Systems Engineering Capability Implementation Initial Determination

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Systems Engineering Capability Implementation Initial Perception

Over the past several years, I have developed a perception of SE from the viewpoint of a company or organization trying to implement and then working with Systems Engineering. A lot of DOD customers are requiring SE be in place in their RFPs and more companies are trying to put SE in place to meet that requirement. However, it is starting to look a lot like when Total Quality Management (TQM) was the current silver bullet - almost all of the capabilities and processes are being laid in with no regard for the needs of the organization and being "implemented" by people with very little overall SE knowledge.

Systems Engineering Capability Implementation Initial Perception

So when it comes to trying to develop proper overall SE for an organization, it doesn't happen. Usually even if the person is a CSEP - and with many ESEPs. The silo effect continues because there are processes that are "more important" to the person or the organization. And with the problem of determining SE Return on Investment (ROI) without historical data and no real metrics to determine SE efficiency and effectiveness, we are getting into shaky territory. And once an organization implements SE, they seldom go back and try to determine if their implementation actually accomplished what they were trying to do.

Actuality Versus Perception - 1996

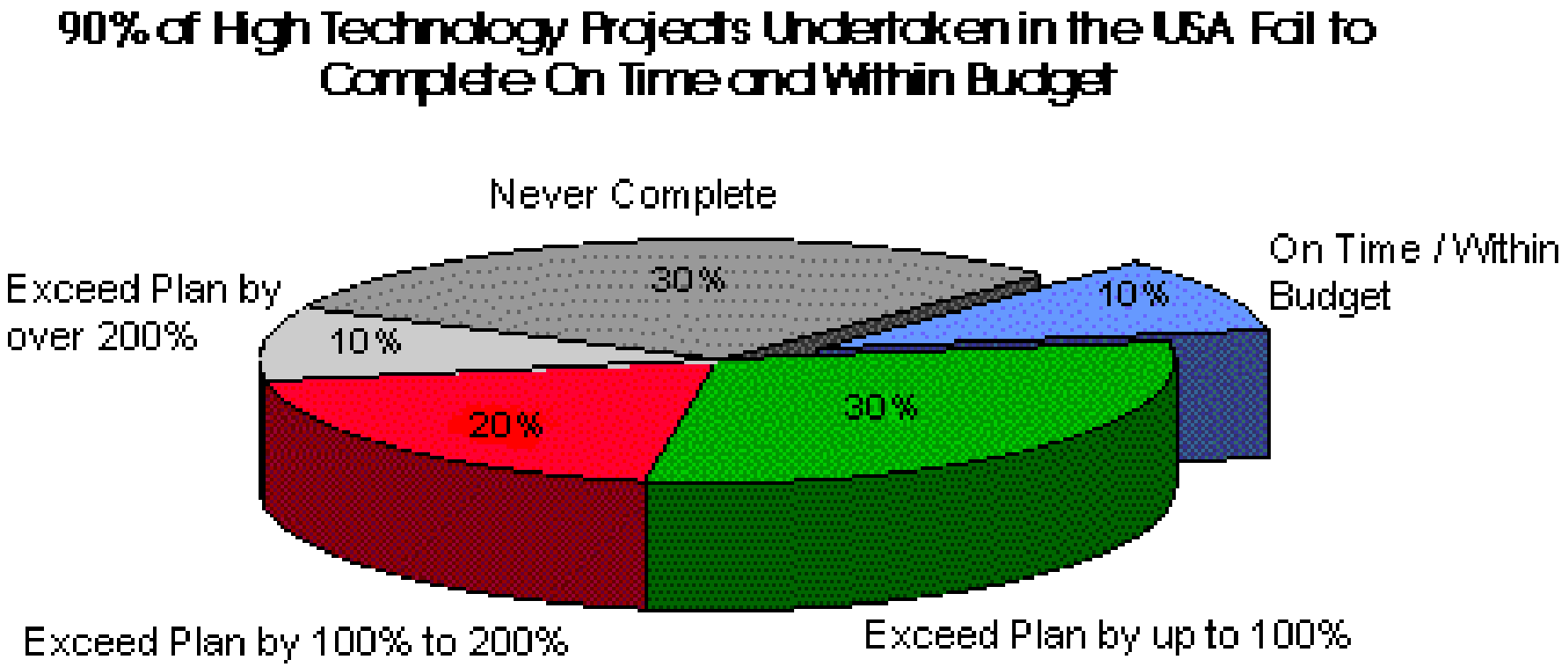


Figure 1

Source: Standish Research Group 1996

Actuality Versus Perception - 1996

In industry today, there is considerable emphasis on attempting to quantify, qualify, and define systems engineering and the systems engineering process.

Systems Engineering Process Assessments (SEPAs) and the like, are being performed to identify the relative maturity of the process (e.g., how well do processes match up with a macro model and how well are they institutionalized and used). While these assessments can be powerful tools, they do not provide insight into the methodology of systems engineering or the effectiveness of the systems engineering process. Only when the maturity level, methods, tools, and effectiveness are viewed in the aggregate, can the systems engineering process be truly assessed.

Actuality Versus Perception - 1996

The following list describes several key benefits of performing a SE benchmarking effort:

- **Identifies the state of practice of systems engineering:**
  - Determines levels of maturity of the organization
  - **Demonstrates how organizations compare**
  - **Provides a baseline to investigate alternates in systems engineering**
  - Provides the means to assess the changes due to the use of alternate systems engineering methodologies, tools, and processes
- Identifies the present systems engineering methodologies:
  - **Provides a basis to develop new methodologies**
  - **Provides the means to measure improvement**
- Identifies the predominant systems engineering tools
- **Correlates practices, methodologies, and tools with process maturity level and marketplaces**

Other benefits of benchmarking the systems engineering process include:

- Provides systems engineering process model exposure
- Identifies expertise in the process areas
- **Provides a tool for process improvement**
- **Provides a means to compare groups and organizations against each other**

Actuality Versus Perception - 2015

On average, large IT projects run 45 percent over budget and 7 percent over time, while delivering 56 percent less value than predicted (A study of 5,400 large scale IT projects)

PricewaterhouseCoopers, which reviewed 10,640 projects from 200 companies in 30 countries and across various industries, found that only 2.5% of the companies successfully completed 100% of their projects. -

A study published in the Harvard Business Review, which analyzed 1,471 IT projects, found that all but one in six projects had a cost overrun of 200% on average and a schedule overrun of almost 70%. And we all have heard about large construction projects — the Channel Tunnel, Euro Disney, and Boston's "Big Dig" — that ended up costing almost double their original estimate. -

57% of projects fail due to "breakdown in communications

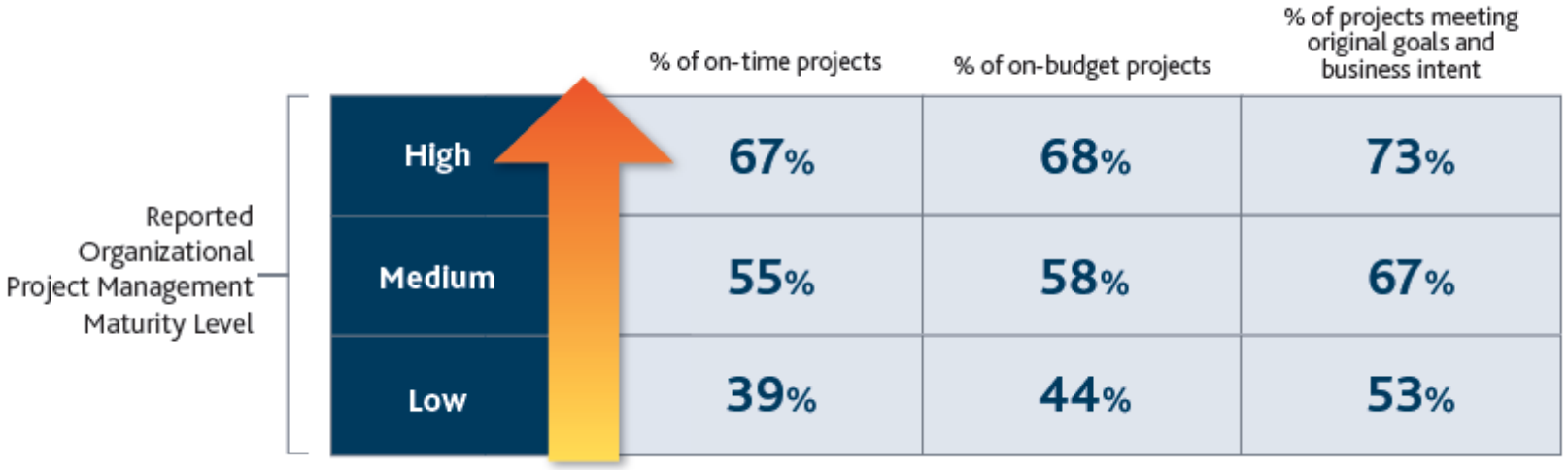
39% of projects fail due to lack of planning, resources, and activities

Actuality Versus Perception - 2015

RESOLUTION

	2004	2006	2008	2010	2012
Successful	29%	35%	32%	37%	39%
Failed	18%	19%	24%	21%	18%
Challenged	53%	46%	44%	42%	43%

Project resolution results from CHAOS research for years 2004 to 2012.



Actuality Versus Perception - 2015

Only **64%** of projects meet their goals.
70% of companies report having at least one failed project in the last year.
Organizations lose $109 million for every $1 billion invested in projects and programs.

Most Common Causes of Project Failure:
Changing priorities within organization – **40%**
Inaccurate requirements – 38%
Change in project objectives – **35%**
Undefined risks/opportunities – 30%
Poor communication – 30%
Undefined project goals – 30%
Inadequate sponsor support – **29%**
Inadequate cost estimates – **29%**
Inaccurate task time estimate – **27%**
Resource dependency – 25%
Poor change management – 25%
Inadequate resource forecasting – 23%
Inexperienced project manager – **20%**
Limited resources – **20%**
Procrastination within team – 13%
Task dependency – 11%
Other – **9%**

Requirement to Enable Appropriate SE Capability to Be Implemented

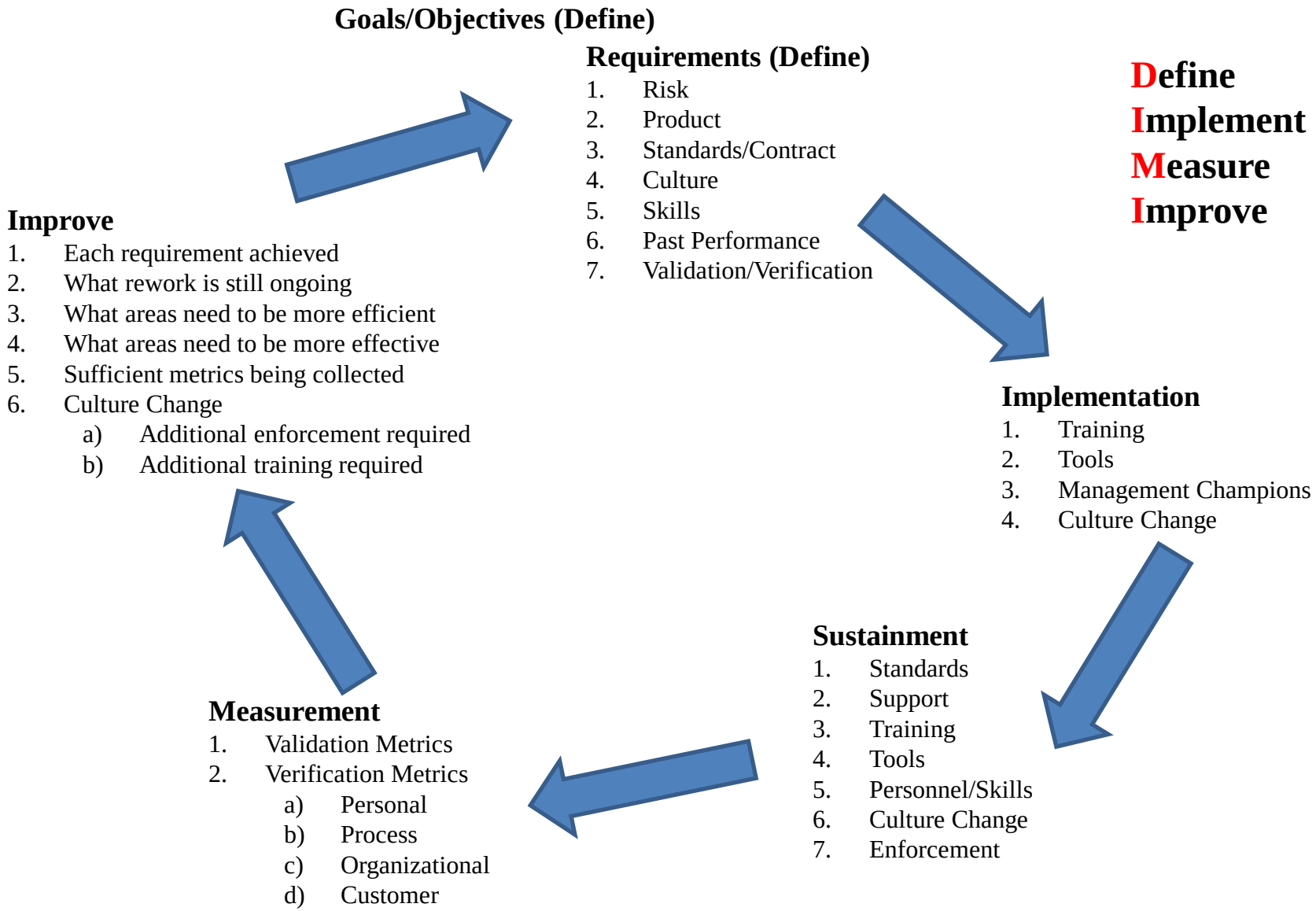
An Implementation methodology based on the INCOSE Systems Engineering process should be developed, documented and supported by INCOSE.

The most effective method is to develop and publish a Systems Engineering Capability Implementation Handbook as a companion to the existing Systems Engineering handbook.

Need to also develop an assessment checklist so organizations and companies can conduct a self assessment as to their implementation process.

If necessary, develop an INCOSE Systems Engineering Maturity Model so various implementations can be compared.

Systems Engineering Capability Implementation



Implementation Handbook should show how to implement and provide examples of good implementation

Systems Engineering Implementation Checklist

Requirements (Define)

1. Risk
    1. What risk baseline was used for the Implementation Process?
    2. Is risk management continuing?
    3. Show artifacts

2. Product/Standards/Contract
    1. What standards are required?
    2. Any additional contractual requirements?
    3. Is specific product defined?
    4. Show artifacts

3. Organizational/Program Culture
    1. Was the existing organizational/program culture defined and taken into account?
    2. What communications channels have been established to get and respond to SE questions/concerns?
    3. Show artifacts

4. Skills
    1. Were existing skill sets and experience defined and taken into account?
    2. Were necessary resources defined and approved?
    3. Show artifacts

5. Past Performance
    1. Was past performance in implementing culture change/systems engineering process(es) taken into account?
    2. Show Artifacts

6. Validation/Verification
    1. Were validation/verification requirements determined for each requirement?
    2. Was a metrics plan sufficient for necessary val/ver developed?
    3. Does the metrics plan contain metrics that can determine enforcement/use?
    4. Show artifacts

Systems Engineering Implementation Checklist

Implementation

1. Training
    1. What training was required before and during implementation?
    2. Was necessary training accomplished?
    3. Show artifacts

2. Tools
    1. What tools were determined necessary before and during implementation?
    2. What tools were implemented?
    3. Any additional contractual requirements?
    4. Show artifacts

3. Management Champions
    1. Have management champions been established and approved?
    2. Why were those management champions chosen?
    3. Show artifacts

4. Skills
    1. Were implementation skills /experience required during implementation?
    2. Show artifacts

5. Culture
    1. Was culture change part of the implementation process?
    2. How did you manage culture change during implementation?
    3. How are you enforcing use of processes?
    4. What communications channels are being implemented for this project?
    5. Show Artifacts

Systems Engineering Implementation Checklist

Sustainment

1. Standards
    1. Are required standards being followed?
    2. Are there any difference in Implementation standards versus sustainment standards?
    3. Show artifacts

2. Support
    1. What support is being provided to customers and users?
    2. What communications channels have been established to get and respond to SE questions/concerns?
    3. Show artifacts

3. Culture Change
    1. Is expected culture change continuing during the sustainment process?
    2. Have management champions been effective during sustainment?
    3. What communications channels have been established to get and respond to SE questions/concerns?
    4. Are enforcement metrics are being collected?
    5. Are val/ver metrics being collected?
    6. Show artifacts

4. Training
    1. Are additional skills/training required during sustainment?
    2. Have any additional skills/training been accomplished during sustainment?
    3. Show artifacts

5. Tools
    1. Have all required tools been enabled?
    2. Are all tools operating as expected?
    3. Show Artifacts

6. Personnel /Skills
    1. Have you maintained required personnel and required skill sets?
    2. Show Artifacts

Systems Engineering Implementation Checklist

Measurement

1. Validation Metrics
    1. Are personnel metrics being collected and used?
    2. Are process metrics being collected and used?
    3. Are organizational metrics being collected and used?
    4. Are customer metrics being collected and used?
    5. Show artifacts

2. Verification Metrics
    1. Are personnel metrics being collected and used?
    2. Are process metrics being collected and used?
    3. Are organizational metrics being collected and used?
    4. Are customer metrics being collected and used?
    5. Show artifacts

Systems Engineering Implementation Checklist

Improvement

1. Is each requirement achieved?
    a) How was that analyzed/proven?
    b) Show artifacts

2. Does any requirement need to be changed/improved?
    a) How was that analyzed/proven?
    b) Show artifacts

3. What rework is still ongoing?
    a) How is that tracked/analyzed?
    b) Show artifacts

4. What areas/processes need to be improved?
    a) How was that analyzed?
    b) Show artifacts

5. What metrics need to be updated/improved/added?
    a) How was that analyzed?
    b) Show artifacts

6. Does culture need to be improved?
    a) Have management champions been effective/need changes?
    b) Does additional enforcement need to be defined?
    c) Does additional training need to be accomplished?
    d) How was that analyzed?
    e) Show artifacts

Systems Engineering Maturity Model

A useful Systems Engineering Maturity Model must provide a checklist of what must be done in four different areas:

1. Advance Systems Engineering as a defined, mature, **and measurable** discipline

2. Enable the successful implementation of **appropriate** Systems Engineering at the project and enterprise level.

3. Determine if Systems Engineering **HAS BEEN** successfully implemented.

4. Provide organizations and companies with a useful tool to enable comparison with other organizations/companies.

Systems Engineering Maturity Model

A useful Systems Engineering Maturity Model should indicate that the company or organization has answered questions like the following:

- Do you work with capability-based assurance
- What does your organization mean by “Systems Engineering”? What is their formal definition? What/who is included? What is the organizational model?
- What is your organization’s definition of a successful program/good program performance?
- What is your definition of good/adequate/mature/complete Systems Engineering?
- Have you determined what metrics will enable senior management to understand the value of your Systems Engineering?
- Have you determined what metrics will enable continuous evaluation and improvement?

Systems Engineering Maturity Model

Maturity Level	Type	Description	Characteristics
Level 1	Ad Hoc	No Systems Engineering or consideration of Systems Engineering, no systems thinking	Totally reactive. No SE knowledge and no interest in SE.
Level 2	Initial	SE processes are dependent on individuals, no defined set of SE processes	Based on individual practitioner's abilities and experience
Level 3	Defined	Attempt to impose some version of Systems Engineering by fiat. No consideration of objectives, goals, requirements or current organizational culture	Standard SE processes are defined and institutionalized. Tools and templates, training and job aids based on standard SE processes.
Level 4	Managed	Establishment and use of goals/objectives/requirements based on product and current organizational culture with imposition through culture shift	Tailored SE processes are defined and institutionalized. Tools and templates, training and job aids based on properly tailored SE processes.
Level 5	Optimized	Achievement of Level 3 and development of metrics for status and use of Systems Engineering processes developed and used to determine effectivity and efficiency and allow for appropriate continuous improvement.	Tools and templates, central repositories, metrics, evaluations, continuous improvement

Recommendations for Further Work

A. Develop a four stage INCOSE Implementation Handbook

1. How to determine requirements/goals/objectives
   - Example Need Configuration Management capability based on Standard XXXX or DOD HB XXXX
   - Establish validation and validation for this requirement.

2. How to Implement
   - Cultural Evaluation
   - Training for Staff
   - Tools necessary for implementation and metrics
   - Management champions and how they need to act
   - Provide examples

3. Sustainment
   - Using SE Handbook and Standards
   - Provide examples

4. Continuous Improvement and ROI Metrics
   - Cultural Evaluation
   - Training for Staff
   - Tools necessary for metrics
   - Management champions and how they need to act
   - Provide examples

Recommendations for Further Work

B. Develop a companion Checklist so self-assessment and 3rd party assessments can be conducted.

C. Develop and distribute an SE Maturity Model based on the Implementation Handbook and Checklist

D. Establish requirements for training SEs to use the Checklist and Maturity Model