INCOSE International Symposium
Las Vegas, NV
June 30 - July 3, 2014

Systems Engineering on California Highs-Speed Rail

Lean Systems Engineering Working Group

Oliver M. Hoehne, PMP
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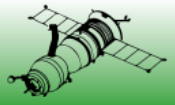
Parsons Brinckerhoff, Transit & Rail Systems, Newark, NJ, USA


CALIFORNIA HIGH-SPEED RAIL

PROJECT BACKGROUND

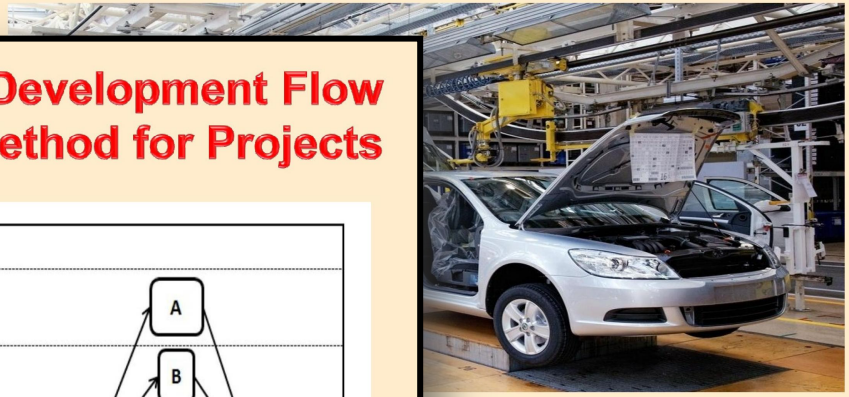
- First High-Speed Rail in U.S.
- Construction has started
- SF to LA in under 3 hours by 2029
- 800 Miles, 24 stations
- Operating Speed of 220 mph

Lean Management of Complex Programs

HSR Authority, Sac
April 4, 201

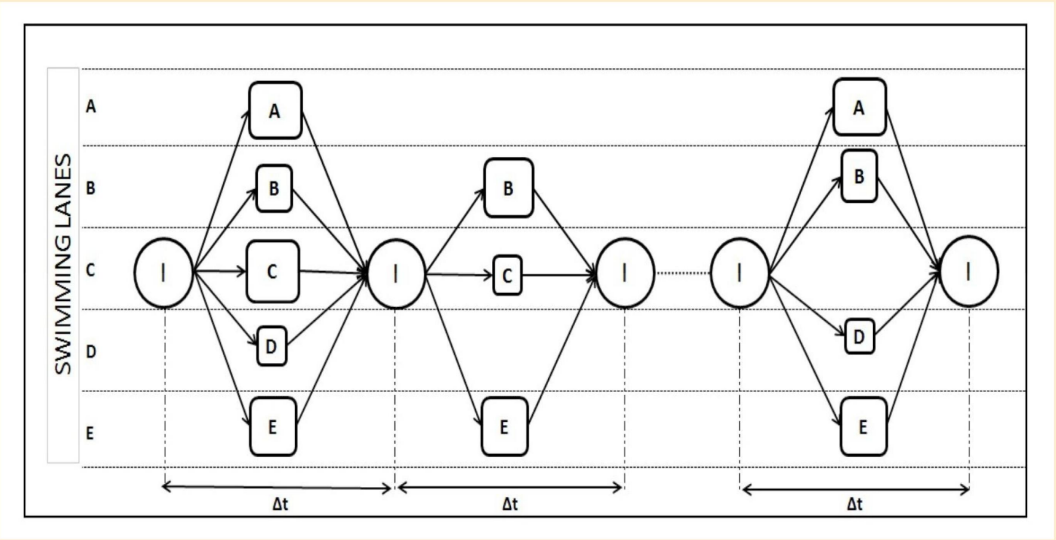
Lean Product Development Flow (LPDF) Method for Projects

Is it possible to execute one-off projects as predictably and efficiently as a car assembly line?



orker
ary object (e.g. a satellite assembly)

Lean Product Development Flow (LPDF) Method for Projects



The flow proceeds through the alternating work periods called Takt Periods (short and of equal duration) and Integrative Events "I", providing common, frequent rhythm and flow to the entire project team.

Overcoming Engineering Silos by Applying Systems Engineering Principles

Case Study: California High-Speed Rail System

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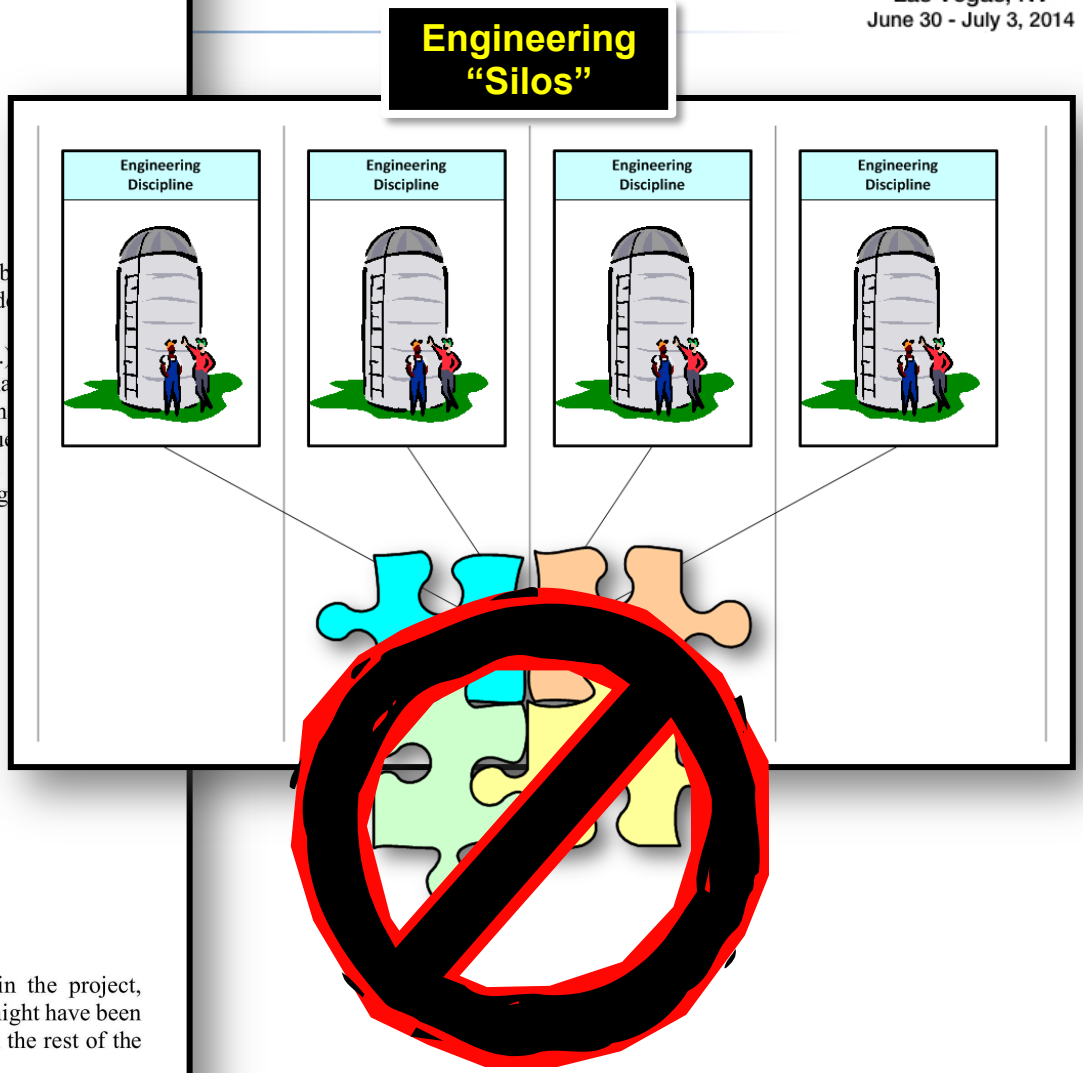
Abstract. Due to their size, large projects are often subdivided into a numb organizational and functional units to remain manageable. Examples includ subsystem (e.g. operations, infrastructure, track, systems, rolling stock, procurement contract (e.g. guideways, tunnels, stations, facilities, systems, etc.) typically managed independently, reporting to an overall program/project mana of command. While this addresses the need for scope, cost and schedule man often at the cost of an inclusive, global engineering perspective. This frequ "engineering silo" solutions which, though perfectly designed and functional systems, may not necessarily be compatible with each other, as illustrated in Fig

Figure 1: Building a Car with Engineering Silos [1]

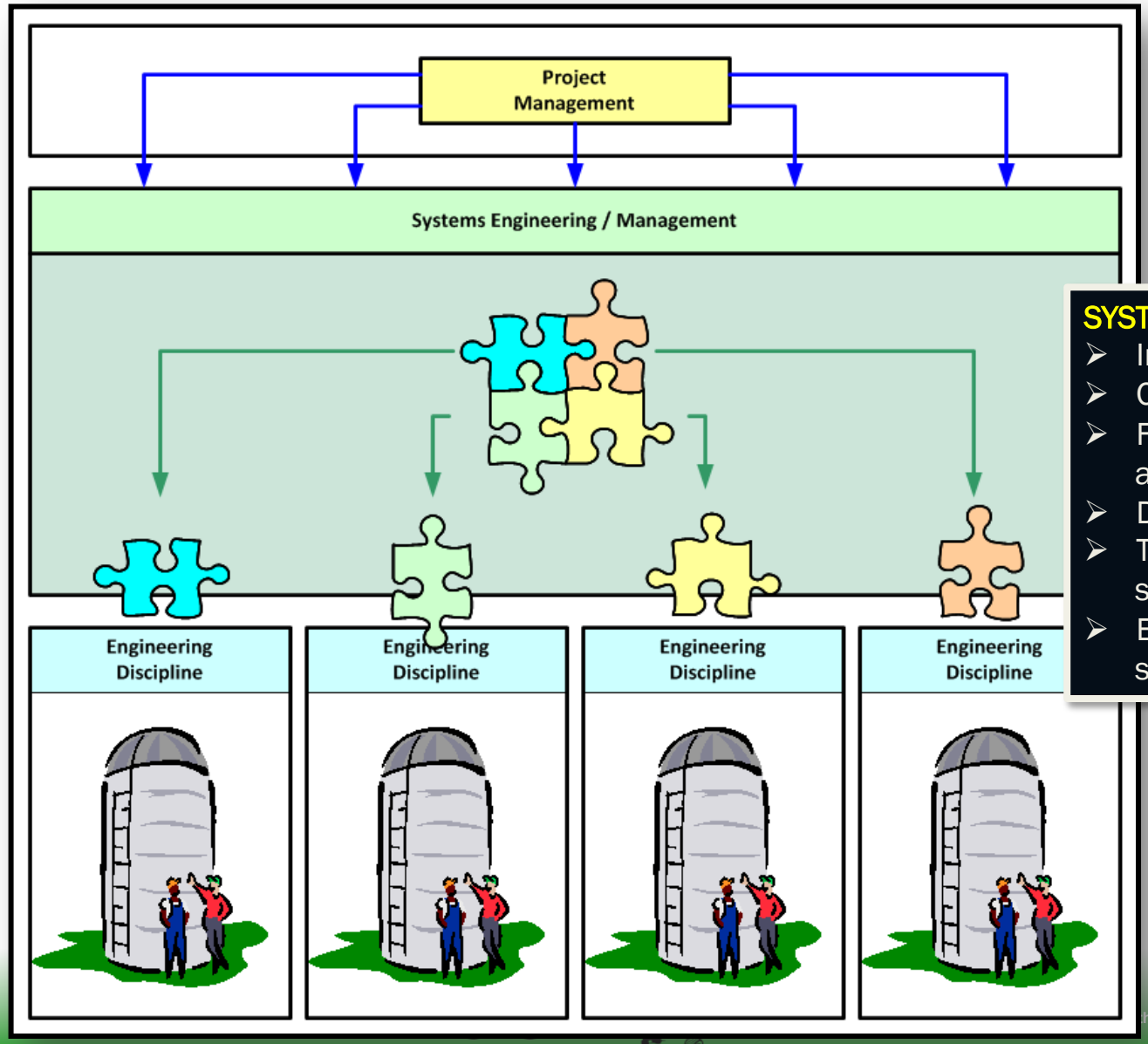
The effects of independent engineering are often not identified until late in the project, typically during construction, system integration or start-up testing. Contracts might have been accepted before it is realized that the subsystems are not fully compatible with the rest of the system.

This paper describes how the California High-Speed Rail System (CHSRS) project uses Systems Engineering (SE) principles to overcome the engineering silo mentality, leading to a better product with fewer defects, unplanned rework and associated negative impacts on cost, schedule and reputation.



CALIFORNIA HIGH-SPEED RAIL

EARLY INTEGRATION ACROSS DISCIPLINES



SYSTEMS ENGINEERING:

- Interdisciplinary approach
- Considers the complete problem
- Focuses early on customer needs and required functionality
- Documentation of requirements
- Then proceeding with design synthesis and system validation
- Enables realization of successful systems

CALIFORNIA HIGH-SPEED RAIL
USER REQUIREMENTS ANALYSIS

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Scenario 4-9 – Hot Axle Bearing Detector

Operational Scenario

CHSRS rolling stock will have an on-board detec… monitoring the health of the axle bearings. Among the fact… bearing. The equipment will also be capable of… detectors (HABD).

The scenarios below are based on the following as…

- All monitoring of CHSRS rolling stock … monitoring system.
- The intent of CHSRS wayside HABDs i… before it enters the CHSRS main track.
- Wayside HABDs will only be placed at th… foreign railroads enter onto, or pass through…
- Wayside CHSRS HABDs will be interface… system and the ATC system.
- Wayside HABDs of other railroads will not b…

Alarm indications from wayside HABDs will … workstations used by Train Dispatchers (TD) and th…

- Director of Operations Control (DOC)
- Deputy Director of Operations Control (DD…
- Infrastructure Operations Controller (IOC)
- Security Operations Controller (SOC)

Why

Scenario 4-9A: HABD Detects Hot Bearing – Train Stopped Clear of Main Track

Foreign train approaching the CHSRS main tracks on a connecting track from another railroad passes HABD which detects a hot bearing. HABD sends input to Wayside Detector SCADA (WDS). WDS sends alert to default workstations.

User	Location	Systems	Role and Responsibilities
HABD Detects Hot Axle Bearing on Passing Train			
Train Dispatcher	OCC/RCC	HABD WDS ATS ATC Telephone	• T… visual and audible alert on workstation indicating the location where a HABD has detected a fault. • TD confirms train movement through location. • TD uses Automatic Train Supervision – Manual (ATS-Manual) train control component of ATC s… stop command to foreign train. • C… OC via direct telephone line, relay pertinent information and action taken.
DOC	OCC/RCC	Telephone Radio	• Confer with TD via direct telephone line; confirm pertinent information and action taken. • Contact foreign via radio, relay reason for stop and instruction to check train for hot axel bearing. (Specific information provided to the extent HABD is capable of providing.) • Instruct crew they have a block on adjacent tracks (if any) to inspect train. • Instruct IOC and SOC via direct telephone line to check SCADA systems for indications of trouble.
IOC	OCC/RCC	Engineering SCADA	• Check engineering SCADA systems for indications of failures.
SOC	OCC/RCC	Intrusion Detection System	• Check intrusion detection (ID) SCADA system for anomalies.
Locomotive Engineer	Train	Radio	• Communicate via radio with DOC. Acknowledge instructions to inspect train and notify crew. Monitor radio for further instructions.
Conductor	Train	Radio	• Communicate with engineer via hand-held radio. Prepare to inspect train.

When

Who **Where** **How** **What**

CALIFORNIA HIGH-SPEED RAIL

HIGH-LEVEL SYSTEM ANALYSIS

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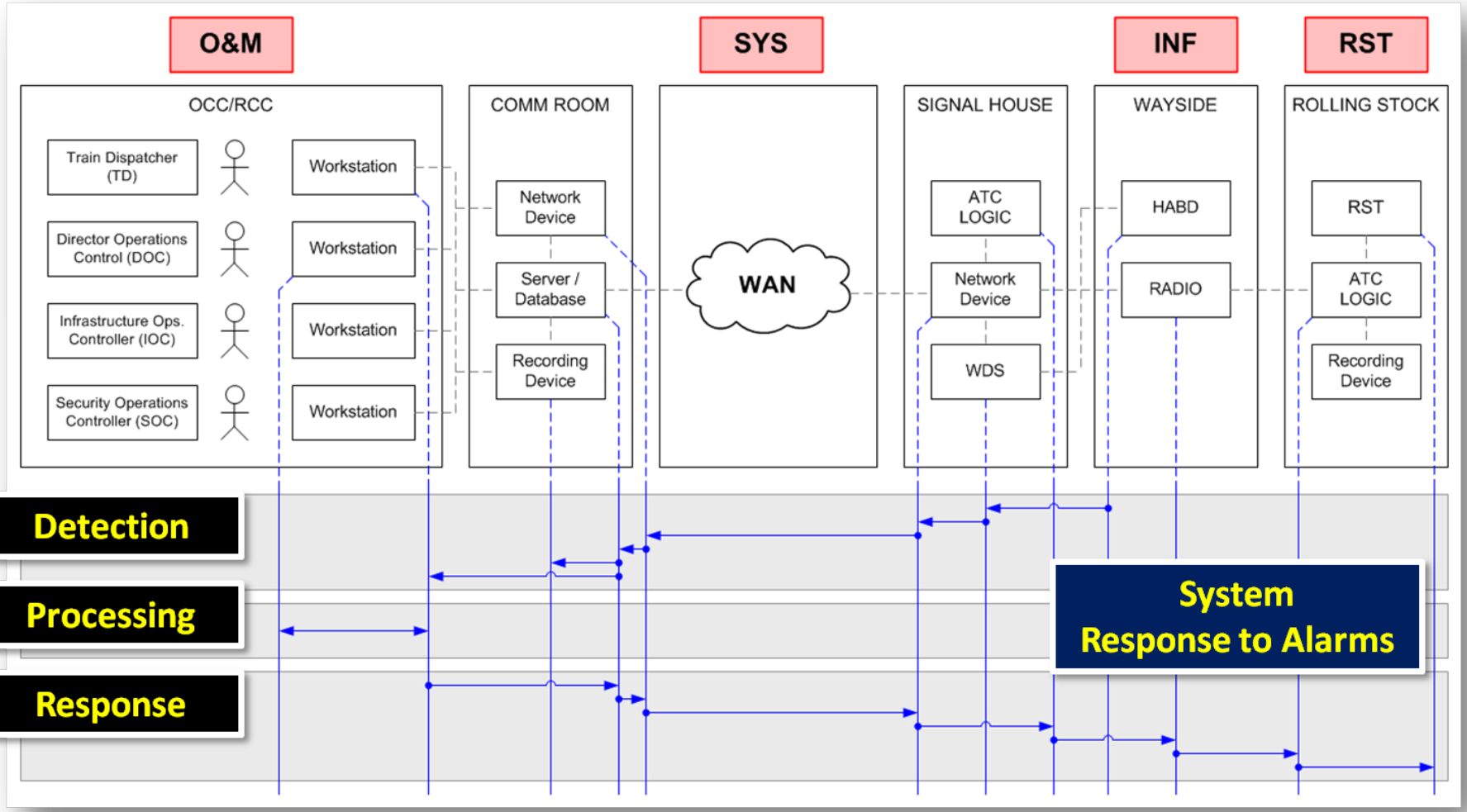

CALIFORNIA HIGH-SPEED RAIL

MORE AT THE INCOSE IW15

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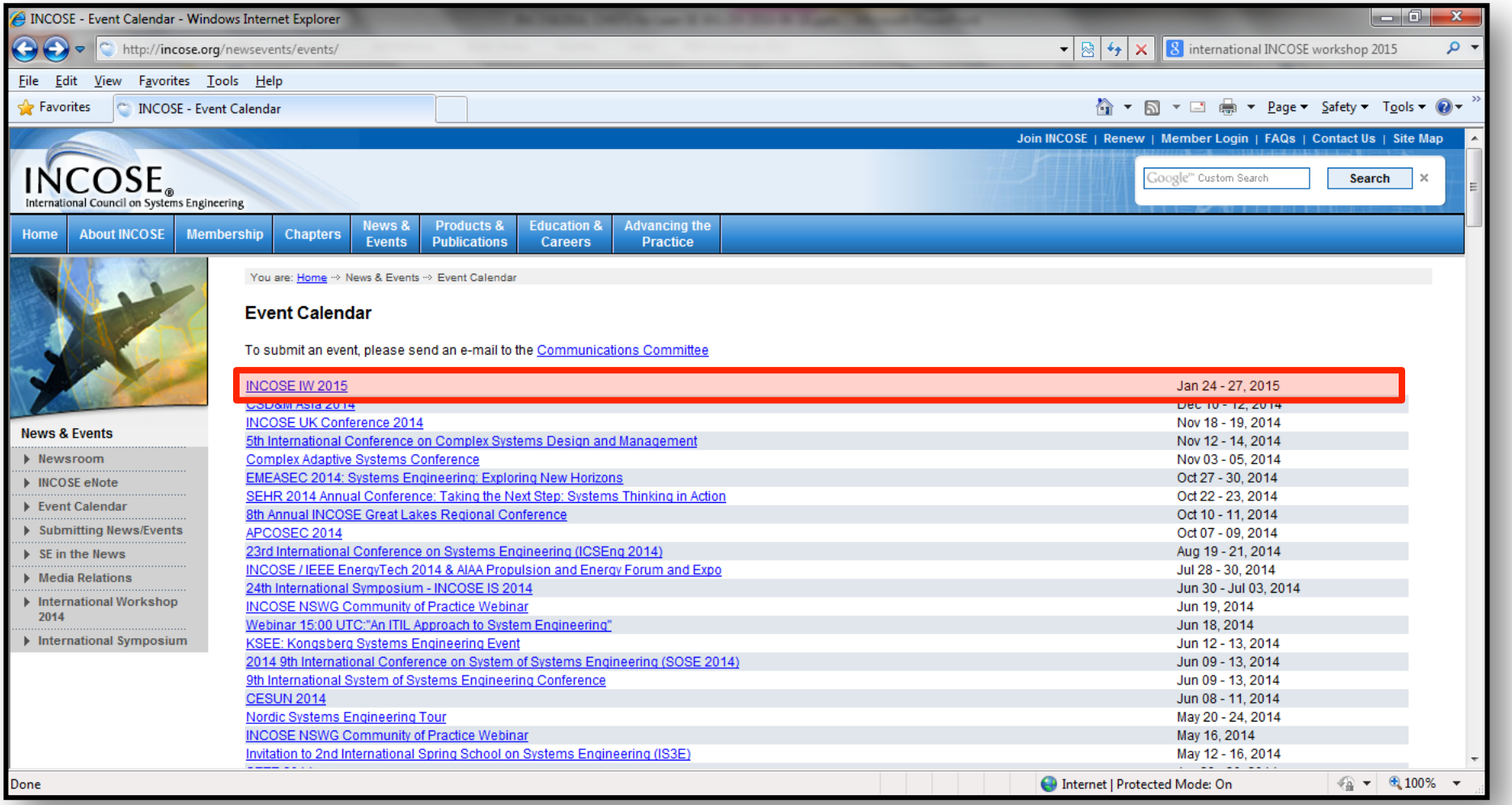

CALIFORNIA HIGH-SPEED RAIL

VISIT US ON TUESDAY JULY 1, 2014

INCOSE International Symposium
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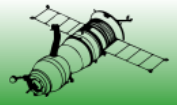
When, Where	What	Who (or Description)
8-9:30am Check location during registration	**Keynote speaker** *Thinking differently about systems engineering change programs – dogs, bears and magic numbers*	Scott McArthur, Sculpture Consulting Ltd
10:00-12:10pm Track 4 La Sirena IV	**Paper Session** *Perspectives on SE*	**Session chair:** Nita Rabadia (HS2)
	On Motivating People to Implement Systems Engineering Getting from the Necessary to the Impossible	Oliver M. Hoehne (Parsons Brinckerhoff, Transit & Rail Systems)
	What color is your nail polish? How to use Myers-Briggs personality characteristics to identify potential Systems Engineers in your organization	Jennifer L. Russell (Parsons Brinckerhoff)
	Coming in Under Par: What Golf Can Teach Us About Systems Engineering	David D. Walden (Sysnovation, LLC)

Transportation WG Presentations, Recommended by Energy & Infrastructure WGs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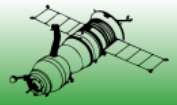
What color is your nail polish?

How to use Myers-Briggs personality characteristics to identify potential Systems Engineers in your organization

Jennifer L. Russell, EISE
Lead Systems Engineer
Parsons Brinckerhoff

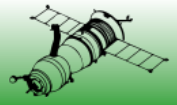

Nail Polish?

- IS13 ~ 30% women; most wore blue/green toe nail polish

Do these Systems Engineers have something in common?

Capturing the essence of SE

- Competency model
- Kasser, Hitchins, Frank, Zhao (2012)
  - Personal skills assessments and competency models found consistency
  - Systems Engineers
    - Learn new skills
    - Have mental flexibility
    - Hone their competencies


Kasser, Hitchins, Frank, Zhao

(2012)

- Definition of competency varies
- Skills vary by industry, position, and function

3. ROLES AND ACTIVITIES OF SYSTEMS ENGINEERS

- The role of the systems engineer in the workplace depends on the situation.
- Definitions and descriptions of systems engineering currently comprise different interpretations of the broad raft of activities that systems engineers might undertake according to their role in the workplace.

Capturing the essence of an SE

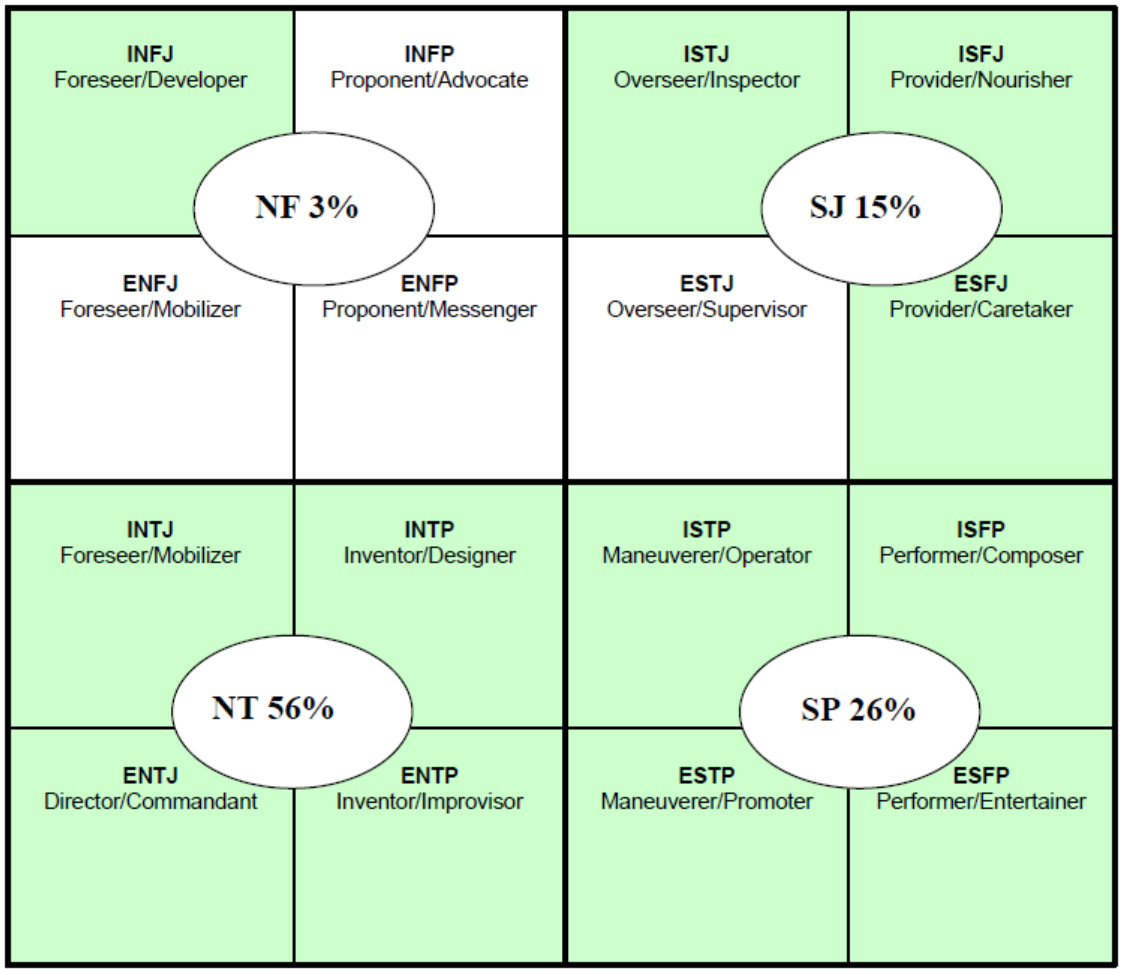
- Williams and Derro (2008) NASA
  - Seeking predictors of success
  - Identified observable behaviors

Table 1 Behavioral Competency Model Framework

Level	Description	Example
Top: Themes	Collections of competencies	Attitudes and Attributes
Middle: Competencies	Aggregations of related observable behaviors	Seeks information and uses the art of questioning
Lowest: Actual Behaviors	Observable behaviors	Asks difficult questions of discipline or subsystem experts regarding boundaries, conditions, and assumptions to ensure continuity across all systems, and to ensure the proposed solution is an integrated solution and fundamentally makes sense

Williams and Derro (2008)

Figure 3 MBTI® Types Occurring in SEs Studied Across the Agency

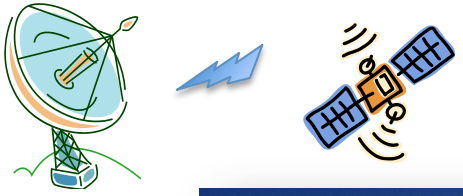


Why look for Systems Engineers

- Part of INCOSE mission "To share, promote, and advance the best of systems engineering…"
- Growing into emerging domains
  - Biomedical
  - Infrastructure
  - Power & Energy
  - Transportation

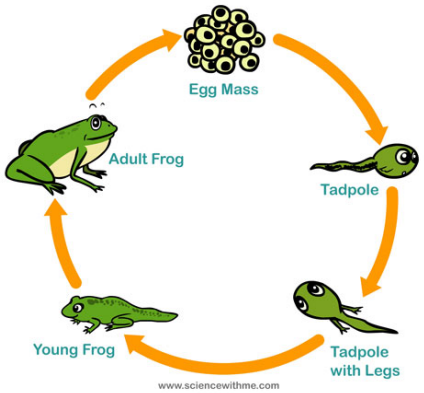
Challenges in emerging domains

- Unreasonable to test for SE competency
- Teams don't know Systems Engineering
- Confusion of terms
  - System



  - Architecture

  - Life-cycle



How emerging domains grow

A. Grassroots approach

B. Leader-driven

- Fragile “test case”
  - Needs to be logical, be right, and be accepted

Alstom MF2000 for Paris Metro

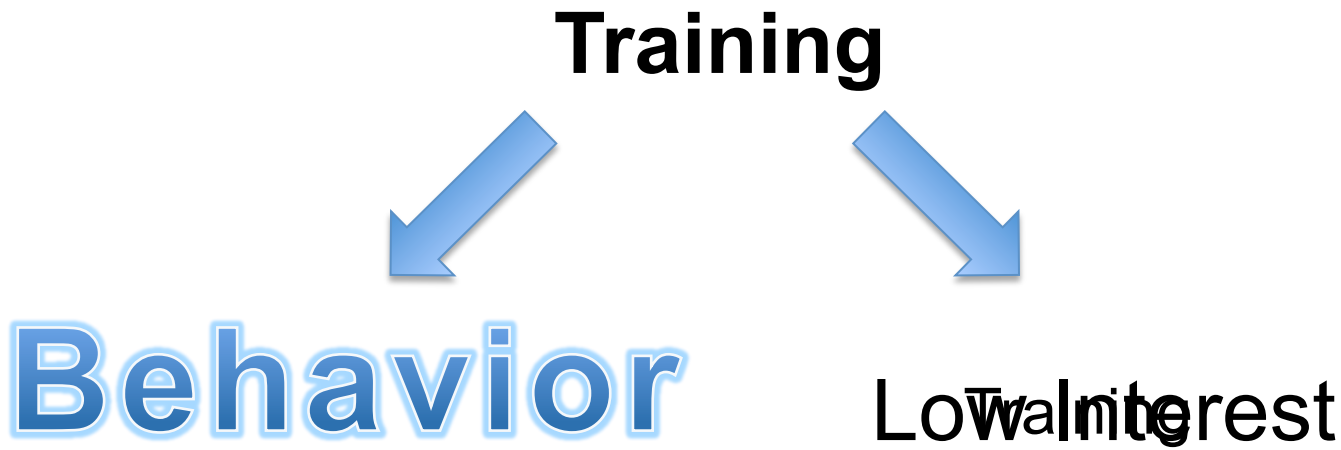
Cognitive Psych

Learn new skills
Apply learning
Higher level skills

- National Research Council (2000) consolidated previous decades of research on how we learn
  - Comprehension
  - Effective application of knowledge
  - Competency

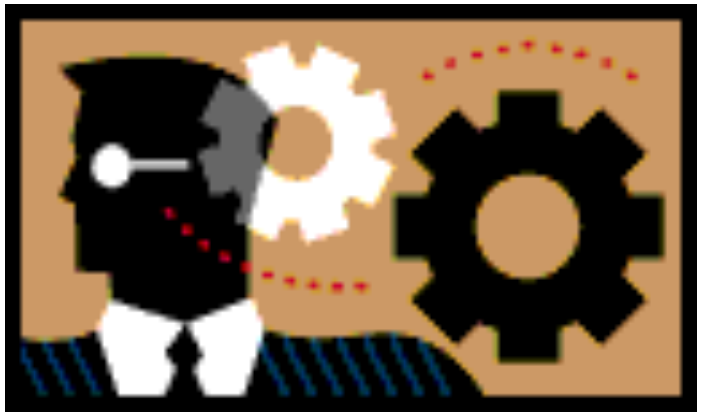
  … all increased when learners had an INTEREST in the subject

Getting closer to success



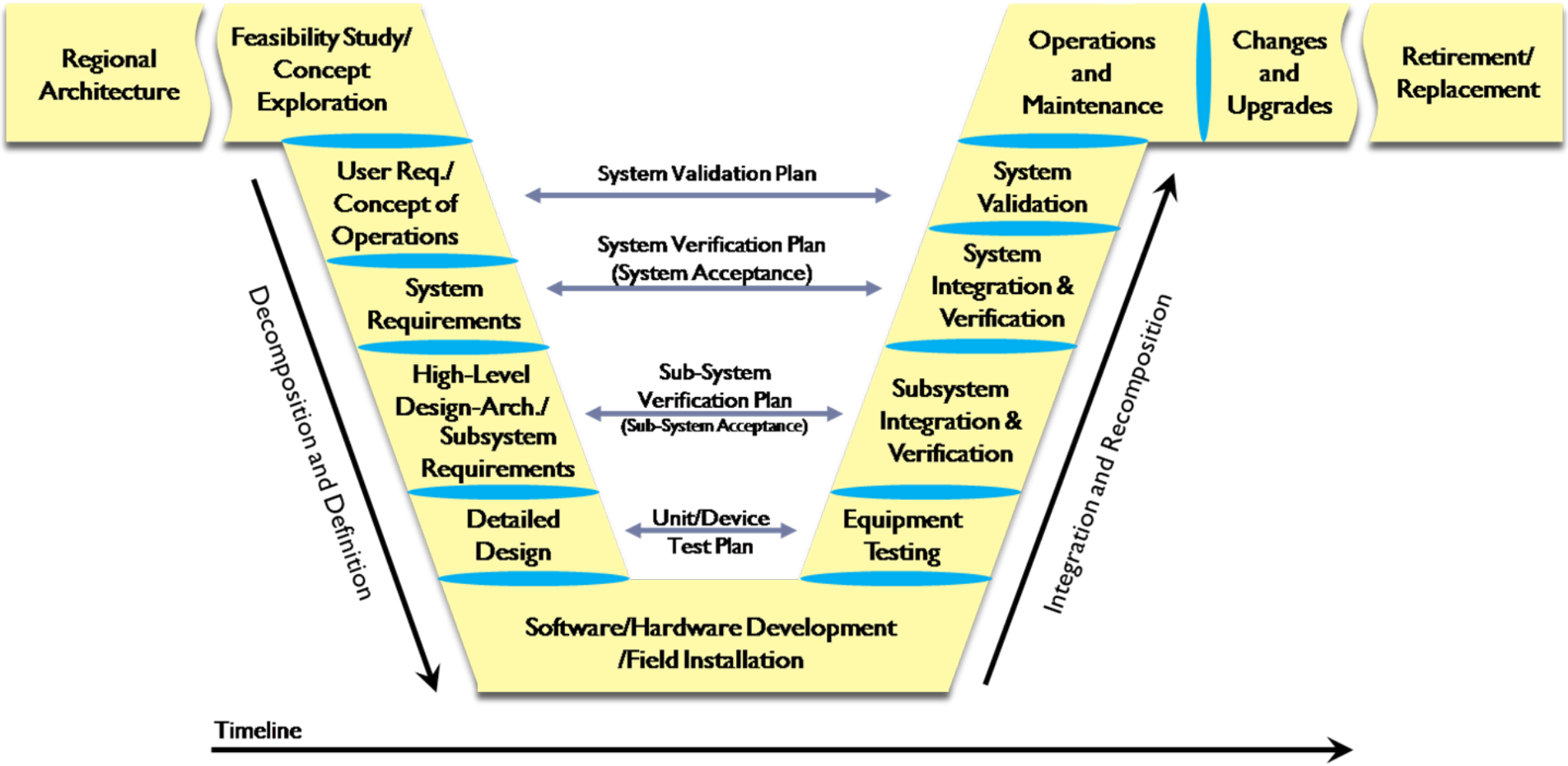
Interested?

- Sometimes visible, identifiable actions
- Phenomenon ~ people do what they like to do

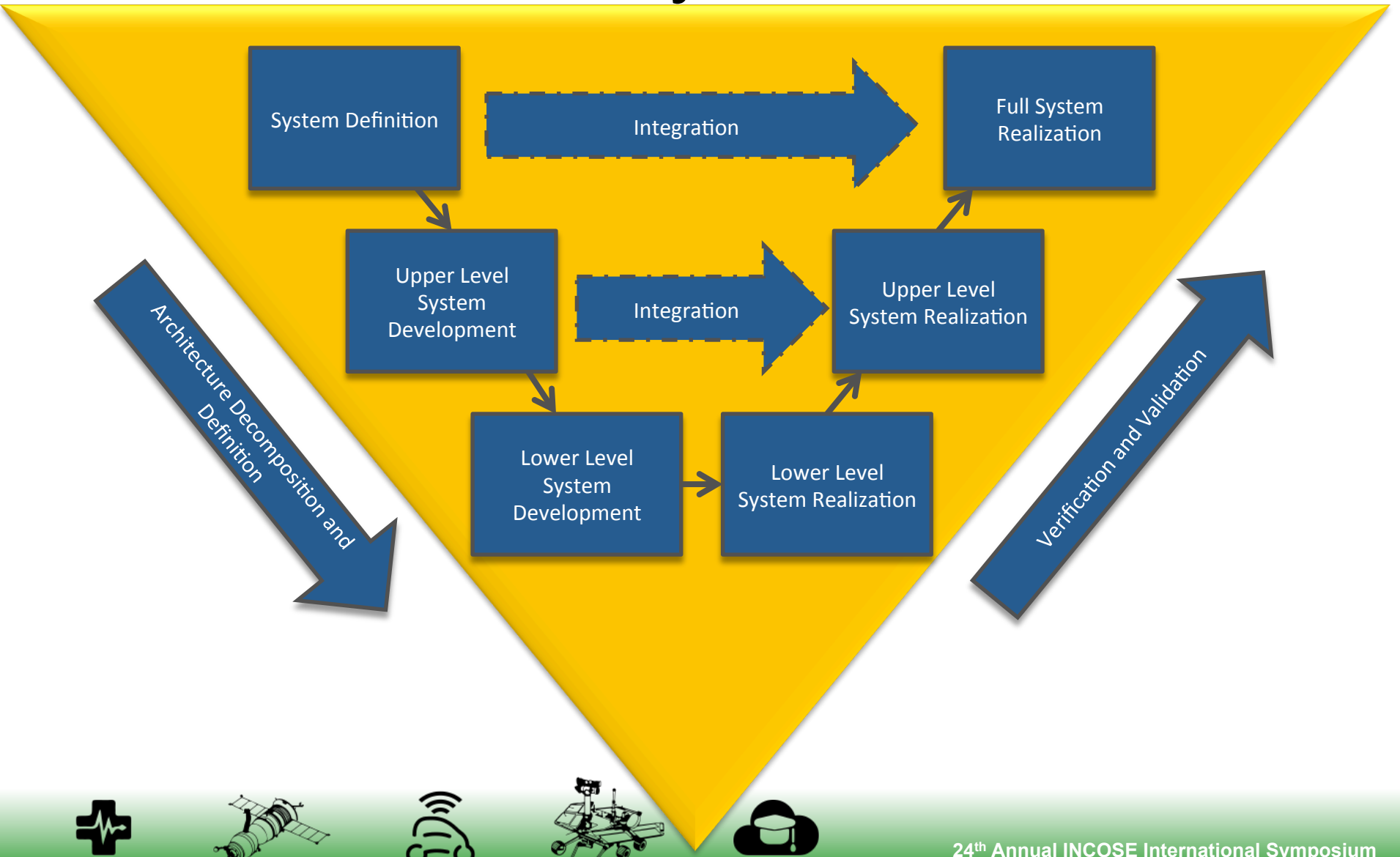


- Therefore, best to find people who may be naturally inclined toward SE behaviors

Step 1:
Understand your tasks

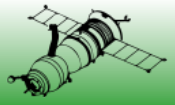


Step 1:
Understand your tasks

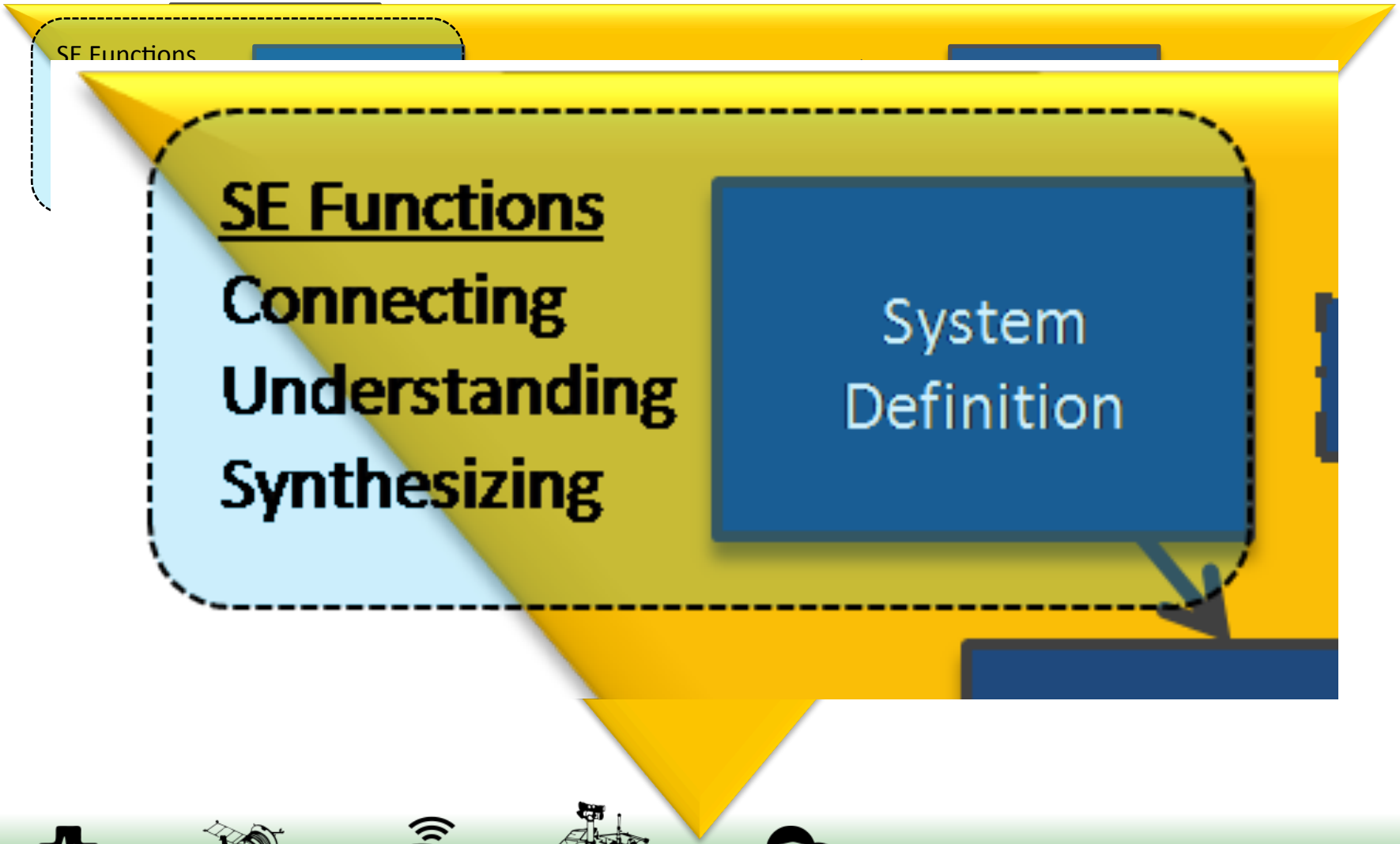


Map tasks to characteristics

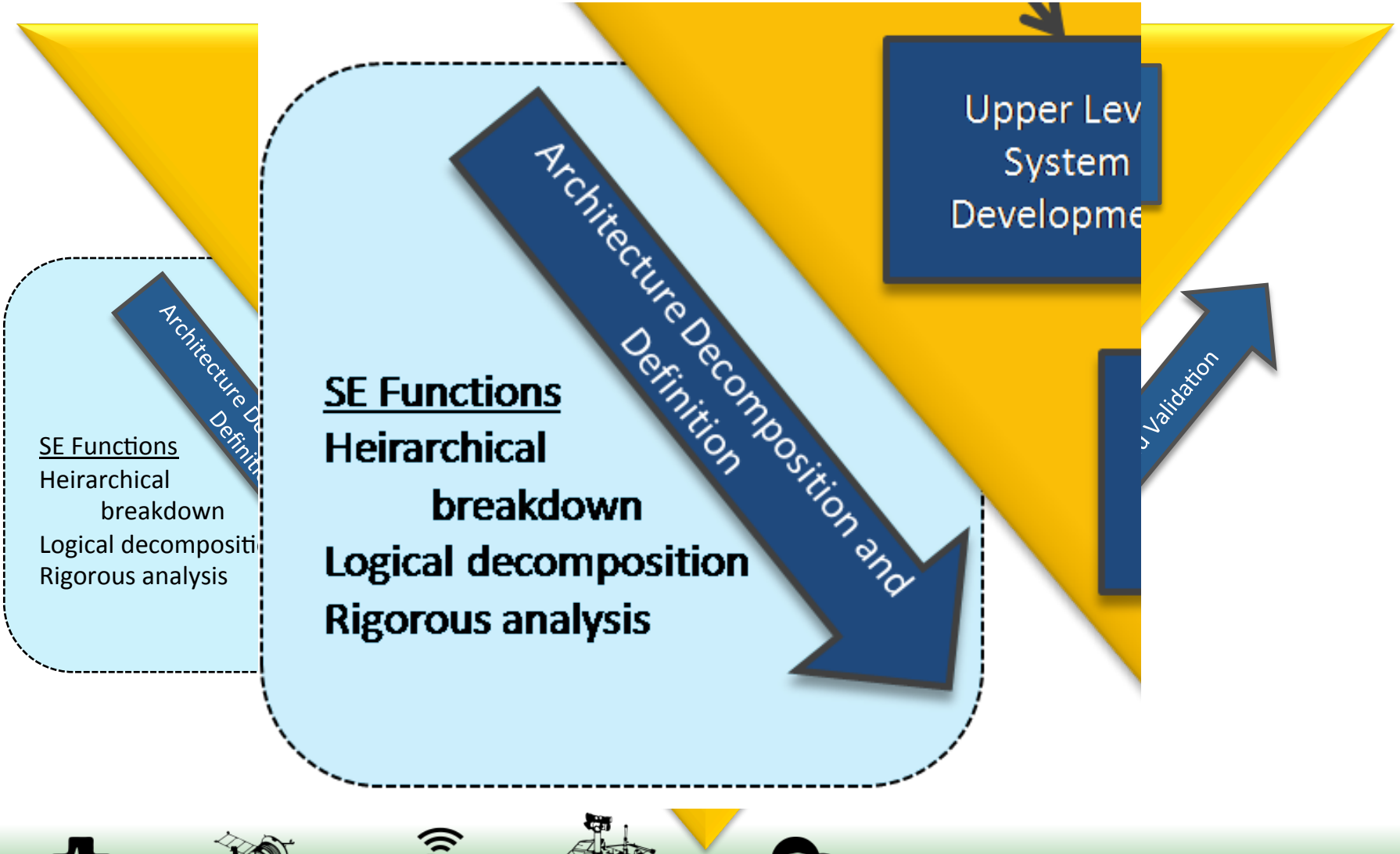
- System Definition
- Architectural Decomposition
- Integration
- Verification and Validation

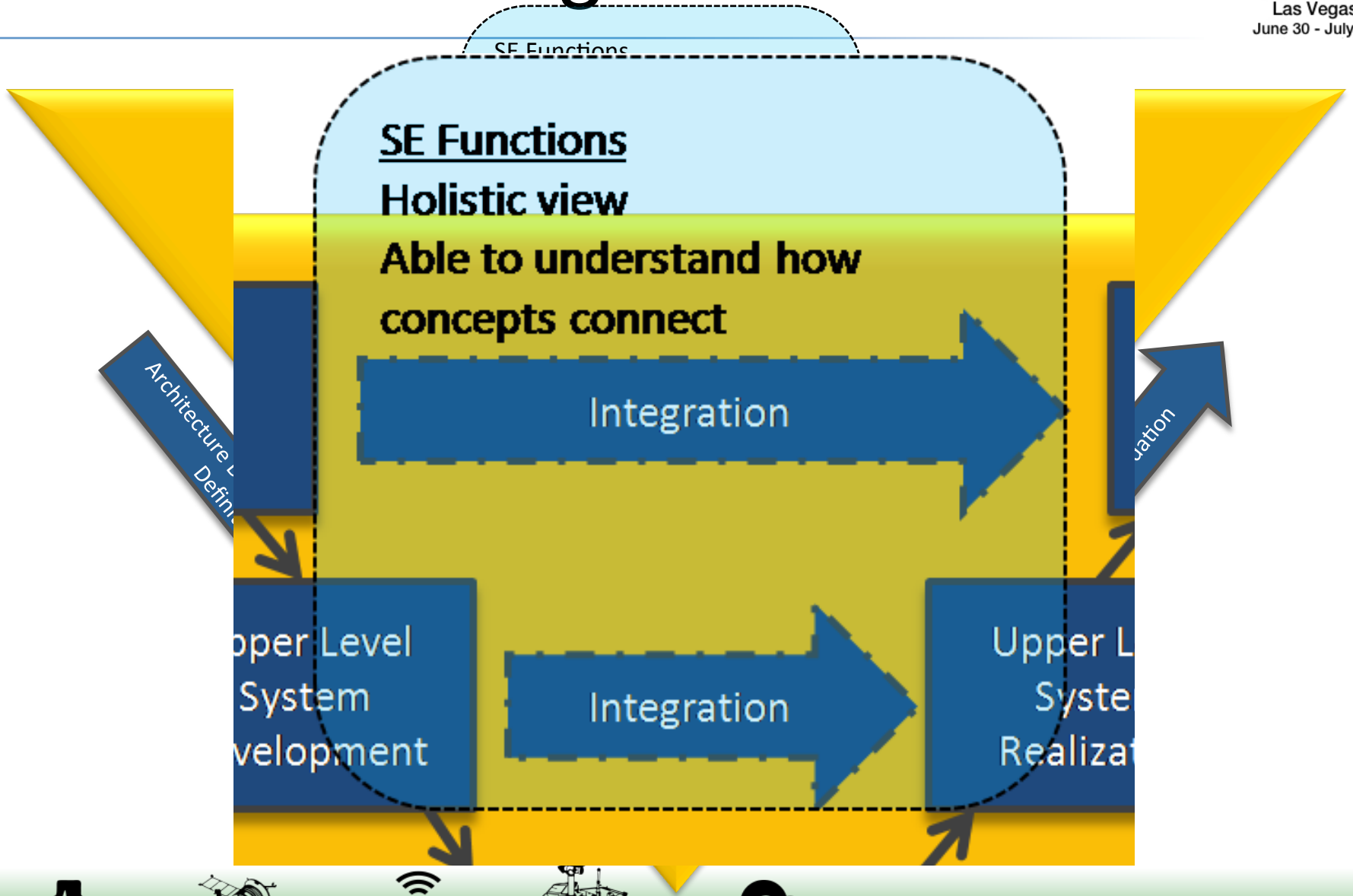

System Definition



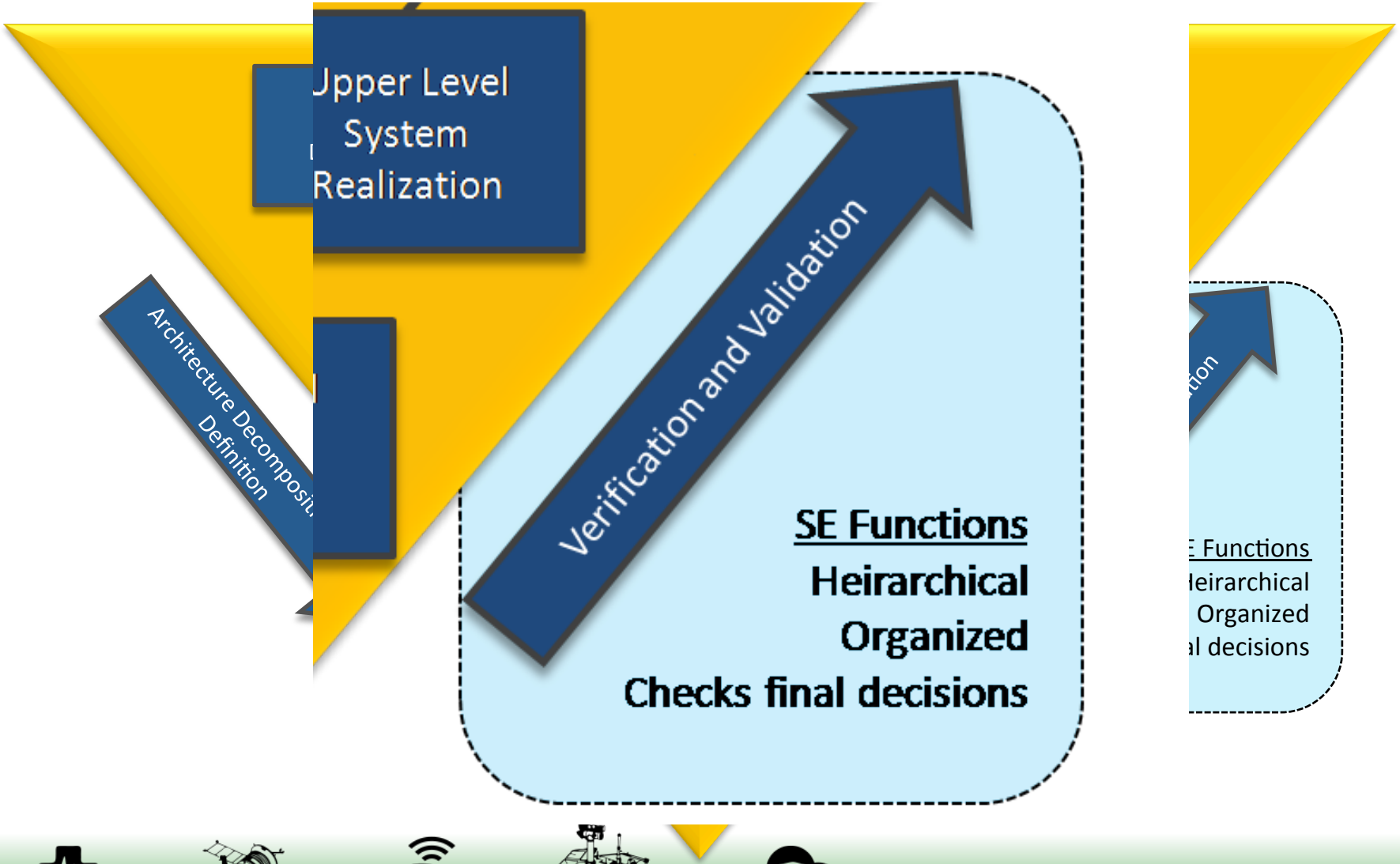
Architectural Decomposition



Integration



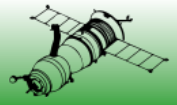
Verification and Validation



Step 2:
Select Assessment

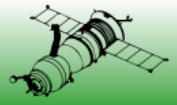
- Myers Briggs Type Indicator (MBTI)
- DiSC
- Keirsey Temperament Sorter
- True Colors
- Insight Inventory

- …


Step 3:
Understand the assessment

- MBTI
  - Developed in early 1940s
  - Based on Jungian theories – psychological attitude and functions
    - Describes preferences
    - Not prediction of behavior
  - Purpose: identify strengths in lieu of experience


Getting closer to success

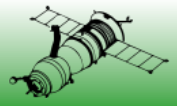
Training

Behavior

Training

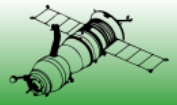
Step 4:
Apply Characteristics

- Energy
  - Introversion
  - Extroversion
- Decisions
  - Thinking
  - Feeling
- Information
  - Sensing
  - Intuitive
- Structure
  - Judging
  - Perceiving

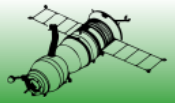




Structure - Judging

- Heirarchical
- Organized
- Prefers fixed (non-flexible) structure

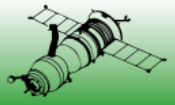



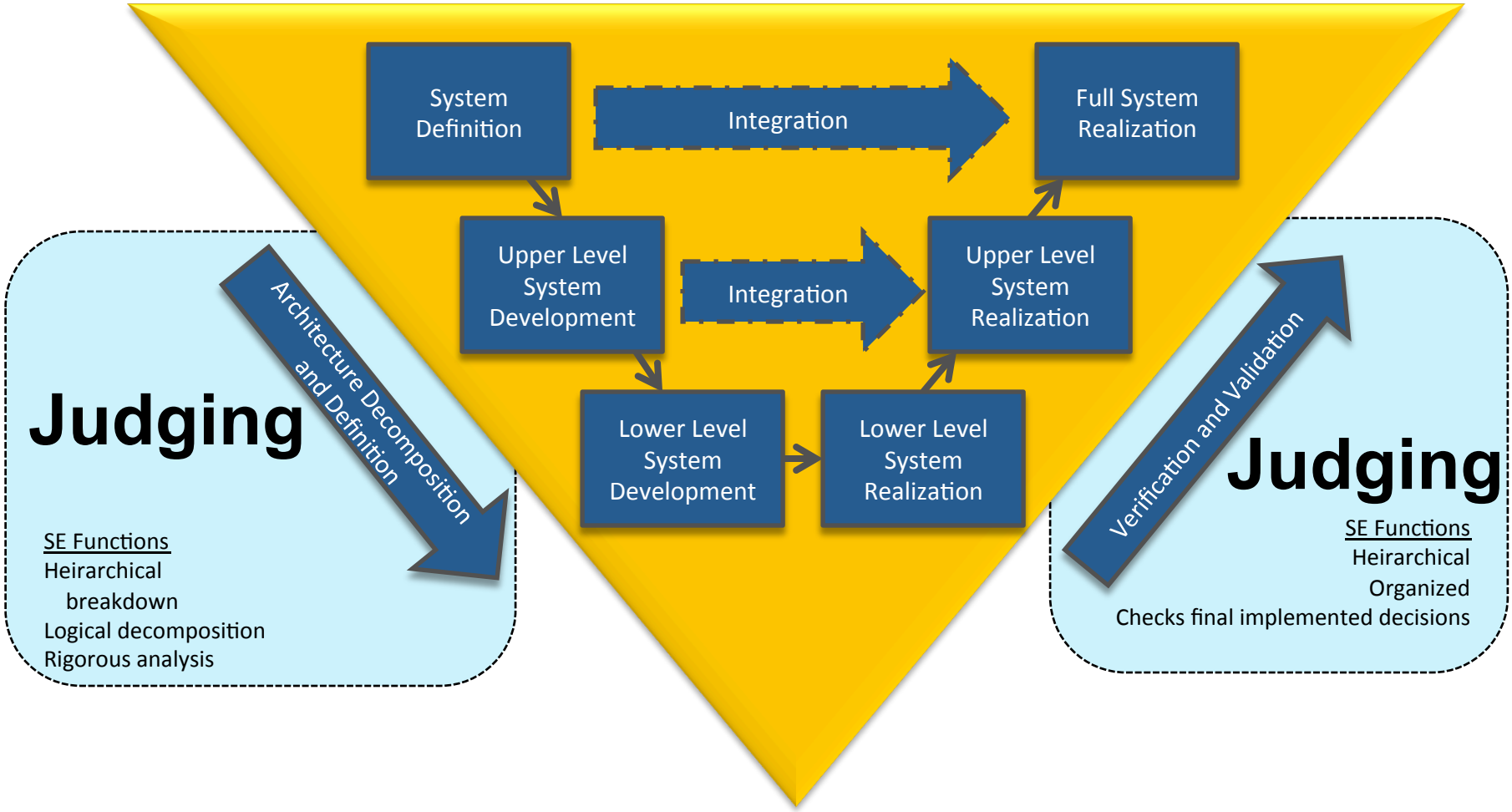





External Structure

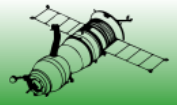
Judging	Perceiving
Heirarchical	Flexible
Organized	Open Ended
Prefers fixed (non-flexible) structure	Prefers adjustable structure

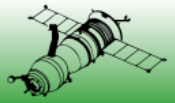


System Definition
Integration
Full System Realization
Upper Level System Development
Integration
Upper Level System Realization
Lower Level System Development
Lower Level System Realization
Architecture Decomposition and Definition
Verification and Validation
Judging
SE Functions
Heirarchical
breakdown
Logical decomposition
Rigorous analysis
Judging
SE Functions
Heirarchical
Organized
Checks final implemented decisions

Information – Sensing

- Discrete, independent parts make a whole
- Step-by-step is best
- Logical and analytical
- Looks for details






Information Processing

Sensing

Discrete, independent parts make a whole

Step-by-step is best

Logical and analytical

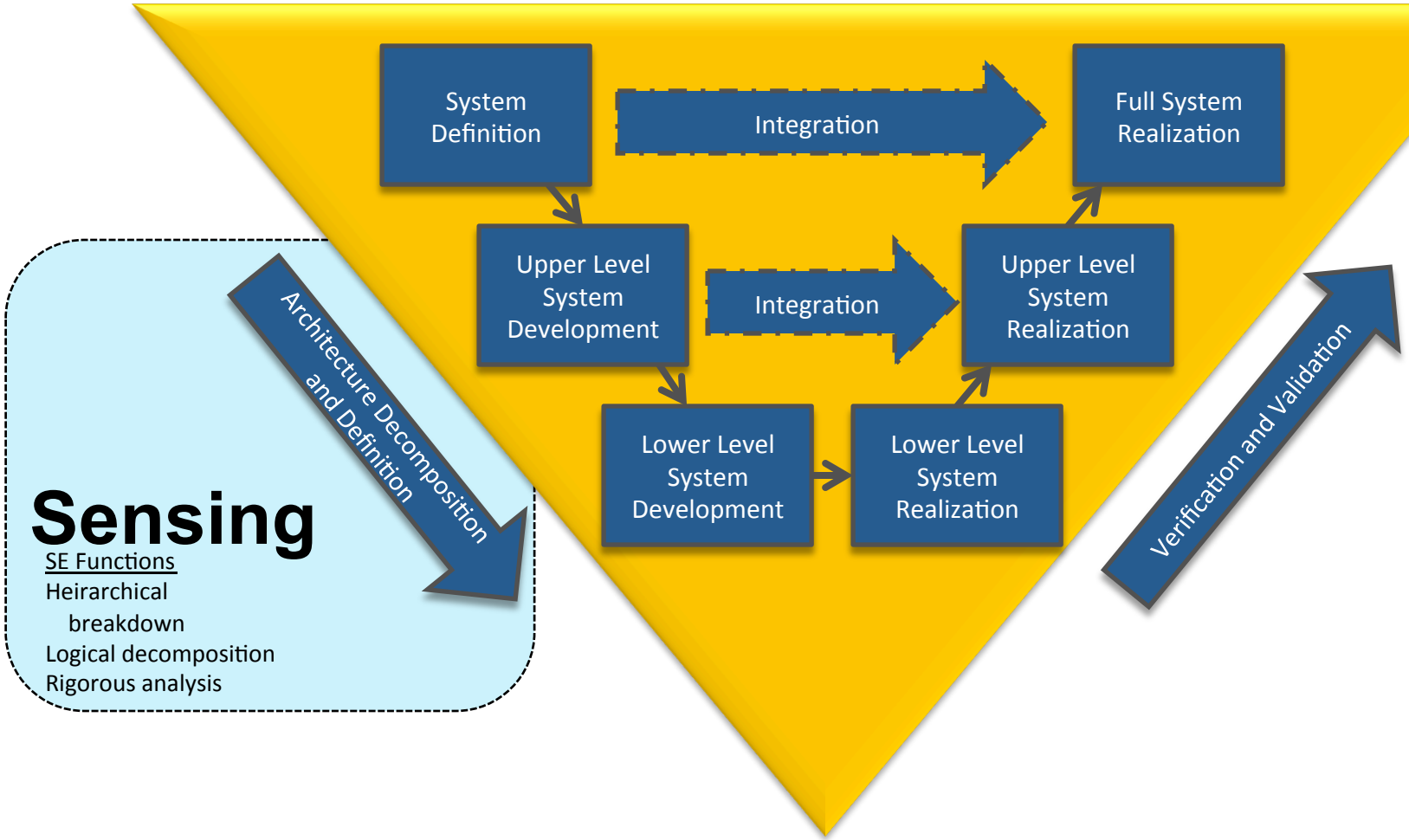
Looks for details

Intuitive

Holistic view of parts making a whole

Applies new concepts with little direction

Needs to see the whole picture

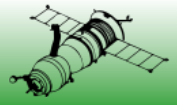


Sensing

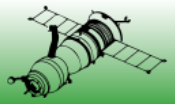
SE Functions
Heirarchical
breakdown
Logical decomposition
Rigorous analysis

Structure – Perceiving

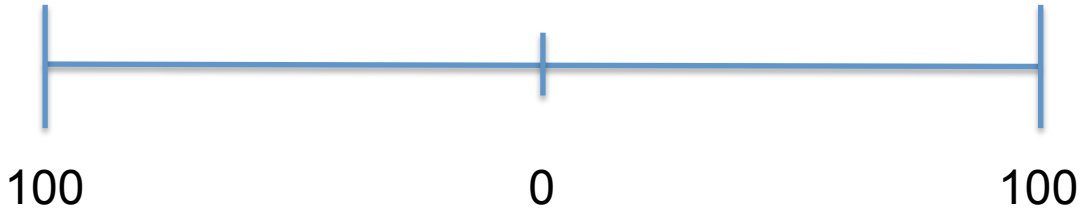
- Flexible
- Open Ended
- Prefers adjustable structure





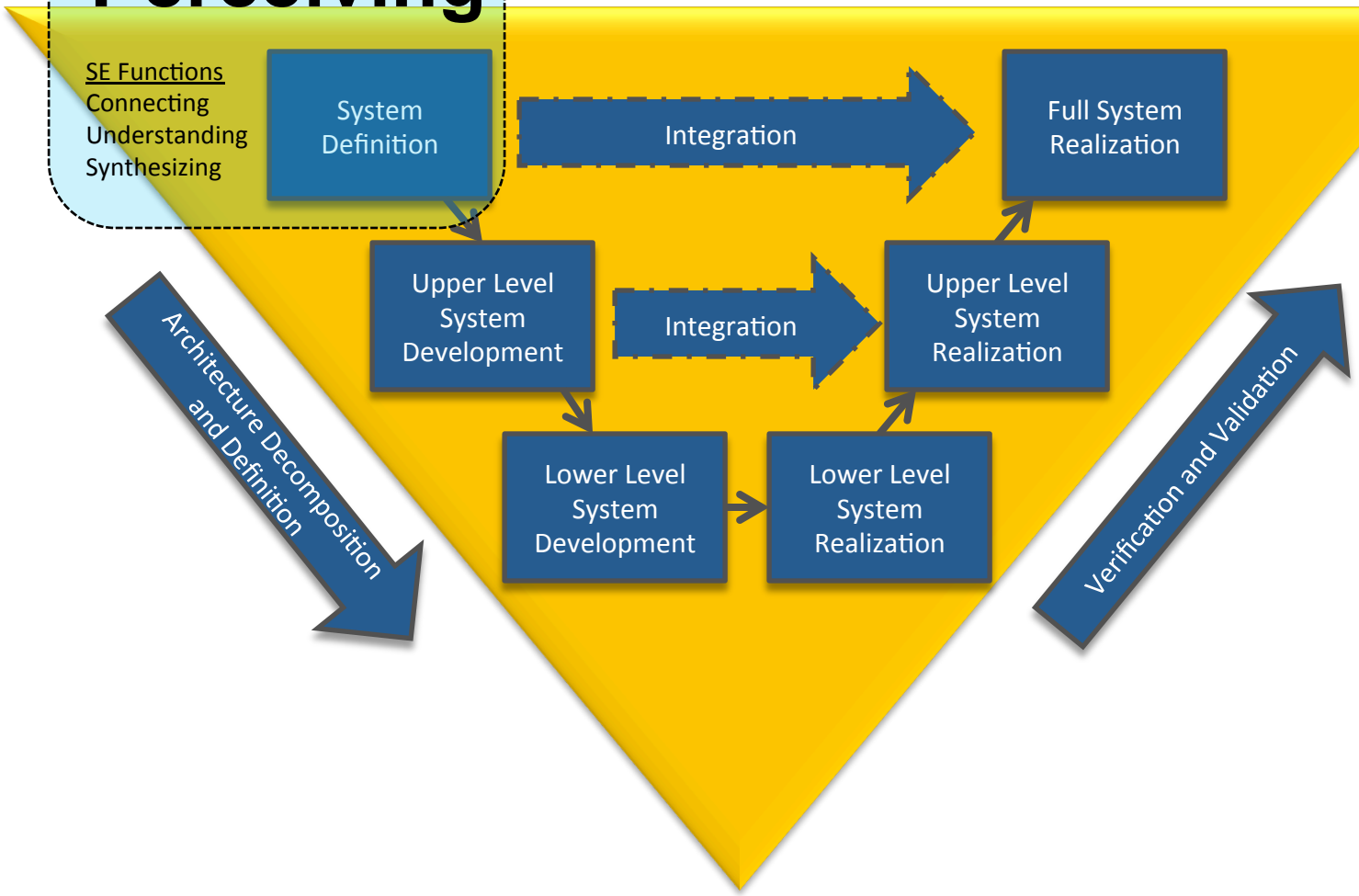

External Structure



Judging	**Perceiving**
Heirarchical	Flexible
Organized	Open Ended
Prefers fixed (non-flexible) structure	Prefers adjustable structure

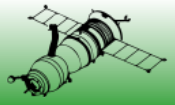
Perceiving

SE Functions
Connecting
Understanding
Synthesizing

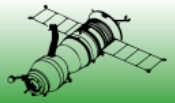


Information – Intuitive

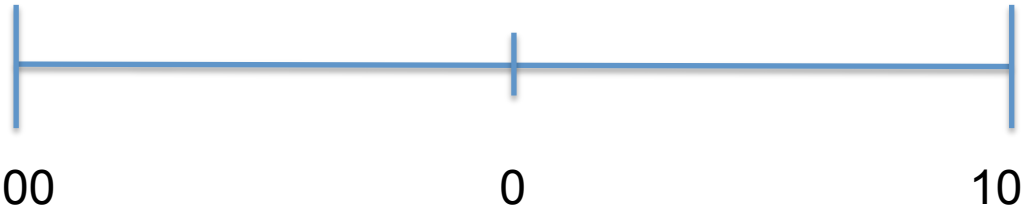
- Holistic view of parts making a whole
- Applies new concepts with little direction
- Needs to see the whole picture






Information Processing



Sensing

Discrete, independent parts make a whole

Step-by-step is best

Logical and analytical

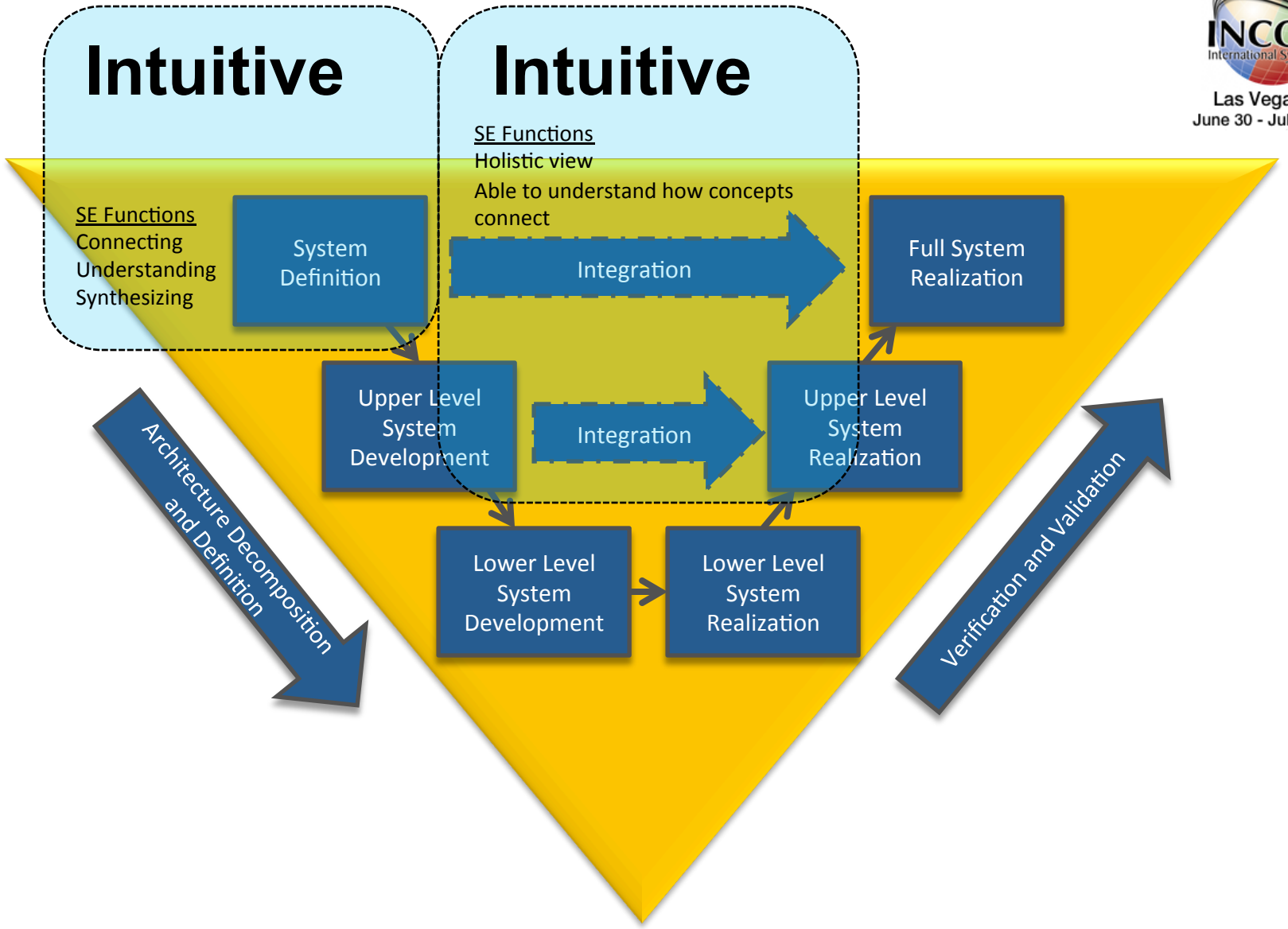
Looks for details

Intuitive

Holistic view of parts making a whole

Applies new concepts with little direction

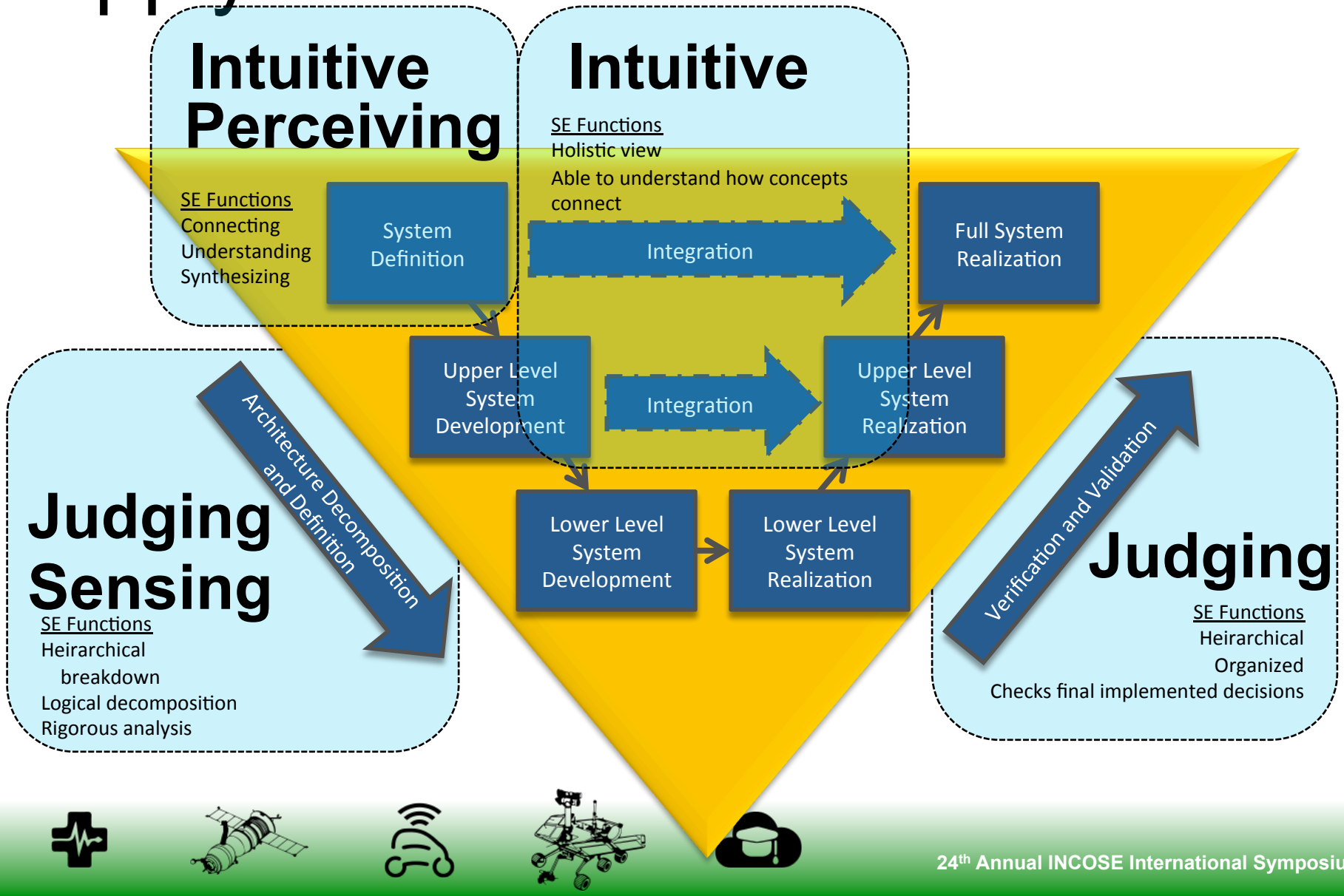
Needs to see the whole picture


Intuitive
Intuitive
SE Functions
Connecting
Understanding
Synthesizing
SE Functions
Holistic view
Able to understand how concepts connect
System Definition
Integration
Full System Realization
Upper Level System Development
Integration
Upper Level System Realization
Architecture Decomposition and Definition
Lower Level System Development
Lower Level System Realization
Verification and Validation

Step 5:

Apply Characteristics to Tasks

INCOSE International Symposium
Las Vegas, NV
June 30 - July 3, 2014



Don’t do this…


FROM NOW ON, ALL TEAMS WILL BE FORMED ON THE BASIS OF MYERS-BRIGGS PERSONALITY TYPES.
IF YOU DO NOT HAVE A PERSONALITY, ONE WILL BE ASSIGNED TO YOU BY HUMAN RESOURCES.
WE NEED A QUIET DUMB GUY TO PAIR WITH AN EXTROVERTED THINKER.
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Questions?


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NT

Visioning

Who's your character?