimize the system
- Move software up in the system's architecture hierarchy
  - Move from a hardware-centric view to a software-centric view
- Communicate requirements at the proper level
- Recognize the importance of well-formed and managed requirements to the success of a program/project
- Define scope and stakeholder needs before developing requirements
- Identify a feasible concept before developing requirements
  - Use modeling to help ensure completeness, consistency, and correctness of stakeholder needs and resulting requirements
  - Address concept maturity at each gate review
- Understand the role of both requirements & diagrams/models and which form is best to communicate a specific thing.

Systems Hierarchy – Software Centric

Stakeholder Needs

Inputs	System of Interest	Outputs

L0

L1

L2

Hardware — **Mechanical** — **Software**

Interfaces

L3: PWR, Comm, STRC, Tanks, GUI, CNTR, Data, DSPL

Development/Design/Modeling

L4: Part, Part, Part, Part, Part, Part, Func, Func, Func, Func

L5: Spec, Spec, Spec, Spec, Spec, Spec, Spec, Specc, Spec, Spec

D e s i g n   I n P u t s

Design Outputs

Questions?