

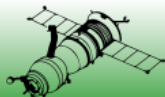
Systems Engineering on California High-Speed Rail

Lean Systems Engineering Working Group

Oliver M. Hoehne, PMP

Senior Engineering Manager

Parsons Brinckerhoff, Transit & Rail Systems, Newark, NJ, USA

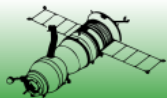


CALIFORNIA HIGH-SPEED RAIL

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



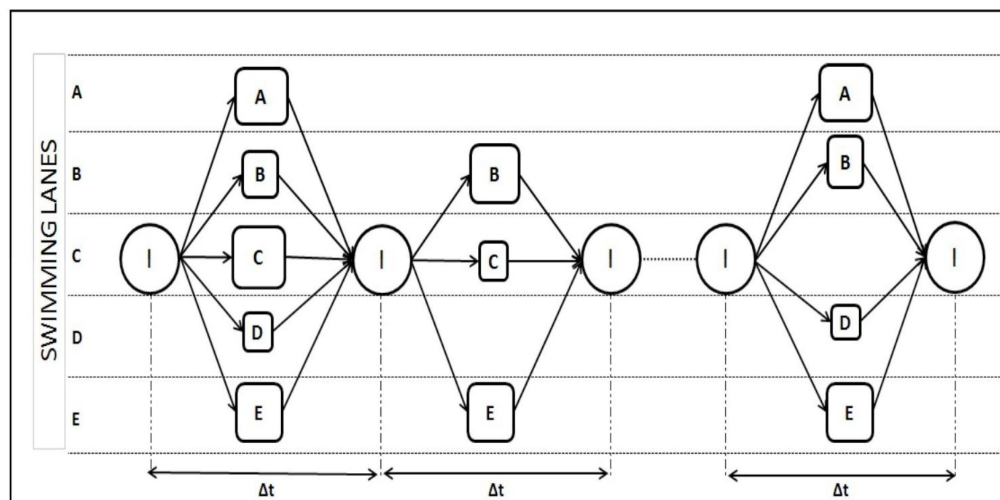
Lean Management of Complex Programs

HSR Authority, Sacramento
April 4, 2014

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?

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.

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worker
primary object (e.g. a satellite assembly)

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Overcoming Engineering Silos by Applying Systems Engineering Principles

Case Study: California High-Speed Rail System

Oliver M. Hoehne, PMP
Senior Engineering Manager, Professional Associate
Parsons Brinckerhoff, Transit & Rail Systems
2 Gateway Center, 18th Floor
Newark, NJ 07102
hoehneom@pbworld.com

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Abstract. Due to their size, large projects are often subdivided into a number of organizational and functional units to remain manageable. Examples include subsystem (e.g. operations, infrastructure, track, systems, rolling stock, etc.) typically managed independently, reporting to an overall program/project manager of command. While this addresses the need for scope, cost and schedule management, it is often at the cost of an inclusive, global engineering perspective. This frequently results in “engineering silo” solutions which, though perfectly designed and functional in their own systems, may not necessarily be compatible with each other, as illustrated in Figure 1.

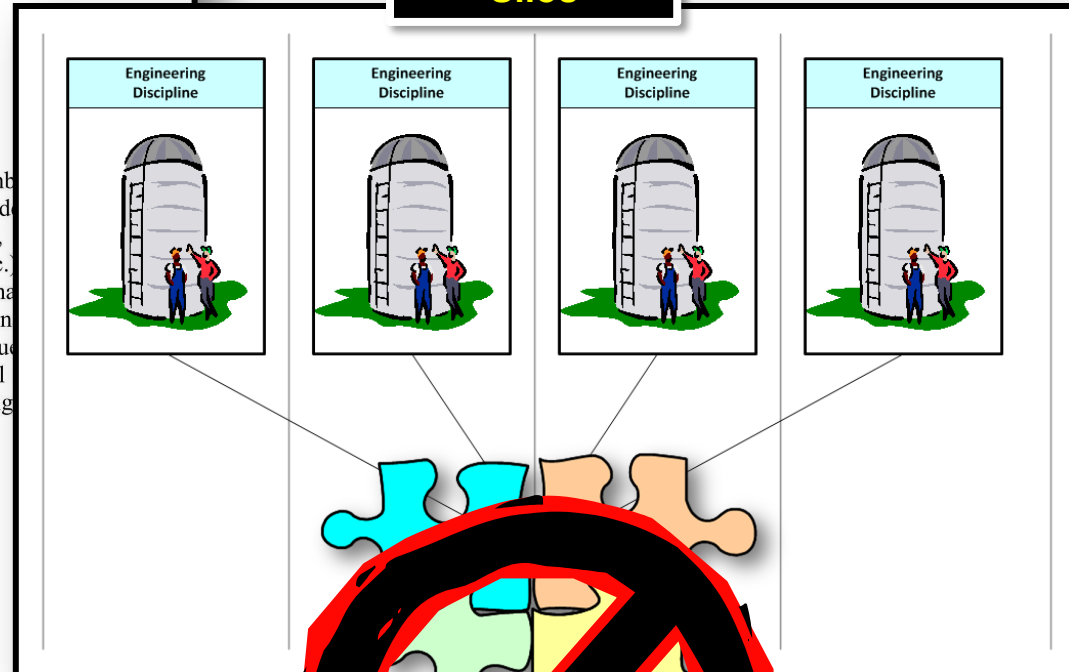


Figure 1: Building a Car with Engineering Silos [1]

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.

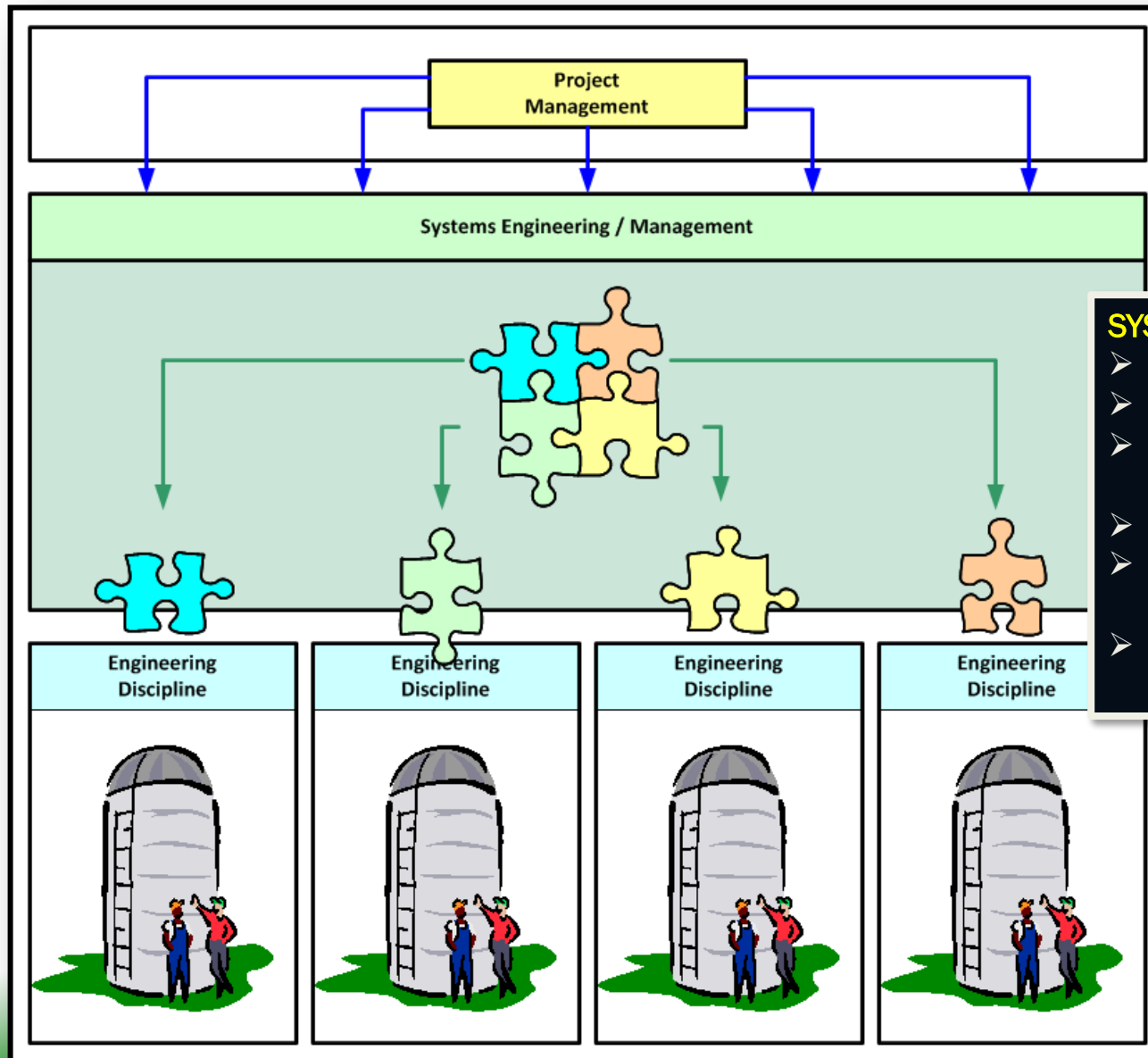
This paper describes how the California High-Speed Rail System (CHSRS) project uses Systems Engineering (SE) principles to overcome the engineering silo mentality, leading to a better product with fewer defects, unplanned rework and associated negative impacts on cost, schedule and reputation.

Engineering “Silos”



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

Scenario 4-9 – Hot Axle Bearing Detector

CHSRS rolling stock will have an on-board detector for the health of the axle bearings. Among the functions of the bearing. The equipment will also be capable of detecting (HABD).

The scenarios below are based on the following assumptions:

- All monitoring of CHSRS rolling stock will be done through the monitoring system.
- The intent of CHSRS wayside HABDs is to detect a fault before it enters the CHSRS main track.
- Wayside HABDs will only be placed at the points where foreign railroads enter onto, or pass through, the CHSRS main track.
- Wayside CHSRS HABDs will be interfaced with the CHSRS system and the ATC system.
- Wayside HABDs of other railroads will not be interfaced with the CHSRS system.

Alarm indications from wayside HABDs will be sent to the workstations used by Train Dispatchers (TD) and the Director of Operations Control (DOC).

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

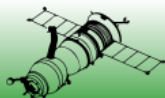
Operational Scenario

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.

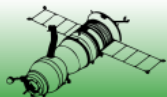
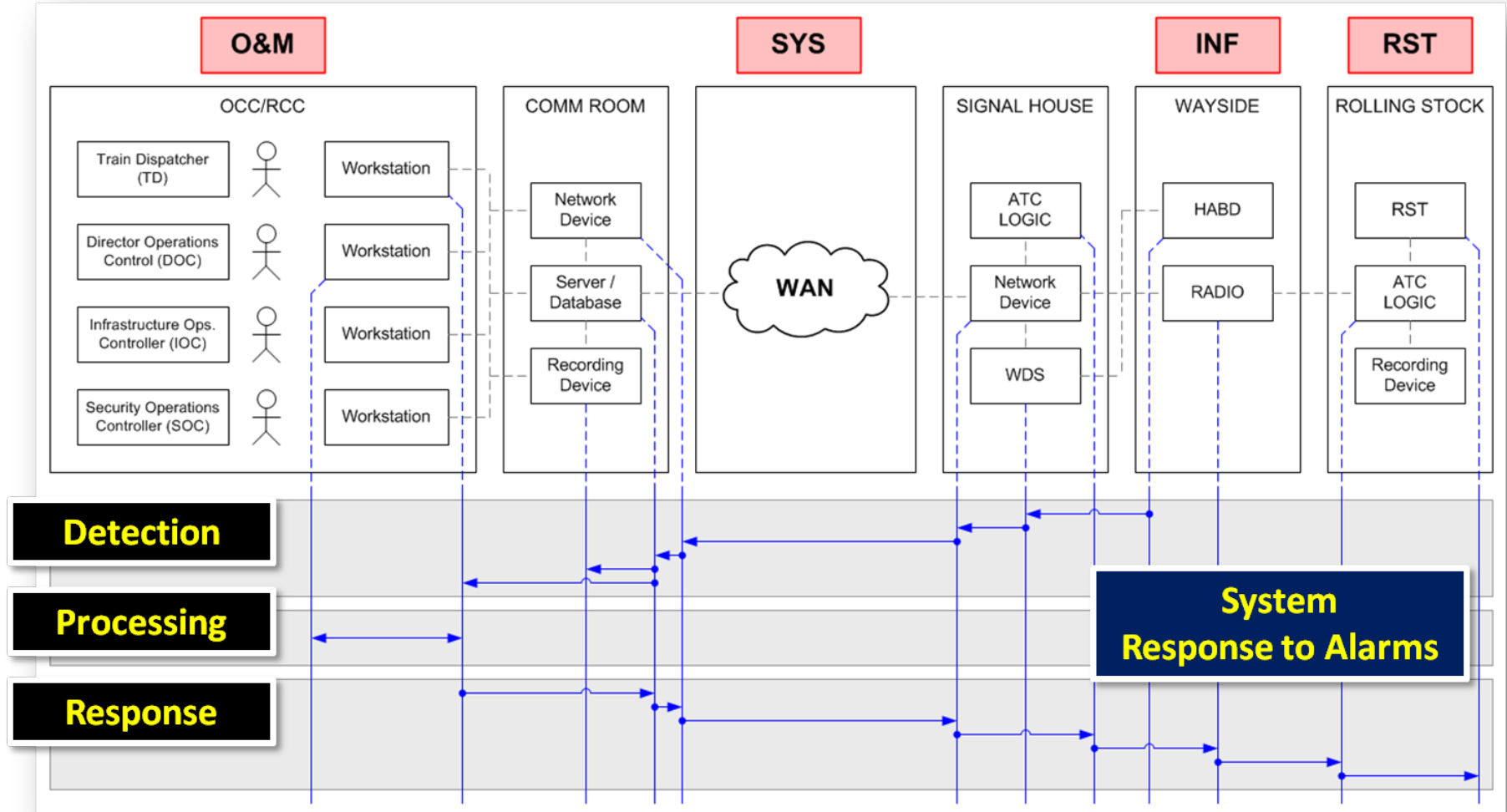
Why

User	Location	Systems	Role and Responsibilities
HABD Detects Hot Axle Bearing on Passing Train			
Train Dispatcher	OCC/RCC	HABD WDS ATS ATC Telephone	<p>When</p> <ul style="list-style-type: none"> • TD receives 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 system to issue stop command to foreign train. • TD contacts DOC via direct telephone line, relay pertinent information and action taken.
DOC	OCC/RCC	Telephone Radio	<p>What</p> <ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Check engineering SCADA systems for indications of failures.
SOC	OCC/RCC	Intrusion Detection System	<ul style="list-style-type: none"> • Check intrusion detection (ID) SCADA system for anomalies.
Locomotive Engineer	Train	Radio	<ul style="list-style-type: none"> • Communicate via radio with DOC. Acknowledge instructions to inspect train and notify crew. Monitor radio for further instructions.
Conductor	Train	Radio	<ul style="list-style-type: none"> • Communicate with engineer via hand-held radio. Prepare to inspect train.



CALIFORNIA HIGH-SPEED RAIL

HIGH-LEVEL SYSTEM ANALYSIS



CALIFORNIA HIGH-SPEED RAIL

MORE AT THE INCOSE IW15



Las Vegas, NV
June 30 - July 3, 2014

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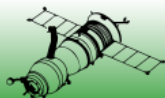
Event Calendar

To submit an event, please send an e-mail to the [Communications Committee](#)

INCOSE IW 2015	Jan 24 - 27, 2015
ISD/Asia 2014	Dec 10 - 12, 2014
INCOSE UK Conference 2014	Nov 18 - 19, 2014
5th International Conference on Complex Systems Design and Management	Nov 12 - 14, 2014
Complex Adaptive Systems Conference	Nov 03 - 05, 2014
EMEASSEC 2014: Systems Engineering: Exploring New Horizons	Oct 27 - 30, 2014
SEHR 2014 Annual Conference: Taking the Next Step: Systems Thinking in Action	Oct 22 - 23, 2014
8th Annual INCOSE Great Lakes Regional Conference	Oct 10 - 11, 2014
APCOSEC 2014	Oct 07 - 09, 2014
23rd International Conference on Systems Engineering (ICSEng 2014)	Aug 19 - 21, 2014
INCOSE / IEEE EnergyTech 2014 & AIAA Propulsion and Energy Forum and Expo	Jul 28 - 30, 2014
24th International Symposium - INCOSE IS 2014	Jun 30 - Jul 03, 2014
INCOSE NSWG Community of Practice Webinar	Jun 19, 2014
Webinar 15:00 UTC: "An ITIL Approach to System Engineering"	Jun 18, 2014
KSEE: Kongsberg Systems Engineering Event	Jun 12 - 13, 2014
2014 9th International Conference on System of Systems Engineering (ISOSE 2014)	Jun 09 - 13, 2014
9th International System of Systems Engineering Conference	Jun 09 - 13, 2014
CESUN 2014	Jun 08 - 11, 2014
Nordic Systems Engineering Tour	May 20 - 24, 2014
INCOSE NSWG Community of Practice Webinar	May 16, 2014
Invitation to 2nd International Spring School on Systems Engineering (ISSE)	May 12 - 16, 2014

Done

Internet | Protected Mode: On 100%



24th Annual INCOSE International Symposium

CALIFORNIA HIGH-SPEED RAIL

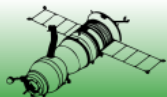
VISIT US ON TUESDAY JULY 1, 2014



Las Vegas, NV
June 30 - July 3, 2014

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

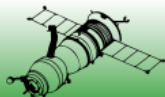
**Transportation WG Presentations,
Recommended by
Energy & Infrastructure WGs**



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

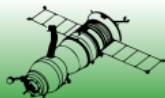


Nail Polish?

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

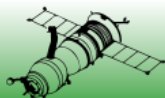


Do these
Systems
Engineers
have
something in
common?



Capturing the essence of SE

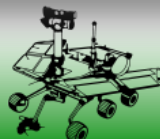
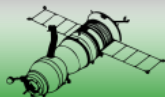
- Competency model
- Kasser, Hitchins, Frank, Zhao (2012)
 - Personal skills assessments and competency models found consistency
 - Systems Engineers
 - Learn new skills
 - Have mental flexibility
 - Hone their competencies



- 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

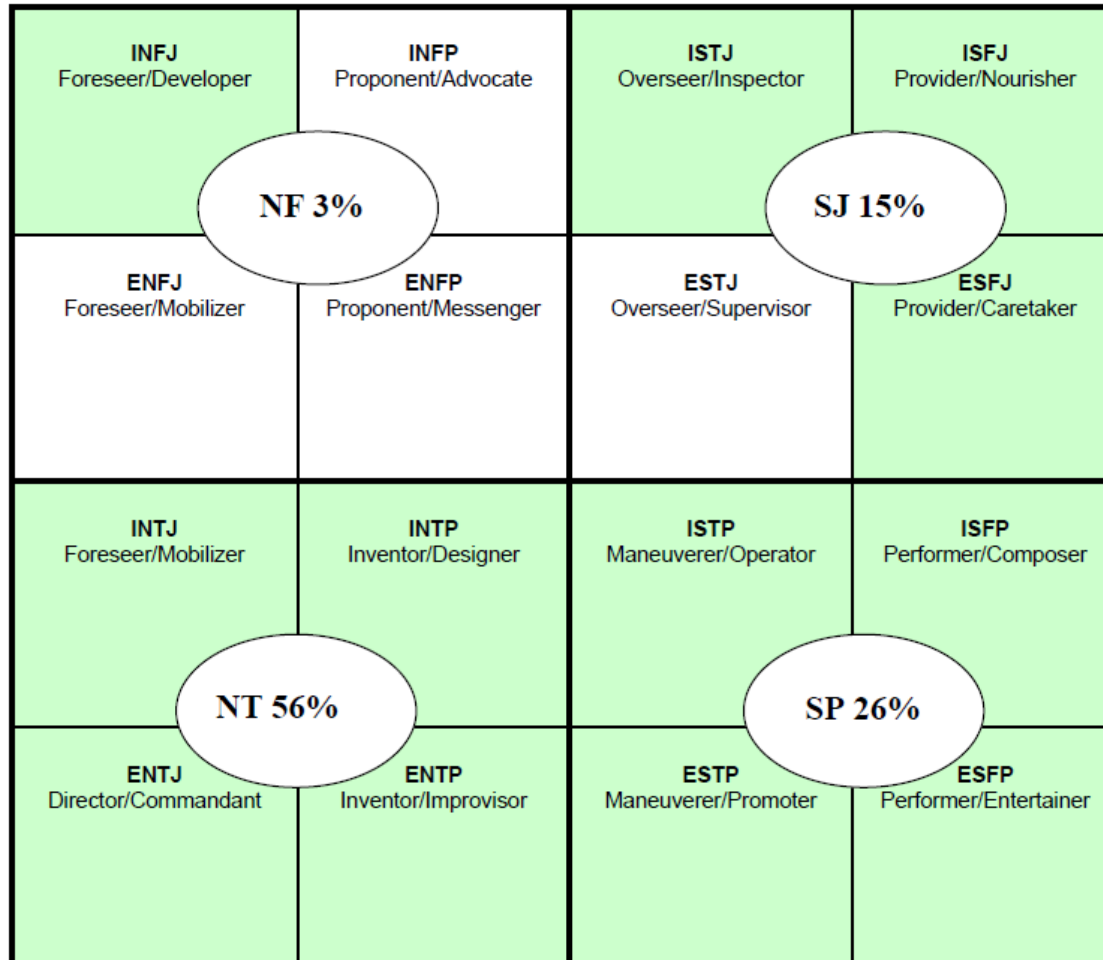
- Williams and Derro (2008) NASA
 - Seeking predictors of success
 - Identified observable behaviors

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

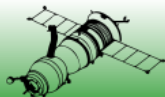


SE MBTI types represented
across the Agency



Why look for Systems Engineers

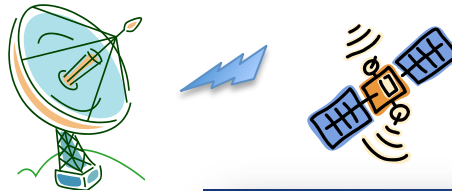
- Part of INCOSE mission “To share, promote, and advance the best of systems engineering...”
- Growing into emerging domains
 - Biomedical
 - Infrastructure
 - Power & Energy
 - Transportation



Challenges in emerging domains

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

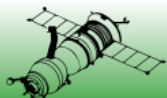
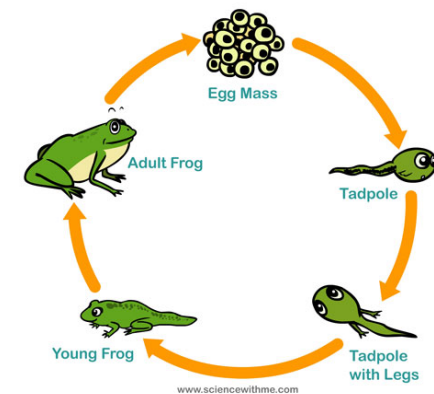
– System



– Architecture



– Life-cycle

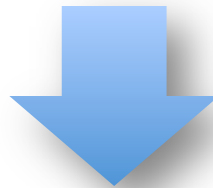


How emerging domains grow

A. Grassroots approach



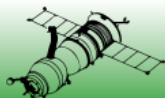
B. Leader-driven



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



Alstom MF2000 for Paris Metro



Cognitive Psych

Comprehension skills

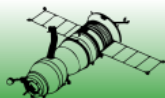
Higher order skills

Applied flexibility

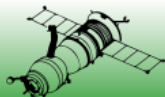
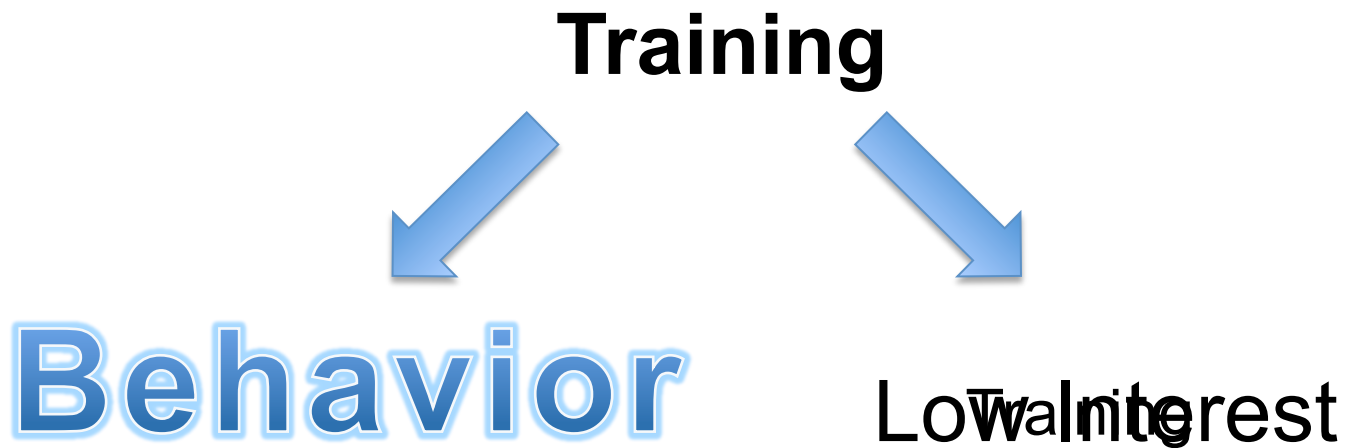
- National Research Council (2000) consolidated previous decades of research on how we learn

- Comprehension
- Effective application of knowledge
- Competency

... all increased when learners had an **INTEREST** in the subject



Getting closer to success

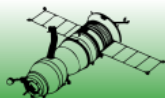


Interested?

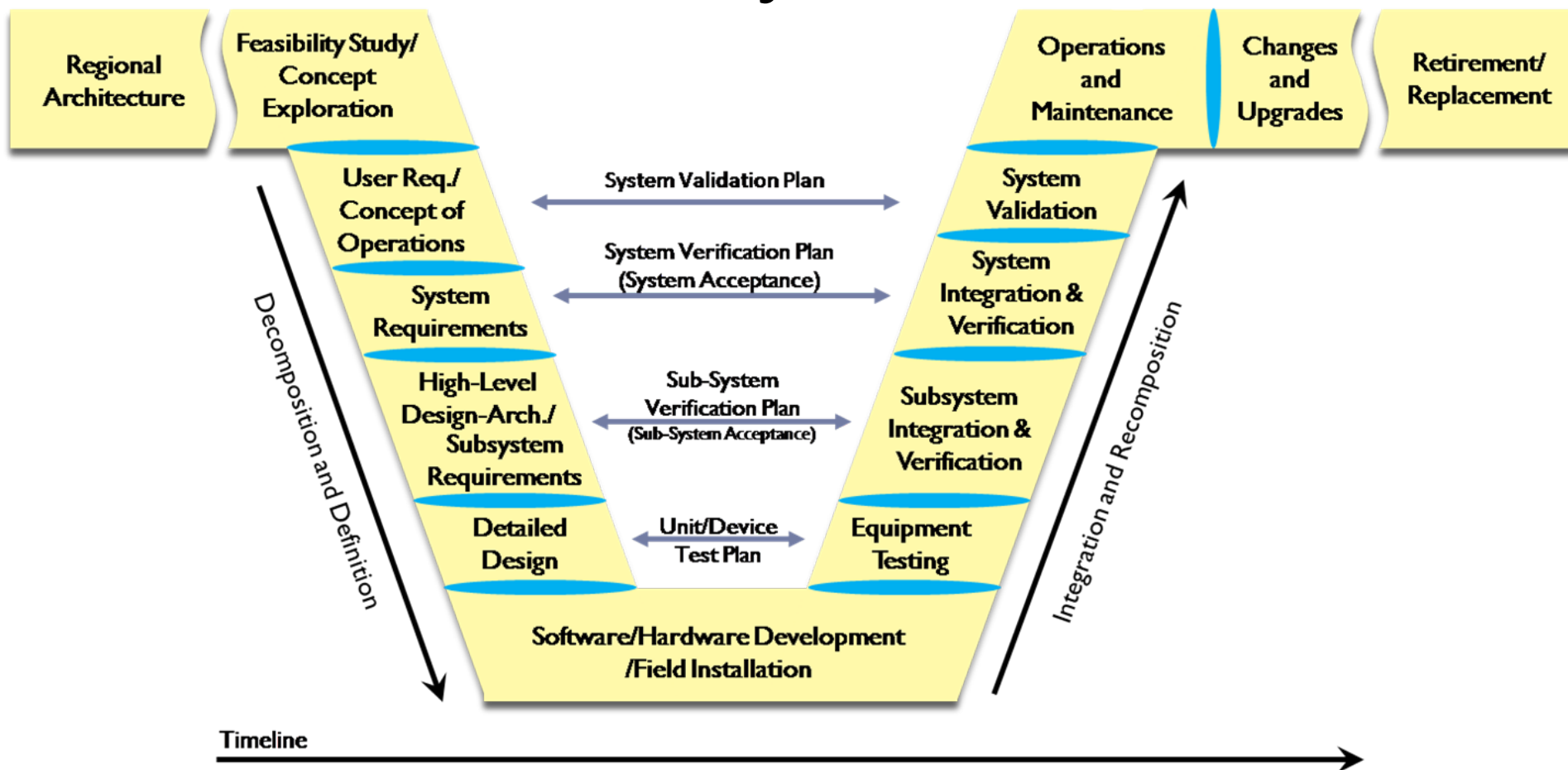
- Sometimes visible, identifiable actions
- Phenomenon ~ people do what they like to do



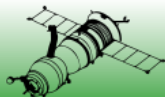
- Therefore, best to find people who may be naturally inclined toward SE behaviors



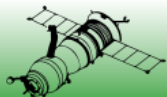
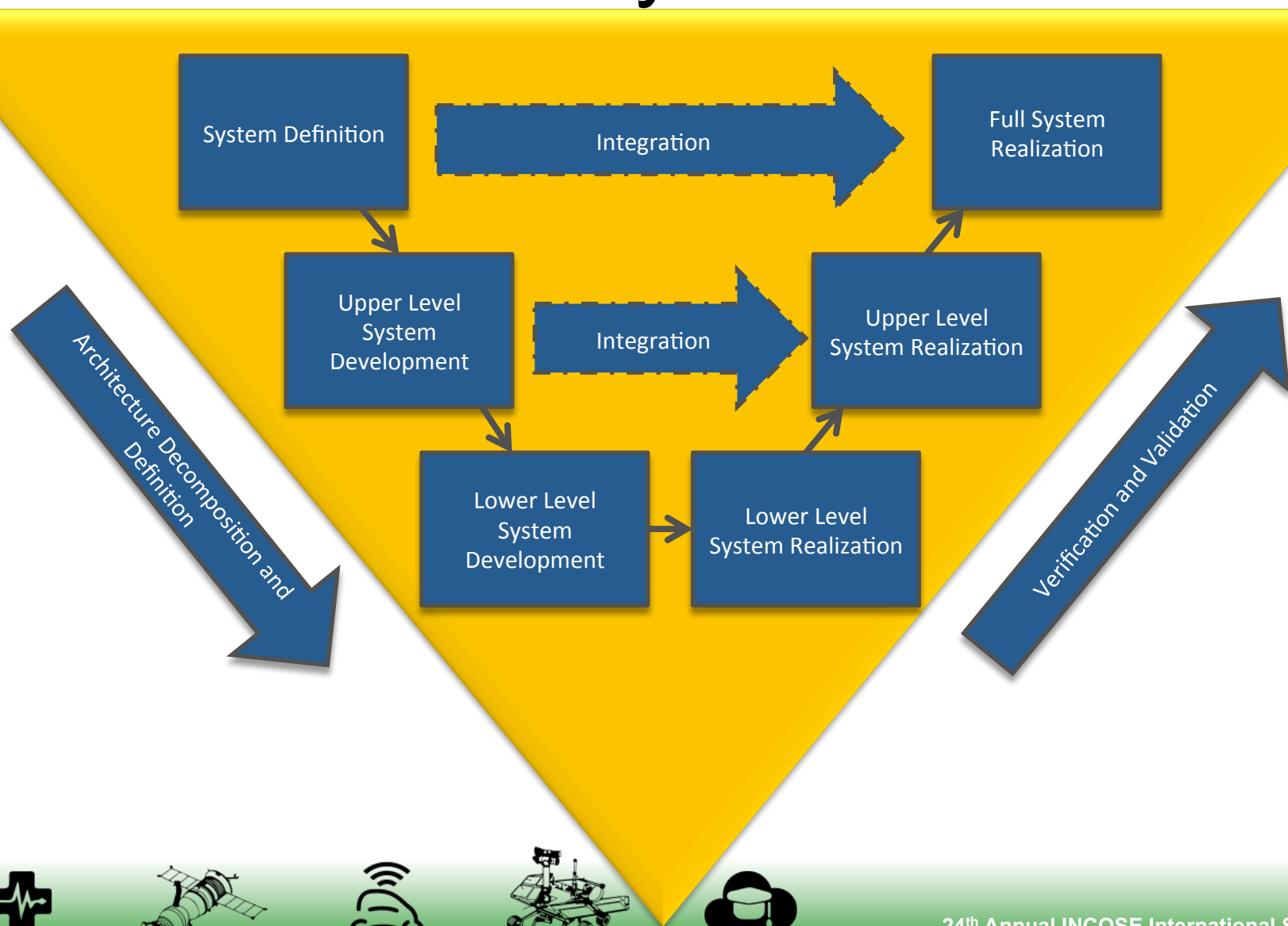
Step 1: Understand your tasks



Design Gate

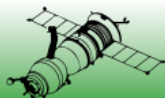


Step 1: Understand your tasks



Map tasks to characteristics

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



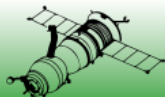
System Definition

SE Functions

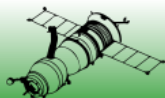
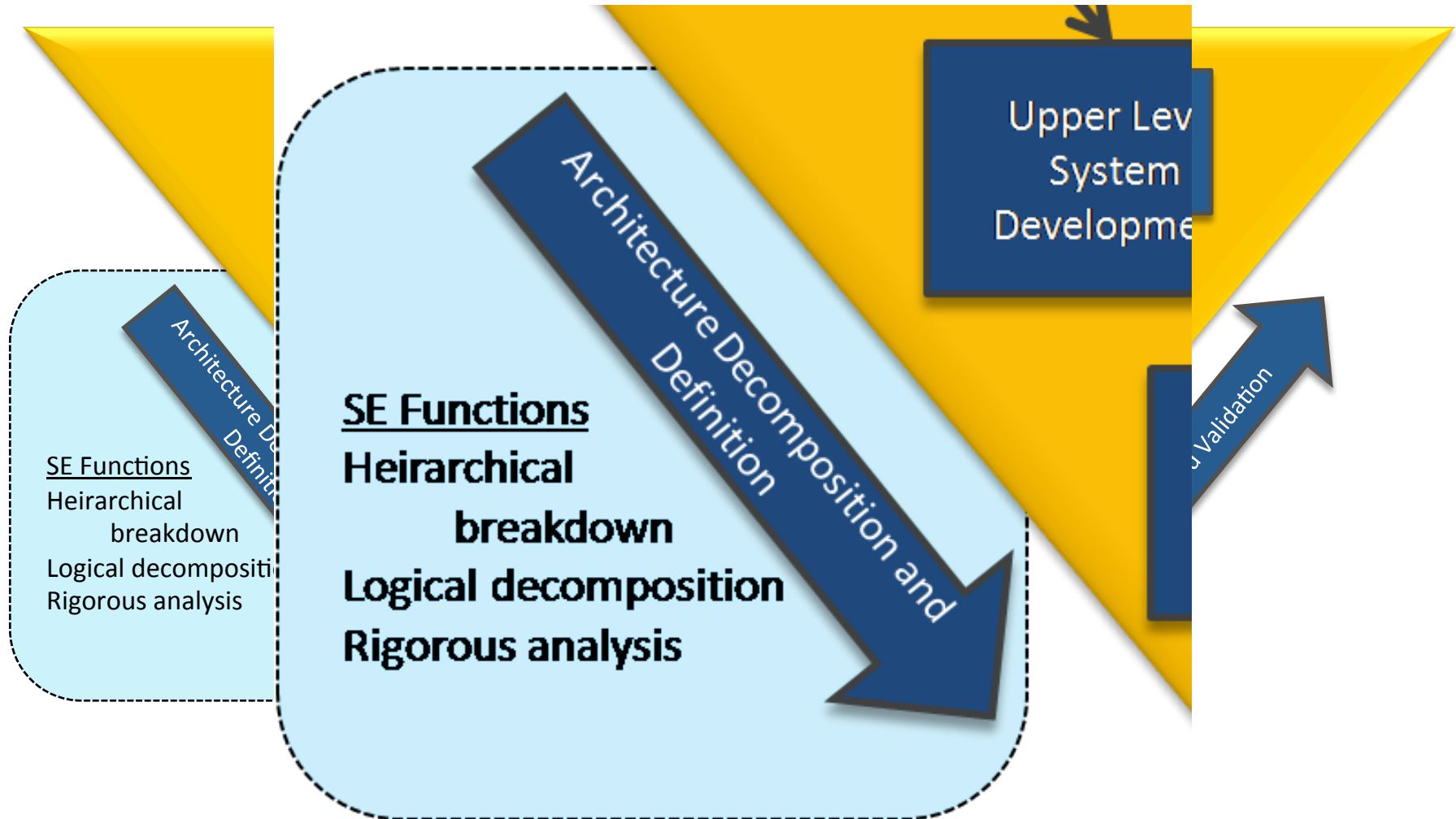
SE Functions

**Connecting
Understanding
Synthesizing**

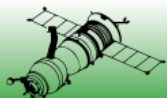
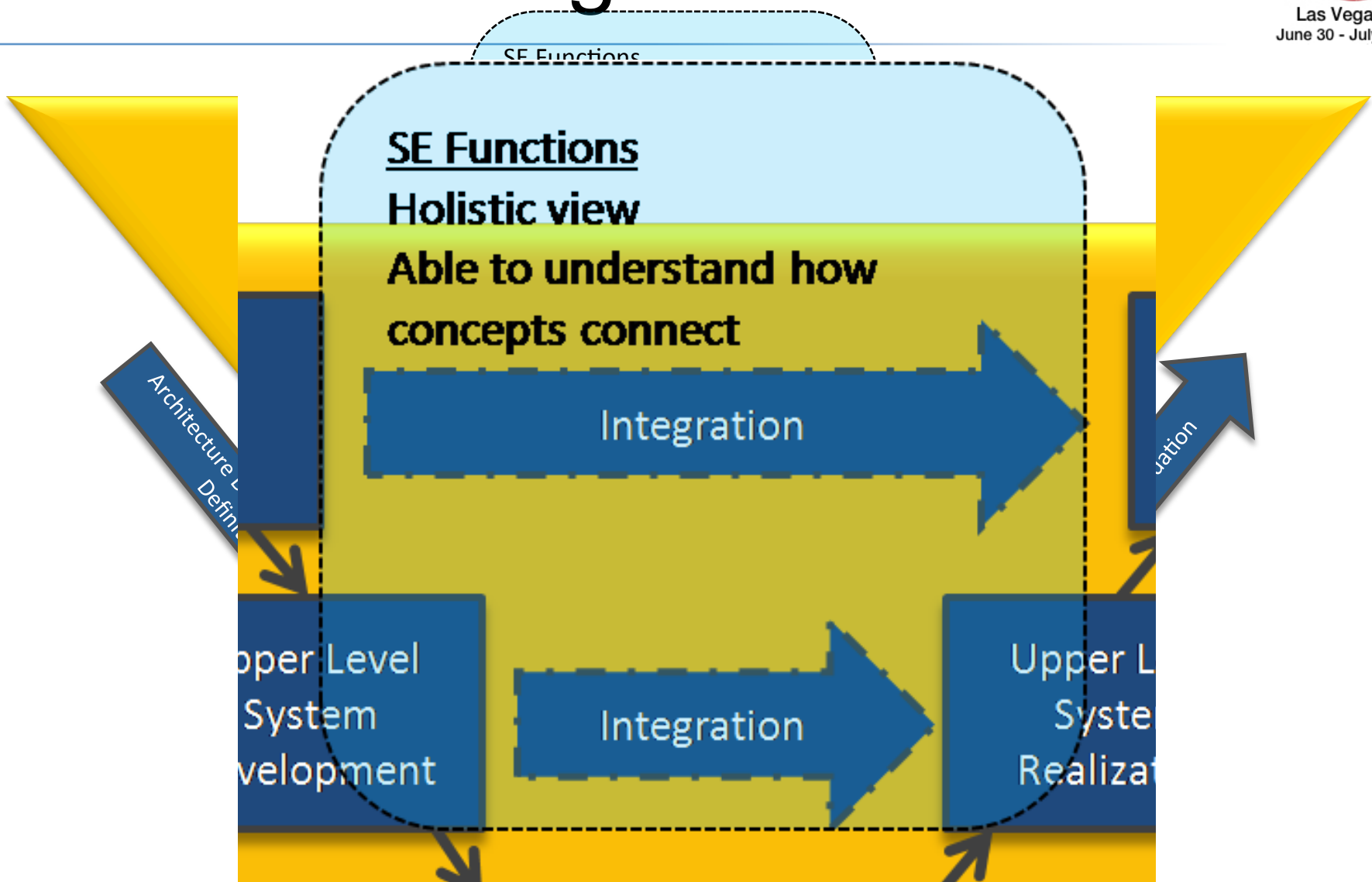
System
Definition



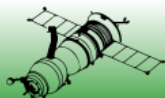
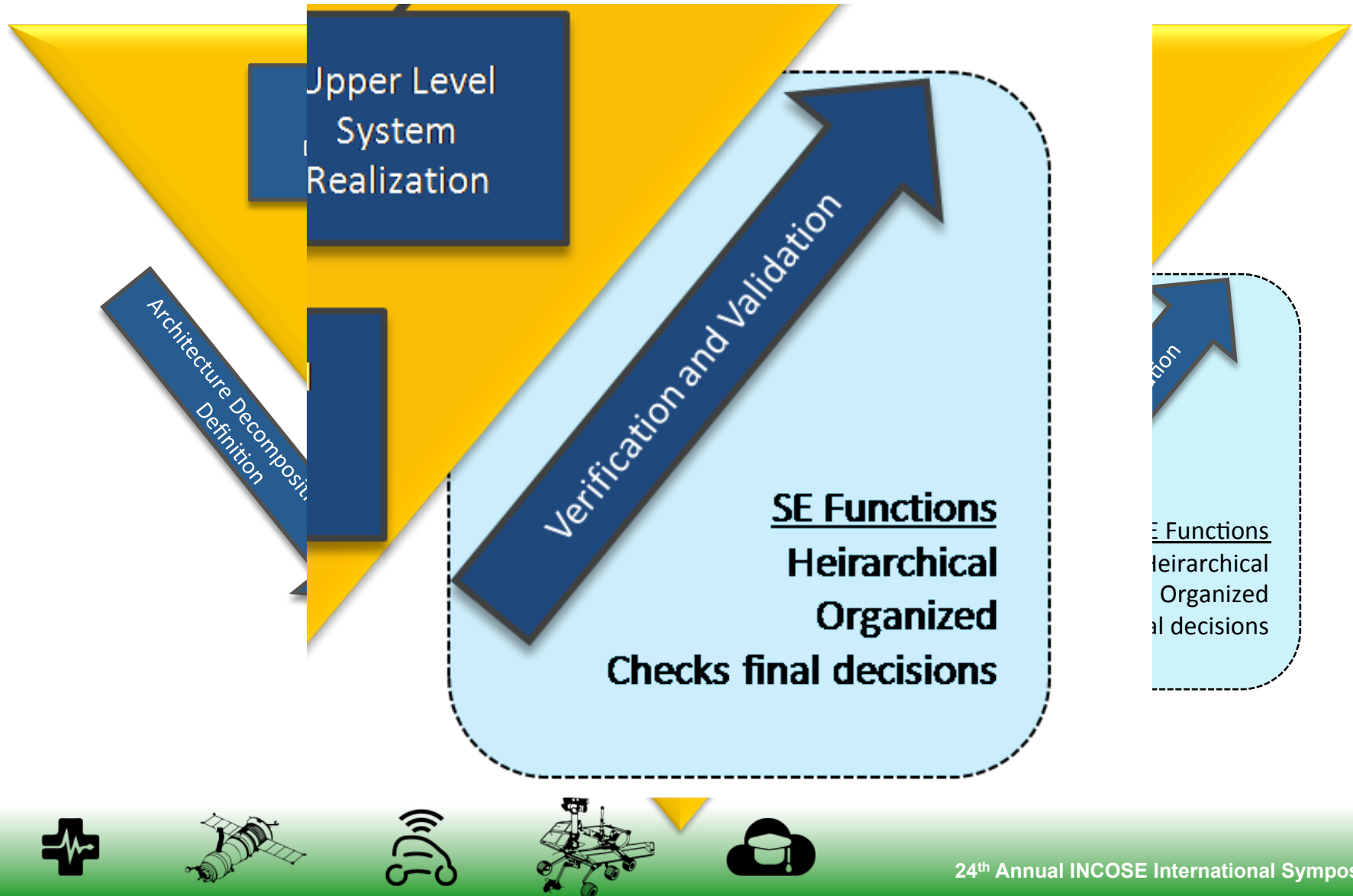
Architectural Decomposition



Integration



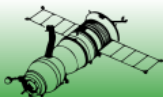
Verification and Validation



Step 2:

Select Assessment

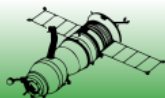
- Myers Briggs Type Indicator (MBTI)
- DiSC
- Keirsey Temperament Sorter
- True Colors
- Insight Inventory
- ...



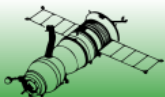
Step 3:

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



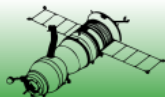
Getting closer to success



Step 4:

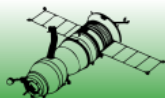
Apply Characteristics

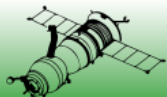
- Energy
 - Introversion
 - Extroversion
- Information
 - Sensing
 - Intuitive
- Decisions
 - Thinking
 - Feeling
- Structure
 - Judging
 - Perceiving



Structure - Judging

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





External Structure

Judging

Heirarchical

Organized

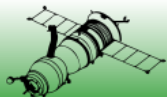
Prefers fixed (non-flexible)
structure

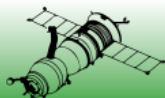
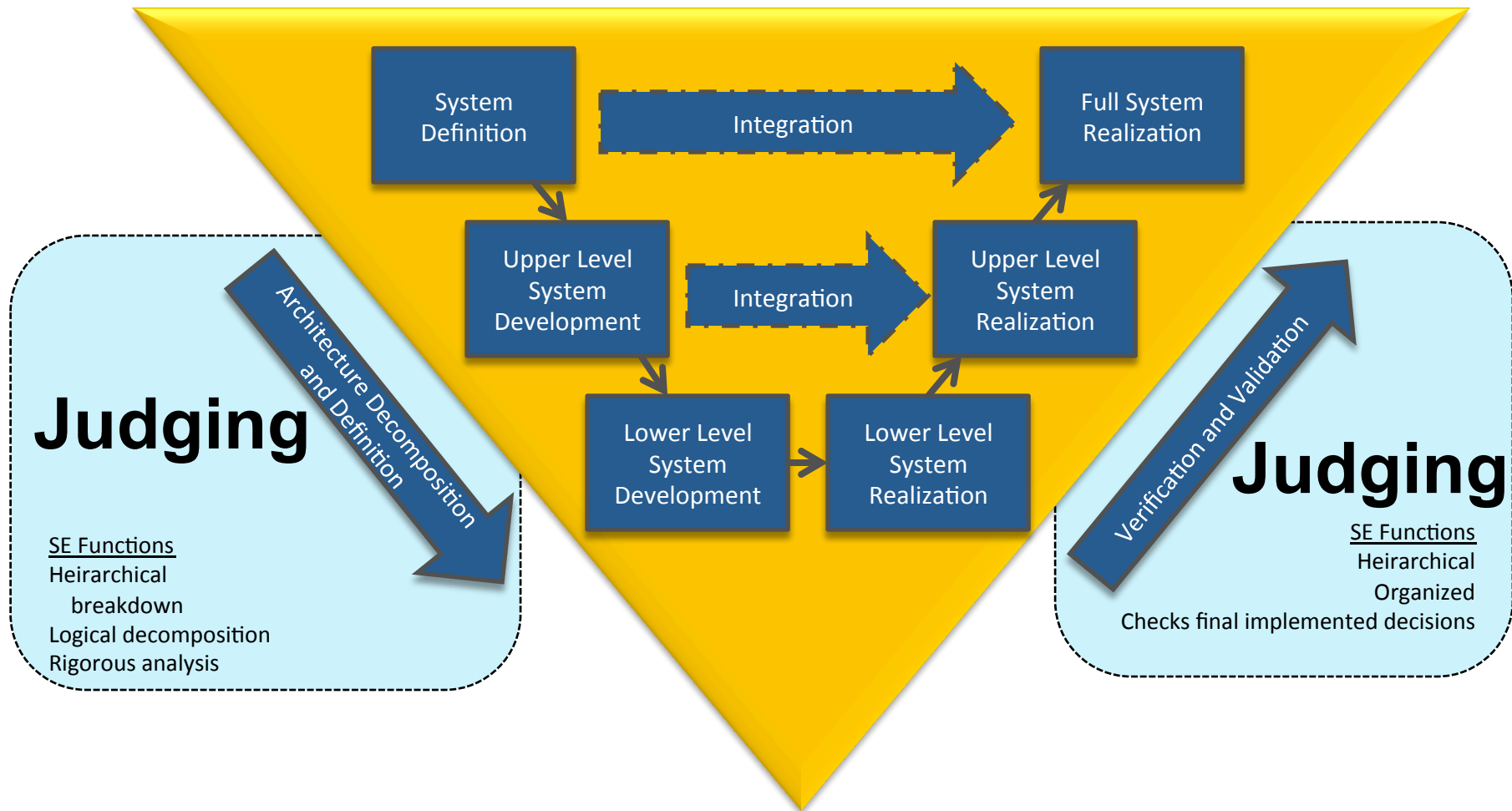
Perceiving

Flexible

Open Ended

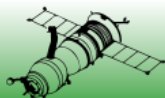
Prefers adjustable structure

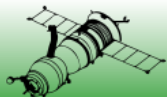




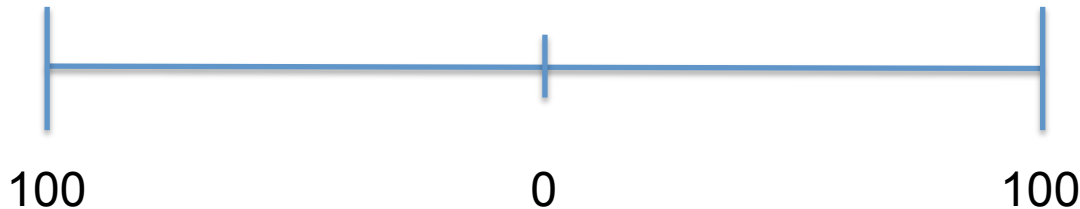
Information – Sensing

- 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

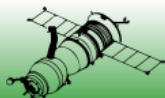
Looks for details

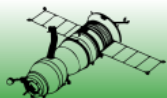
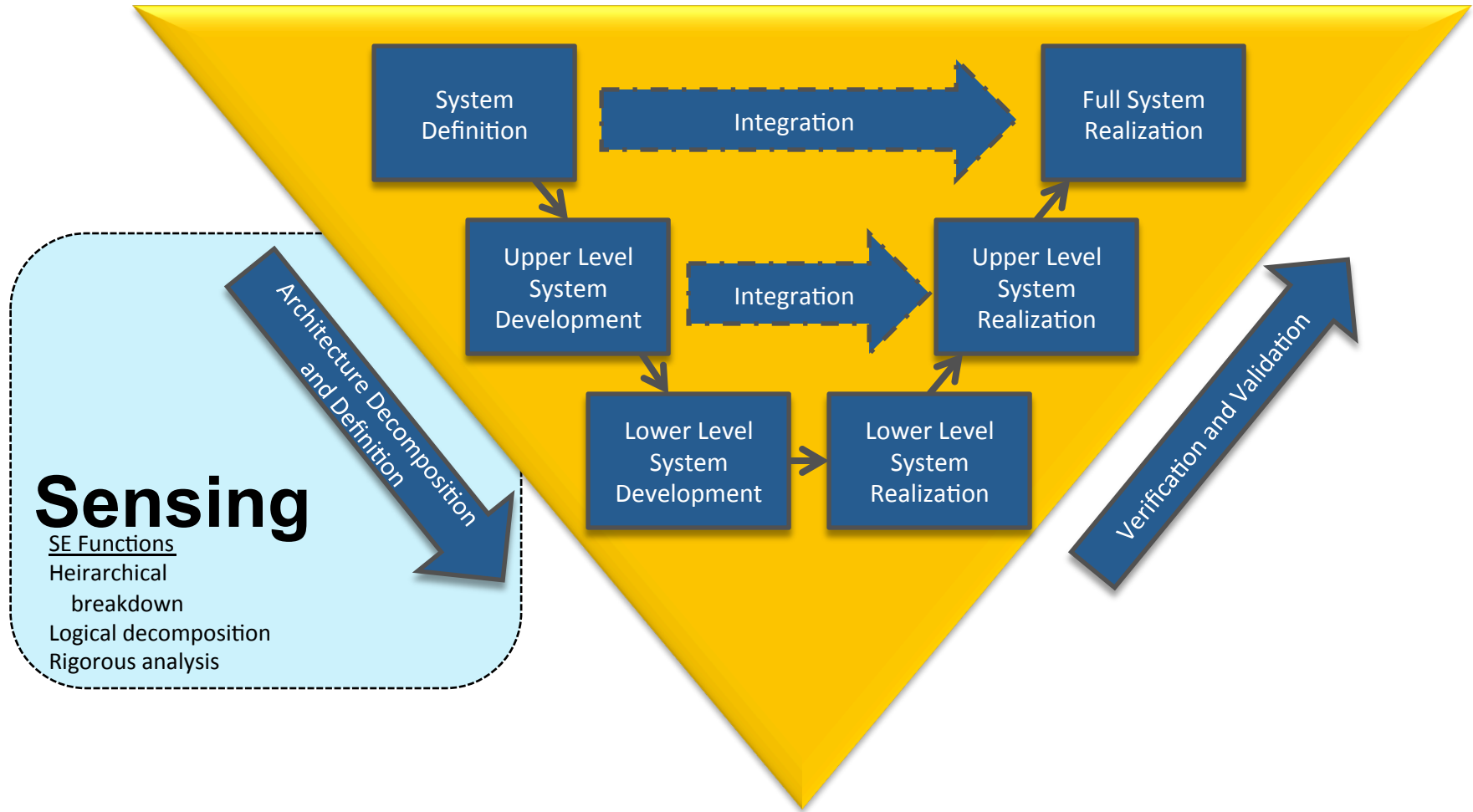
Intuitive

Holistic view of parts making
a whole

Applies new concepts with
little direction

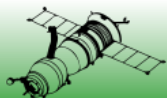
Needs to see the whole
picture

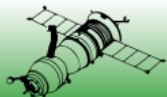




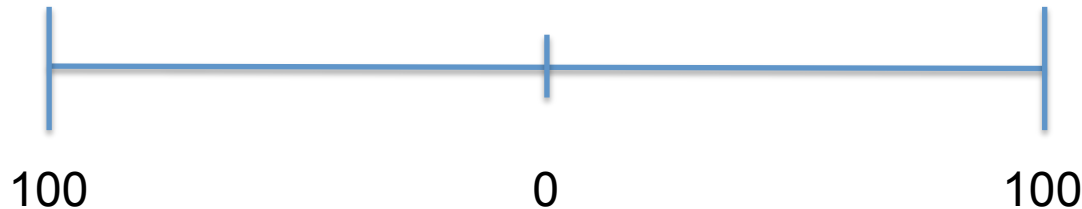
Structure – Perceiving

- Flexible
- Open Ended
- Prefers adjustable structure





External Structure



Judging

Heirarchical

Organized

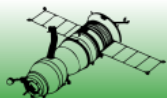
Prefers fixed (non-flexible)
structure

Perceiving

Flexible

Open Ended

Prefers adjustable structure



Perceiving

SE Functions
Connecting
Understanding
Synthesizing

System
Definition

Integration

Full System
Realization

Upper Level
System
Development

Integration

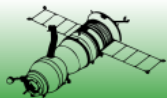
Upper Level
System
Realization

Lower Level
System
Development

Lower Level
System
Realization

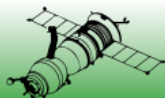
Architecture Decomposition
and Definition

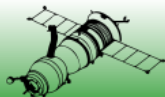
Verification and Validation



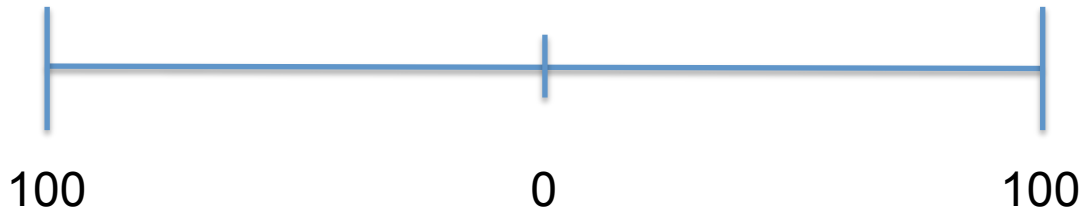
Information – Intuitive

- 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

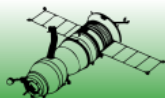
Looks for details

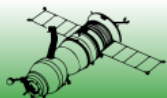
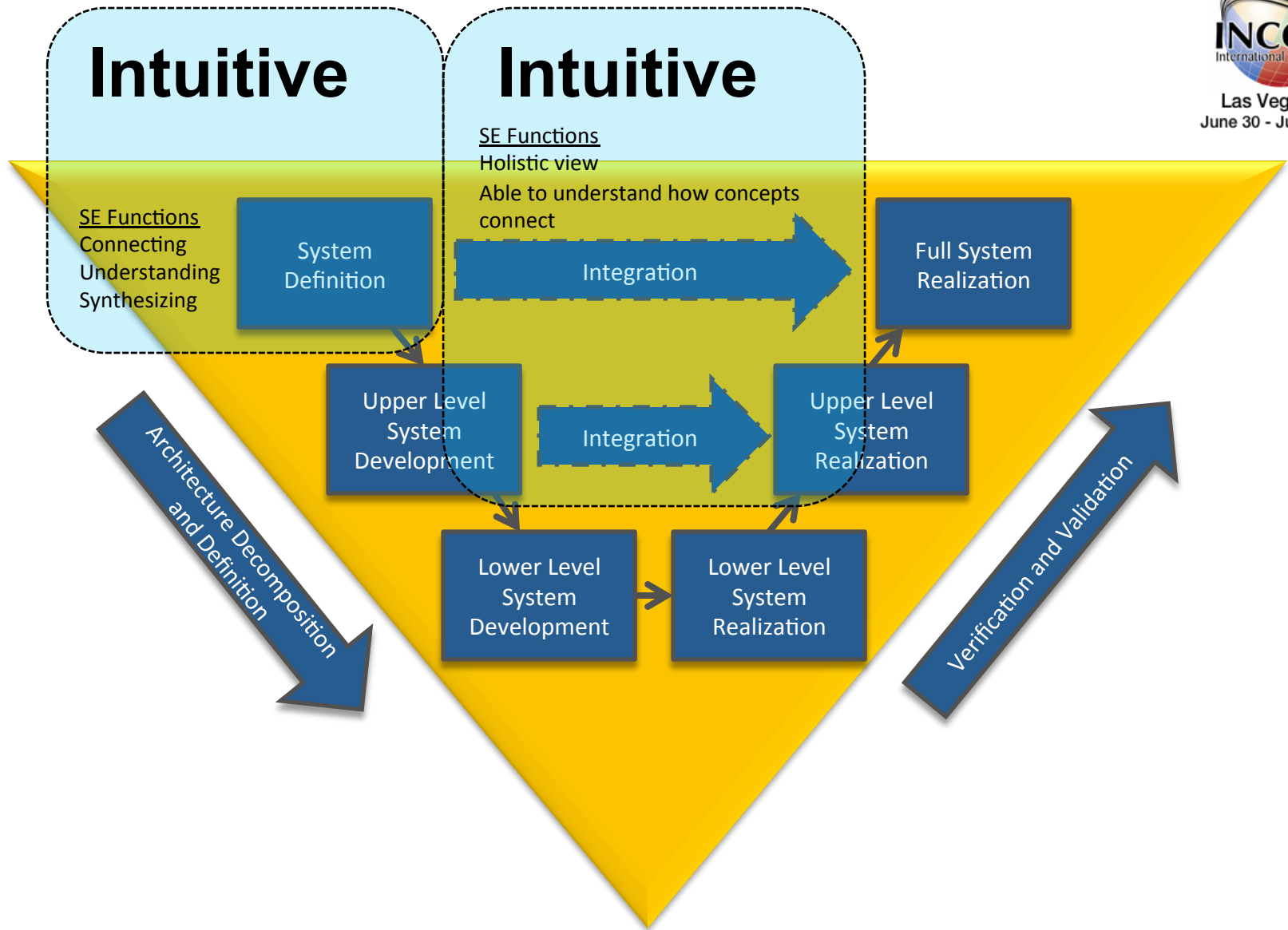
Intuitive

Holistic view of parts making
a whole

Applies new concepts with
little direction

Needs to see the whole
picture





Step 5:

Apply Characteristics to Tasks

Intuitive Perceiving

SE Functions
Connecting
Understanding
Synthesizing

System
Definition

Intuitive

SE Functions

Holistic view

Able to understand how concepts
connect

Integration

Full System
Realization

Upper Level
System
Development

Integration

Upper Level
System
Realization

Lower Level
System
Development

Lower Level
System
Realization

Judging Sensing

SE Functions

Heirarchical
breakdown
Logical decomposition
Rigorous analysis

Architecture Decomposition
and Definition

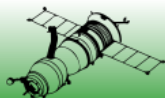
Judging

SE Functions

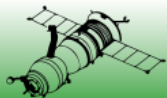
Heirarchical
Organized

Checks final implemented decisions

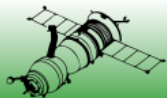
Verification and Validation



Don't do this...



Questions?



NT

Visioning

Who's your character?

MBTI in LOVE

WHO

HARR



THE EXAMINER
ESFJ
SEVERUS Snape

INTROVERTED | SENSING | THINKING | JUDGING

DEFINED BY THEIR HONOR AND DUTY, TAKE ANY TASK SERIOUSLY AND GIVE IT MORE THAN THEIR BEST. SOMEWHAT RESERVED AND PREFER TO WORK ALONE, BUT CAN MAKE GREAT TEAM MEMBERS IF THE NEED ARISES. HIGHLY VALUE TRADITION AND LOYALTY AND OFTEN PUT DUTY BEFORE PLEASURE.



THE CRAFTSMAN
ISTP
HARRY Potter

INTROVERTED | SENSING | THINKING | PERCEIVING

FIERCELY INDEPENDENT, ADVENTUROUS, DON'T LIKE MUCH ATTENTION, MORE INTERESTED IN THEIR OWN PROJECTS THAN BEING OTHERS. DO NOT BELIEVE IN RULES AS THEY PROMOTE THEIR ABILITY TO DO THEIR OWN THING. ORGANIZE FACTS USING LOGICAL PRINCIPLES AND VALUE EFFICIENCY.



THE PROMOTER
ESTP
GINNY Weasley

EXTROVERTED | SENSING | THINKING | PERCEIVING

FLEXIBLE AND TOLERANT, THEY WANT TO ACT INSTINCTIVELY TO SOLVE THEIR PROBLEMS USING THEIR QUICK WIT AND CLEVERNESS. LOVE AT SELLING THEIR IDEAS. ENJOY ACTIVITIES INVOLVING PHYSICAL ACTION AND RISK-MAKING, AND ESPECIALLY THRIVE ON THE SPIRIT OF COMPETITION.



THE SUPERVISOR
ESTJ
HERMION Granger

EXTROVERTED | JUDGING | THINKING | JUDGING

PRACTICAL, REALISTIC, MATTER-OF-FACT, AND QUICK TO IMPLEMENT DECISIONS. ORGANIZE PROJECTS AND PEOPLE TO GET THINGS DONE. FOCUS ON GETTING RESULTS IN THE MOST EFFICIENT WAY POSSIBLE AND TAKE CARE OF ROUTINE DETAILS. FORCEFUL IN IMPLEMENTING THEIR PLANS.

ARTWORK: MAKANIL



ESFJ

Is there a spot on your ass that I haven't kissed yet? Please, let me remedy that.



ISFJ

Free hugs for EVERYBODY!!!



ESTJ

Misunderstanding you within normal parameters.



ISTJ

Nonchalantly side-stepping your bullshit since the dawn of time.



INTP

Say goodbye to all your



ENFP

You only WISH you



INFP

You say "human apology"



ENFP

Take your pick: sugar

STAR



ISTJ
Owen Lars

The Inspector

Responsible, loyal, and hard working. Have an acute sense of right and wrong and work to preserve established norms and traditions. Somewhat reserved and prefer to work alone, but can make great team members if the need arises. Characterized by the ability to work hard and make sacrifices to keep society running smoothly.



ISTP
Chewbacca

The Crafter

Independent and adventurous, yet quiet and reserved. Interested in how and why things work. Adaptable and spontaneous, likes to live in the moment. Loyal to their peers and to their internal value systems, but not overly concerned with respecting rules if they get in the way. Characterized by their ability to get things done.



ESTP
Han Solo

The Promoter

Friendly, adaptable, and action-oriented "doers" who are focused on immediate results. Think on their feet and thrive in crises. Informal risk-takers who live fast-paced lives. Never allow rules to get in the way of their ambitions. Straightforward and realistic, take criticism well. Characterized by their ability to get things done and work well with others.



ESTJ
Darth Vader

The Supervisor

Practical, realistic, organized, and strategic. Possess natural leadership qualities. Strict boundary setters who take personal responsibility very seriously. Intensely focused on getting results and seek ways to do so in the most efficient way possible. Characterized by their ability to preserve traditions and provide security for their loved ones.



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Owen Lars

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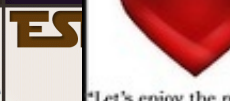
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ENFJ

"Anything to please you."



INFJ

"You are perfect."



INTJ

"I will fix you."



ENTJ

"Come away with me."



ENFP

"I love you, and you, and you."



INFP

"You're my only dream."



INTP

"Loving you is easy."



ENTP

"Grow old with you."



ESFP

"Let's enjoy the moment."



ISFP

"Runs away."



ISTP

"I like you now."



ESTP

"You know you love me."



ESFJ

"I cherish you."



ISFJ

"Unconditionally."



ISTJ

"My pledge of love cannot be broken."



ESTJ

"I do."

