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Model-Based System Engineering (MBSE)
Organizational Panacea or Mirage

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Congratulations!

5th Annual INCOSE Great Lakes Conference

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MBSE: Organizational Panacea of Mirage
Presentation Overview

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- **Introduction, Observations, & Problem Statement**

- **Understanding Organizational Change Management (OCM)**

- **Organizational MBSE Measures of Effectiveness (MOEs)**

- **Recommendations**

MBSE: Organizational Panacea of Mirage

Introduction

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- **MBSE, as a method, when planned and implemented properly, provides the potential for strengthening their SDE capabilities but also enabling them to achieve new levels of organizational SE capabilities and performance.**

- **As an SE author and educator**
  - I am a proponent of MBSE and promote its widespread use.

- **As an organizational consultant**
  - The mission is to help organizations achieve System Engineering and Development success.

MBSE: Organizational Panacea of Mirage
Observations (1 of 2)

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- **MBSE as a <u>Method</u>**
  - Myth – MBSE is a new innovation; conceptual roots to the 1950s and 1960s
  - Is essential to the success of most projects … especially large, complex systems.
  - Promotes a "shared vision" among multiple disciplinary teams
  - Provides early design data and verification, risk mitigation, etc.

- **Math Models - Are a foundational element of MBSE, but not MBSE**

- **MBSE <u>Tools</u>**
  - As a <u>supporting</u>– not a driving – element to a valid SE process implementation, provide mechanisms for collaboration and capture of the Four Domain Solutions – i.e., requirements, operational, behavioral, and physical – at multiple levels of a system.
    - Wasson, *System Analysis, Design, and Development*, John Wiley & Sons, 2006.

- **UNDERSTAND THE DIFFERENCES!!!**

MBSE: Organizational Panacea of Mirage
Observations (2 of 2)

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- **Over the past 5 years, MBSE has experienced new, accelerated**
  - Everyone seems to be "leaping onto the bandwagon"

- **2009 INCOSE Fellows Key System Engineering Issues**
  - *Issue 3. How can you "prove" that your systems design will solve the customer's problem before you build and prove that design?*
    - Fellows' Insight, *Key Issues in Systems Engineering*, INCOSE Insight, Vol. 12 Issue 4, December, 2009, p. 58.

- **2 types of MBSE organizational extremes**

Extreme #1 Organizations ← → All Other Organizations ← → Extreme #2 Organizations

MBSE: Organizational Panacea of Mirage
Extreme #1 MBSE Organizations

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- **Do not understand or have not mastered the SE & Development Process**
  - As a structured methodology to problem solving and solution development
  - Failed at implementing SE; continue to operate using the Build, Test, Fix Paradigm … and have decided to "moved on" to MBSE.
  - Consider MBSE to be:
    - 1 person (local guru) who mathematically models the system and its functional or physical performance
  - Erroneously believe MBSE, as a tool, will correct:
    - Organizational SE capability deficiencies
    - Poor project delivery performance

- **Extreme #1 organizational characteristics are addressed in:**
  - Wasson, Charles S., *System Engineering Competency: The Missing Element in Engineering Education, INCOSE IS 2010, Chicago, IL.*

My experience has been … If you or your organization do not understand how to implement true Development SE, not Acquisition SE, MBSE will be nothing more than a graphics tool.
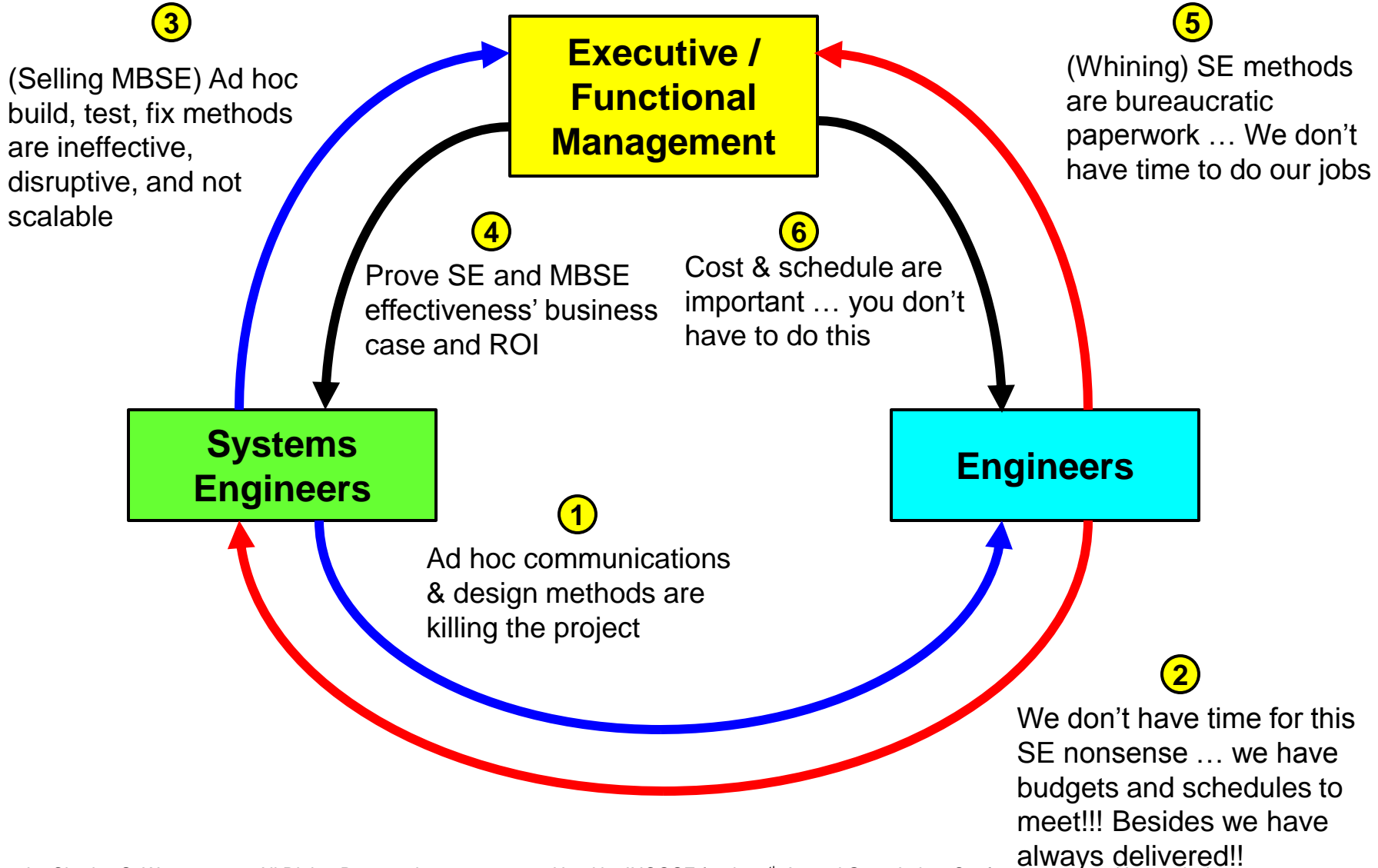
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Typical SE – Organizational Scenario

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③ (Selling MBSE) Ad hoc build, test, fix methods are ineffective, disruptive, and not scalable

Executive / Functional Management

⑤ (Whining) SE methods are bureaucratic paperwork … We don't have time to do our jobs

④ Prove SE and MBSE effectiveness' business case and ROI

⑥ Cost & schedule are important … you don't have to do this

Systems Engineers

Engineers

① Ad hoc communications & design methods are killing the project

② We don't have time for this SE nonsense … we have budgets and schedules to meet!!! Besides we have always delivered!!

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MBSE: Organizational Panacea of Mirage
Extreme #2 MBSE Organizations

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- **View MBSE as an integral element of their long-term corporate strategy to improve SE capabilities and project delivery performance.**
    - Perform perform MBSE business case analysis and implementation planning and risk assessments <u>before</u> committing to MBSE.
    - Have buy-in and action-based support at the executive, functional, and project management levels.

- **If committed to MBSE …**
    - Establish the enterprise infrastructure to ensure the probability of success:
        - Command media, processes, resources, and leadership
        - Strategic and "roll-out" tactical planning
        - SE and Team-based training
        - Performance-based objectives for personnel.

    - Pilot MBSE before committing to moderate or large, complex projects.

- **Relentlessly improve based on deficiencies and lessons learned of what is / is not working.**

Problem Statement – The MBSE Mirage

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- **Organizations characterized by poor project delivery performance and compliance issues sometimes envision (mirage) and commit to MBSE as a <u>fast track</u> to solving those organizational problems (panacea).**
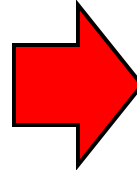
MBSE: Organizational Panacea of Mirage

MBSE Publicity Versus Reality

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Publicity

- **If you invest in the stock market over time, you will probably make a return on investment (ROI).**

- **If you implement MBSE, teams will be able to collaborate and have a shared vision of system design, …**

Reality

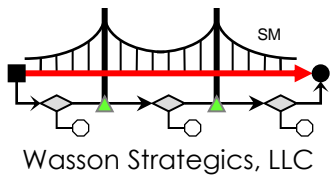- **If you invest [wisely] in the stock market over time, you will probably make a return on investment (ROI).**

- **If you [plan and] implement MBSE [wisely], teams will be able to collaborate and have a shared vision of system design, …**
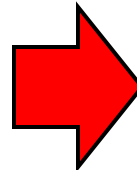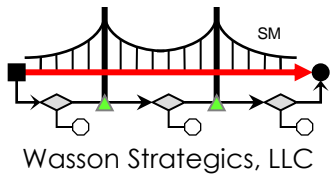
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Understanding Organizational Change Management (OCM)

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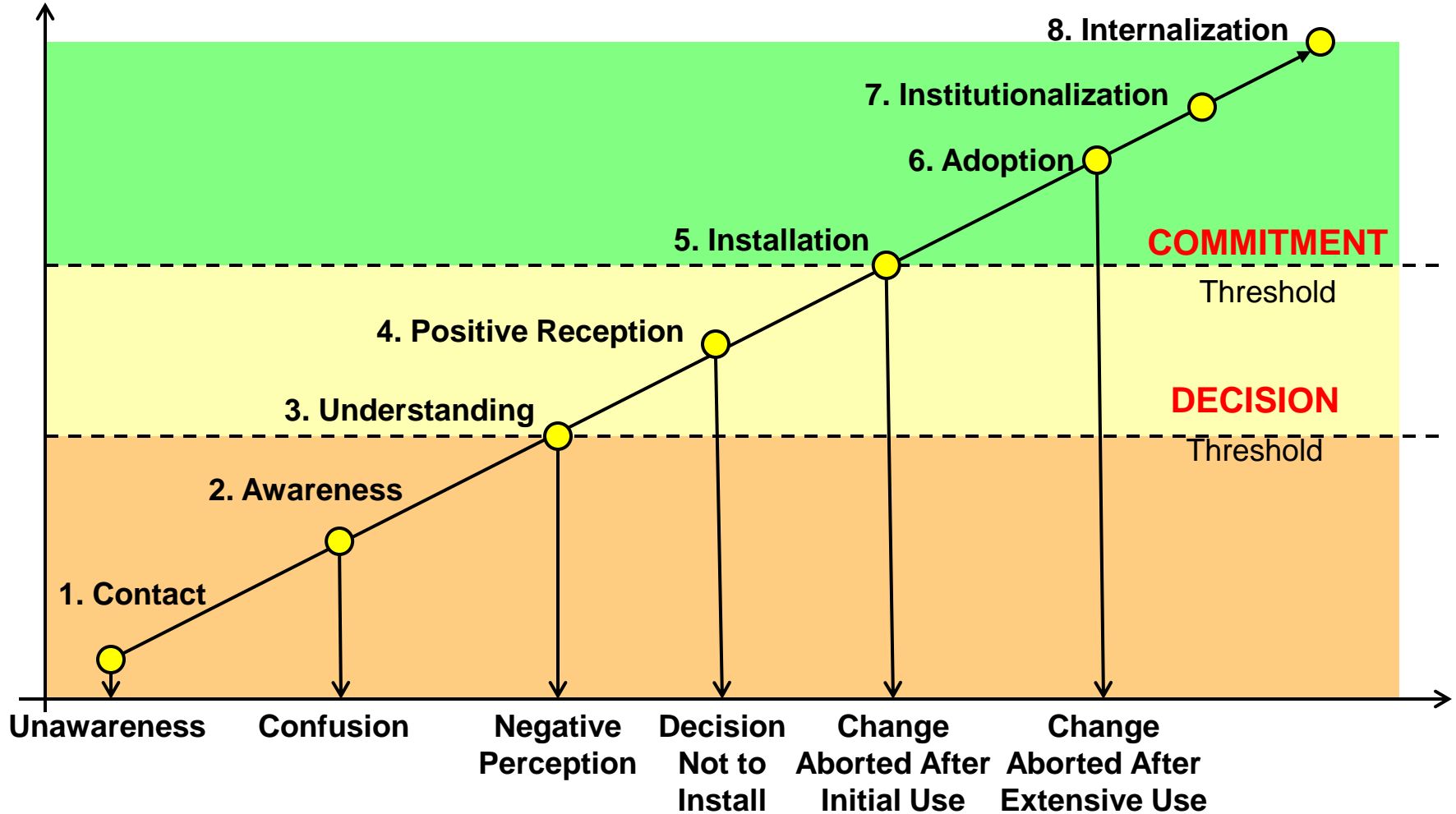# Fable – The Young Proponent and the CEO

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MBSE: Organizational Panacea of Mirage

How People React Negatively to Change

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Source: Paulk, M., *How People Commit to Change*, Software Engineering Institute (SEI), circa 1993, p. 31.

(SEI) Adapted from Conner, Daryl R. and Patterson, Robert W., *Building Commitment to Organization Change*, Training and Development Journal, April 1982.

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MBSE: Organizational Panacea of Mirage
Planning for Transition

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- "While the Capability Maturity Model Integration (CMMI®) has initiated a flurry of change, many organizations have struggled with its implementation **because they have failed to recognize that resistance to change, and not immediate adoption of change, is the norm**.

- **This is not a fault of the (CMMI) model: 70% of the efforts to perform "business reengineering" have failed [1] as have 57% of the efforts to introduce CASE tools [2] because they have neglected the human factor in change.** William Bridges, in "Managing Transitions; Making the Most of Change" points out that every change is not only a beginning, but an end.

- What hinders adoption is that **during the transition the old and the new coexist and people have a hard time "letting go" of the past**. This conflict leads to loss of productivity."
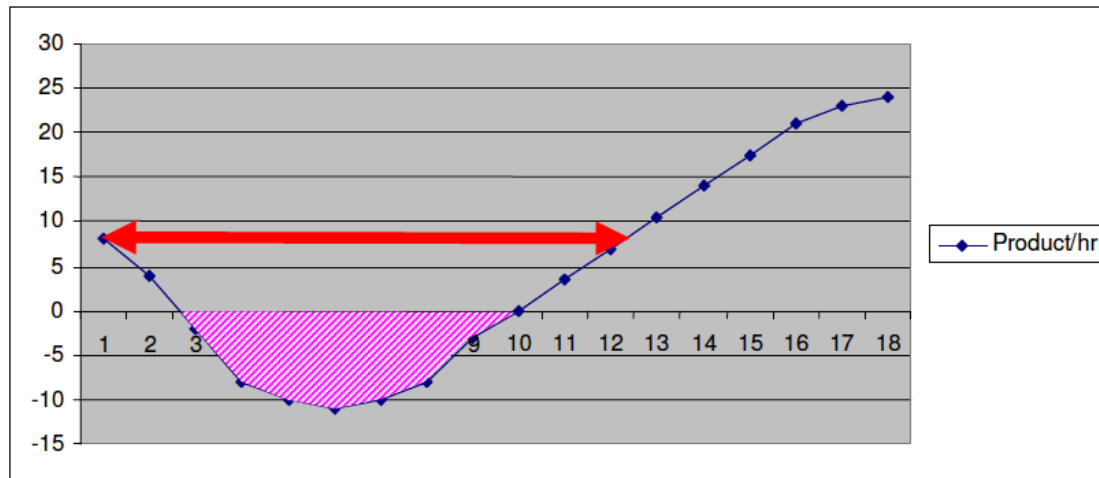

Figure 1: Loss of Productivity During the Transition

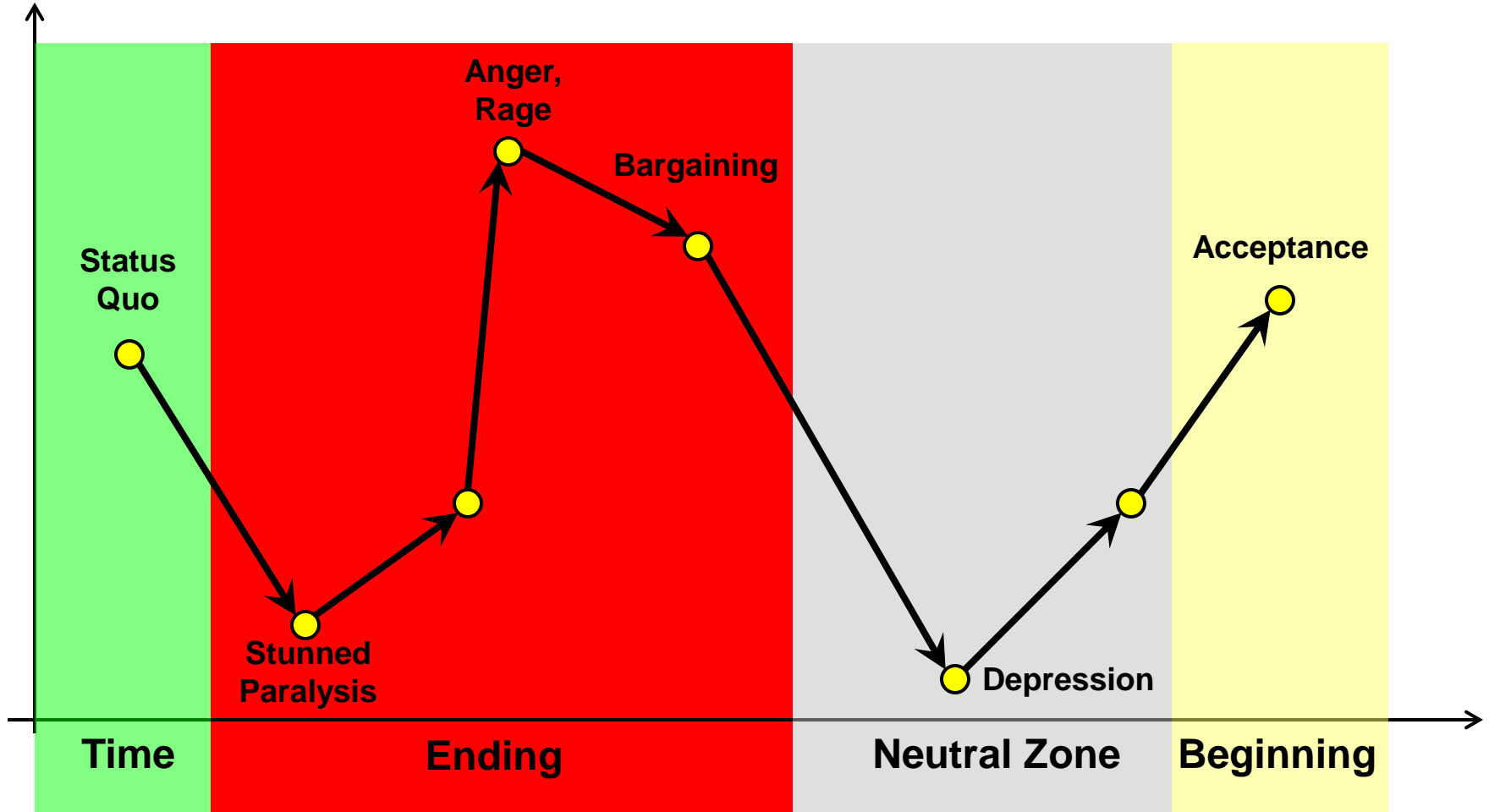Source: Boria, Jorge Luis, *Change dos not "Happen"* concerning CMMI Adoption.

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How People React Negatively to Change

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Source: Paulk, M., *How People React Negatively to Change*, Software Engineering Institute (SEI), circa 1993, p. 34.

Referencing (SEI) Adapted from: Kuber-Ross, Elizabeth, On Death and Dying, 1969, and Bridges, William, Surviving Corporate Transformations, 1988.

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Organizational Change Management (OCM)

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Source: Hihn, Jarius, *The Conundrums of the Costing World*, 23rd International Forum on COCOMO and Systems/Software Cost Modeling, October 28, 2008, p. 1-10.
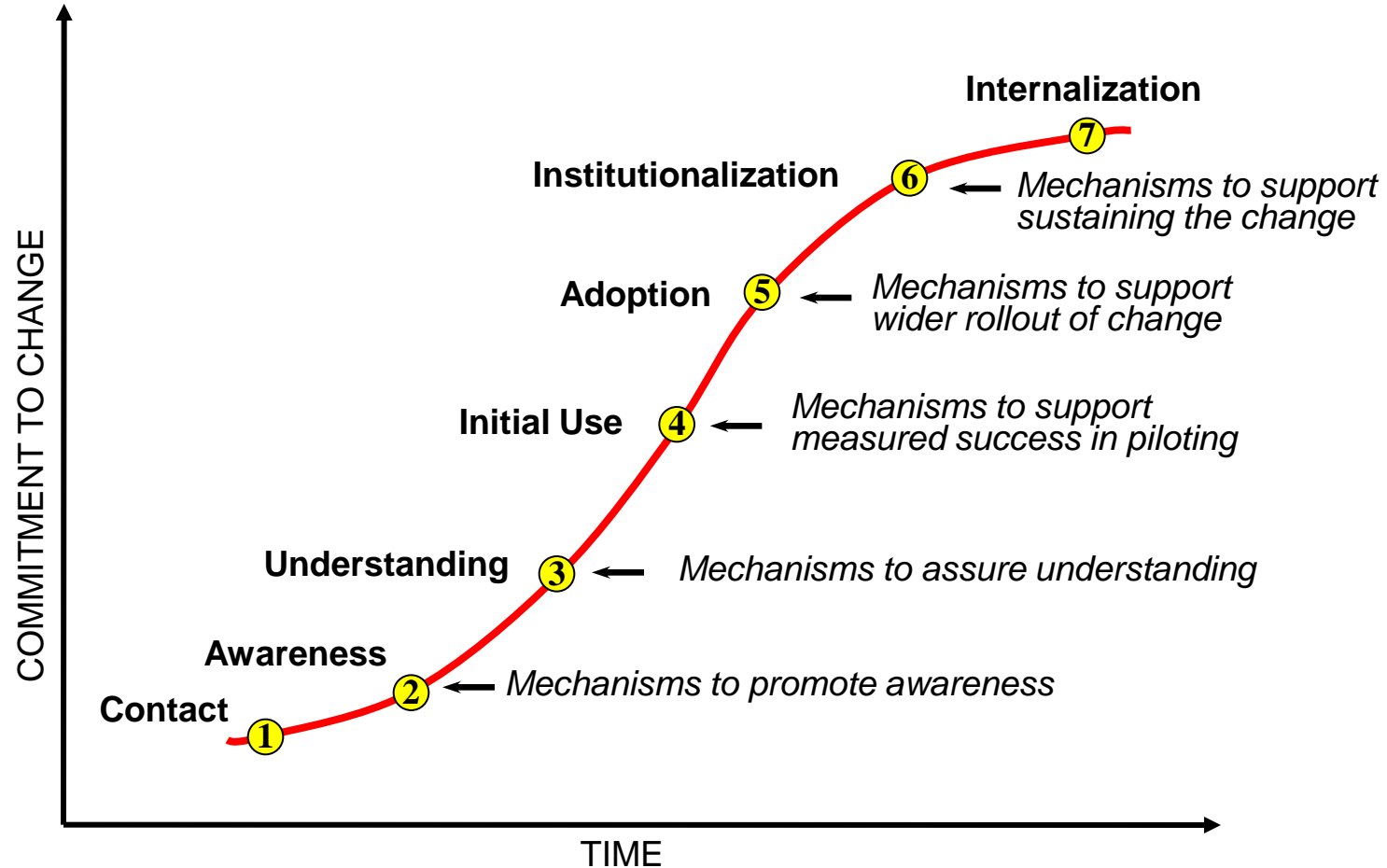
(JPL quoting) Adapted from *Out from Dependency: Thriving as an Insurgent in a Sometimes Hostile Environment*, SuZ Garcia and Chuck Myers, SEPG Conference, 2001

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Example MBSE Strategy – JPL

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Source: Lin, C; Nichols, D.; Stone, H.; Jenkins, S.; Bayer, T.; and Dvorak, D.; *Experiences Deploying MBSE at NASA JPL*, Frontiers in Model-Based SE Workshop, Georgia Institute of Technology, April 27 – 28, 2011 .

(JPL) Adapted from *Out from Dependency: Thriving as an Insurgent in a Sometimes Hostile Environment*, SuZ Garcia and Chuck Myers, SEPG Conference, 2001
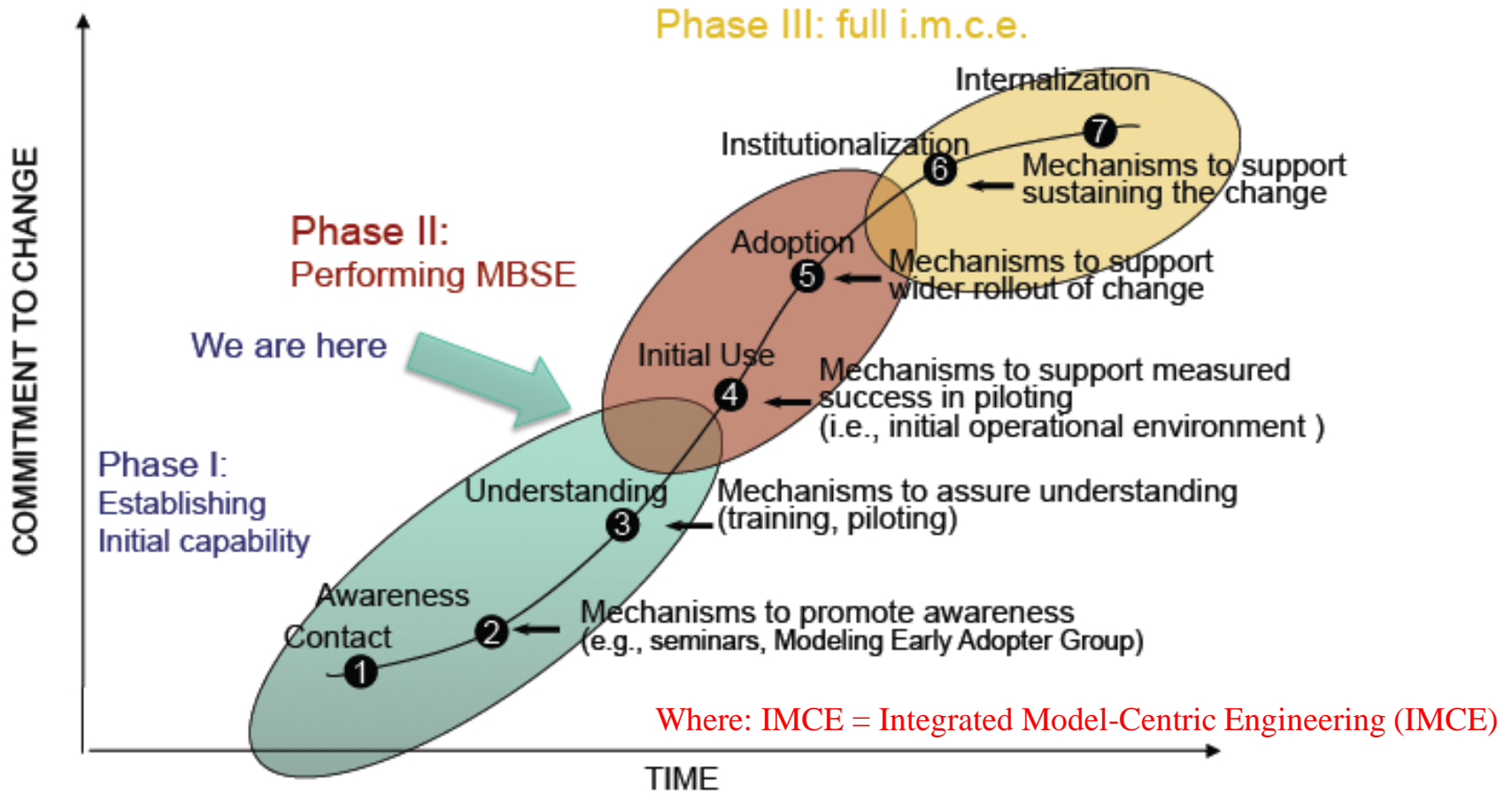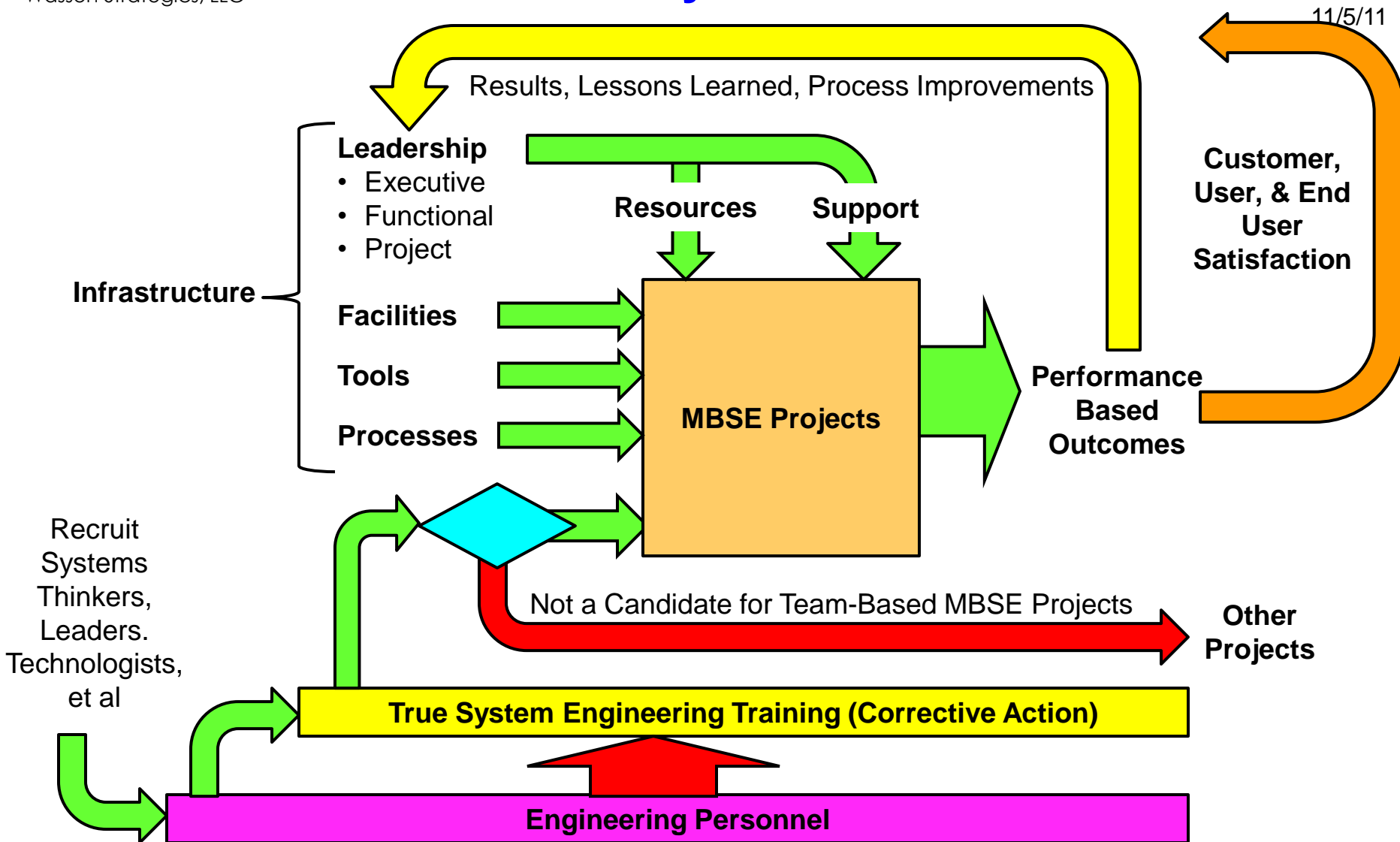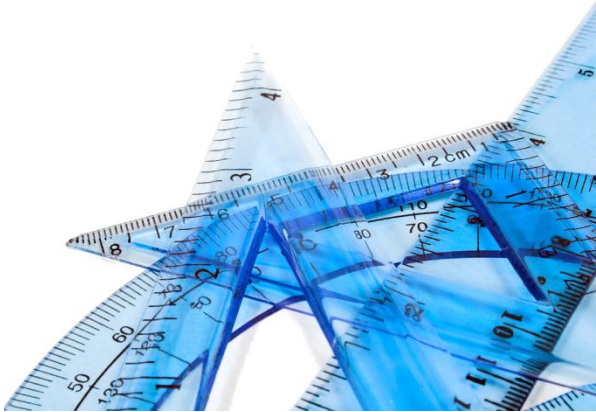
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MBSE "System" Success Model

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Results, Lessons Learned, Process Improvements

Leadership
- Executive
- Functional
- Project

Resources　　**Support**

Infrastructure

Facilities

Tools

Processes

MBSE Projects

Performance Based Outcomes

Customer, User, & End User Satisfaction

Recruit Systems Thinkers, Leaders. Technologists, et al

Not a Candidate for Team-Based MBSE Projects

Other Projects

True System Engineering Training (Corrective Action)

Engineering Personnel

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Organizational
Measures of Effectiveness (MOEs)
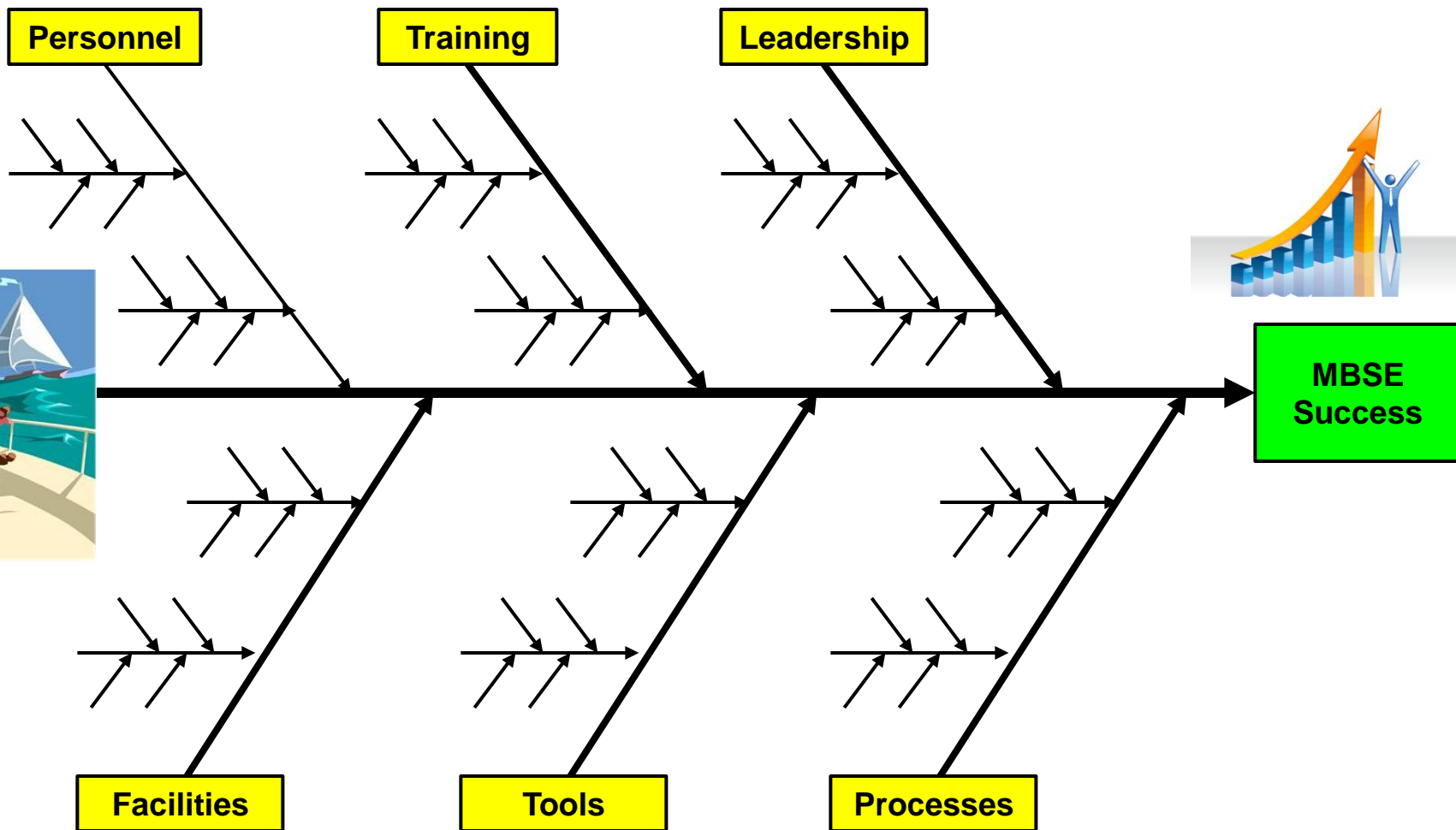
MBSE Measures of Effectiveness (MOEs)

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- **Every system, including organizational systems, should have a set of MOEs**
  - To establish the business case baseline of what the organization desires to achieve.
  - Organizationally, industry benchmarks ("keeping up with the Jones'") are often used to measure and assess performance … however …. every organization is different and has its own measures of success ➔ MOEs.

- **How does an organization establish MBSE MOEs?**
  - As a system selected on a predicated on achieving success, we characterize that performance in terms of its contributory performance effecters:

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MBSE: Organizational Panacea of Mirage
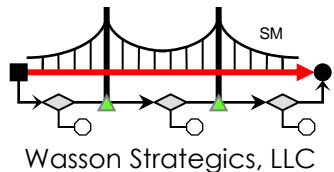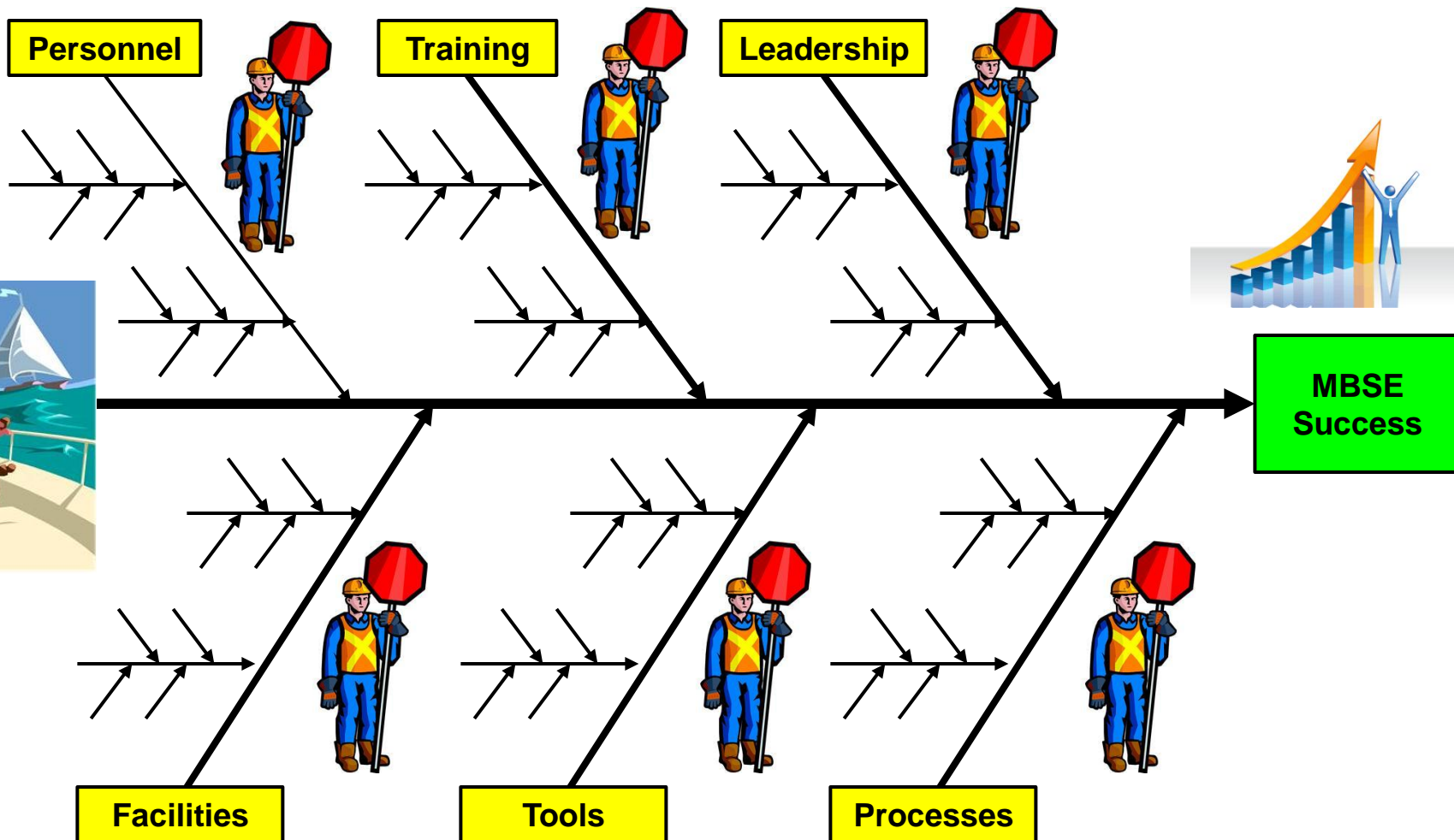
Understanding MBSE Success Factors

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MBSE: Organizational Panacea of Mirage

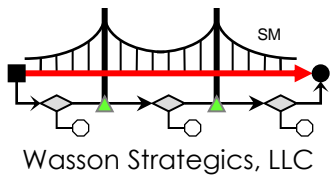# Managing MBSE Obstacles & Success Factors

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Personnel

Training

Leadership

Facilities

Tools

Processes

MBSE Success

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MBSE Measures of Effectiveness (MOEs)

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> **Establish MBSE MOEs based on the "sales features" that drove the "commit" decision.**

- **Organizational Measures of Effectiveness (MOEs) Candidate Examples**
  - Leadership - Accomplishment of MBSE strategic planning implementation milestones (Note the 8 staged OCM decision points – VG#18).

- **Technical MOE Candidate Examples**
  - Requirements coverage => Personnel competency dependent
  - Design completeness => Personnel competency dependent
  - Reduction in missing requirements => Personnel competency dependent
  - Early data for design risk mitigation and verification – Peer Reviews => Personnel dependent
  - Reduction in design errors, flaws, or defects at system integration & test (seamless integration) => Personnel dependent

MBSE: Organizational Panacea of Mirage
MBSE Measures of Effectiveness (MOEs)

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- **Team-Based MOE Candidate Examples**
  - Shared vision – common, collaborative, design frame of reference knowledge base.
  - Interfaces - Maturity of interface definitions

- **Individual MOE Candidate Examples**
  - Efficiency – Timely access to data required to perform assigned tasks and actions.
  - Effectiveness – Ability to collaborate and integrate current design thinking into the mainstream design in real-time.

- **System Engineering MOE Candidate Examples**
  - What ifs – Timely and insightful analyses into system performance issues, design changes, etc.
  - Requirements traceability – To specs, use cases, design, test procedures, etc.
  - Efficiency – Multi-disciplined change impact analysis

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Recommendations

MBSE: Organizational Panacea of Mirage
Recommendations(1 of 2)

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- **If you are contemplating or planning to implement MBSE:**
  - "Grow and nurture the seed" via organizational strategic and tactical planning.
  - Treat MBSE as a project:
    - Establish accountability at the executive, functional management, project, and personnel levels.
    - Develop a roll-out plan
      - With milestones to be accomplished
      - Train personnel in SE and MBSE – e.g., tools, languages, methodologies
      - Staff with personnel who understand SE and are passionate about MBSE
      - Take small steps - pilot small projects first.
      - Migrate pilot project personnel into larger projects.
      - Evaluate progress against Measures of Effectiveness (MOEs).
    - Relentlessly monitor results and corrective actions
  - Longer term - Recruit new and seasoned professionals who support MBSE
    - "Systems thinkers"
    - Understand SE and preferably MBSE

Recommendations(2 of 2)

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- **If you are are already implementing MBSE:**
  - Integrate MBSE into the organization's strategic and tactical planning.
  - Assess where the organization is relative to the Organizational Change Management (OCM) Model presented earlier.
  - Institute the MBSE system Success Model
  - Remove barriers – e.g., slow computers, networks, attitudes, et al – that impede progress.
  - Make corrective actions.

Remember – Every organization and individual has their own view of MBSE success … MANAGE EXPECTATIONS

Closing

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Thank you for the opportunity to participate in the 5th Annual INCOSE Great Lakes Conference

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