System Engineering Metrics

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Why Measure Systems Engineering?

- When performance is measured … performance improves
- When performance is measured and reported … the rate of performance improves
- When performance is measured, reported, and compared … the rate of performance continues to improve

Problem

- Sys Eng Scope is Huge, So …
  - What tenets should be measured?
  - What are the key characteristics?
  - How can it apply across different programs and organizations?
- Sys Eng Important, But …
  - No accepted, standard metrics
  - No measure of sys eng current status
  - No metrics for both PM and upper management

Sys Eng Metrics Key Characteristics

- Must Measure Major Components of Sys Eng
- Must Be Targeted for Management
- Must Be Few in Number
- Must Describe Current Status, Not Lagging
- Must Allow For Comparison Between Programs, Organizations, and Time
- Must Be Cumulative (Ability to Roll-Up)
- Must Avoid Extensive Data Collection Efforts

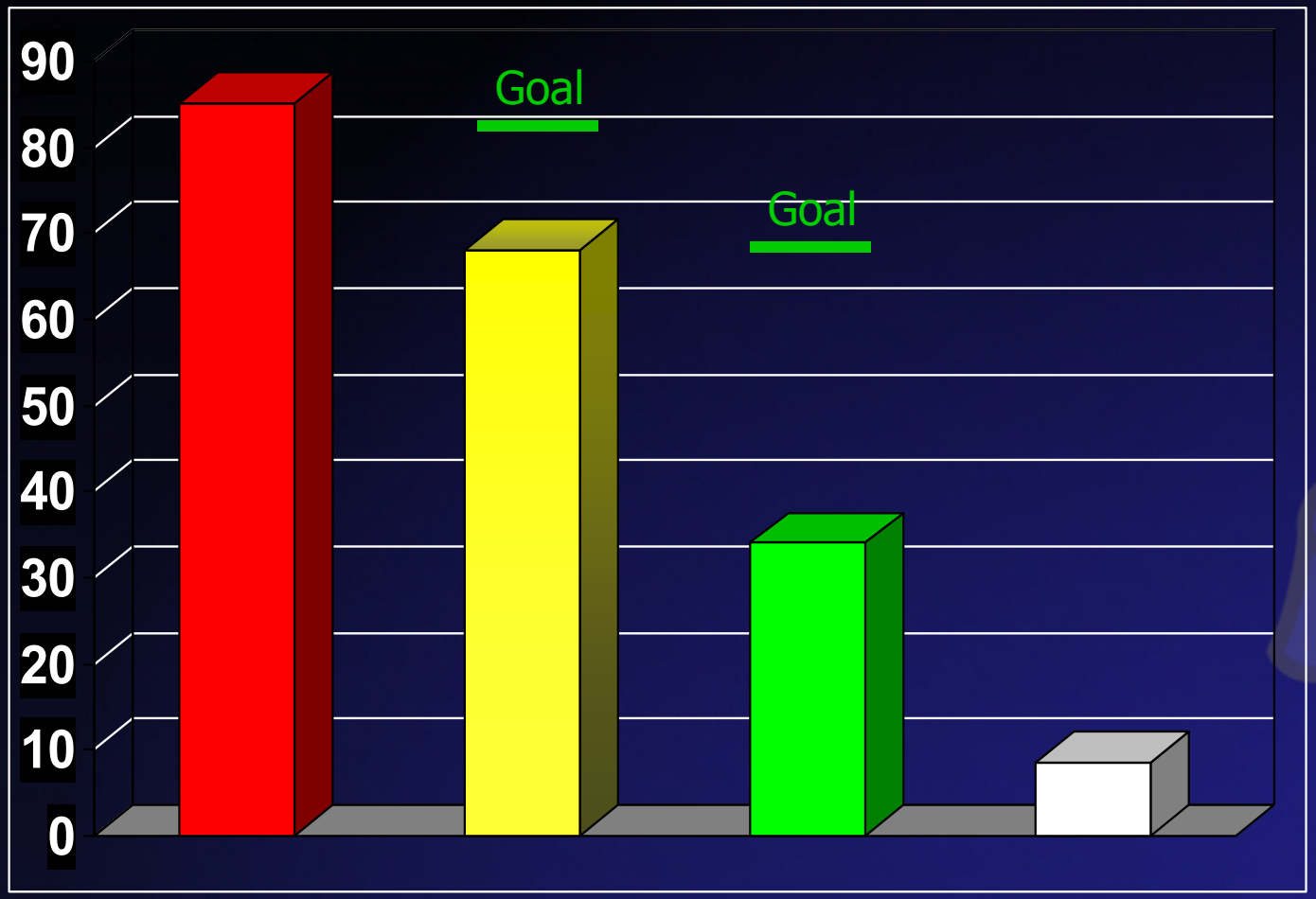
Solution: Sys Eng "Dashboard"

- Measure Five Key Areas of Sys Eng:
  - Requirements Management
  - Risk Management
  - Incentivizing Contractors
  - Robustness/LCC
  - Process Management
- Used on All Programs
- Regularly Shown at Organization Staff Meetings

1. Requirements Management Metric

- Most Important Area
- Quantify, quantify, quantify
- Level of Detail
  - Appropriate to Life Cycle
  - Examples
- Objective Review
- Agreement & Understanding
  - User
  - Contractor
  - Program Manager
- Sources

Requirements Management Metric

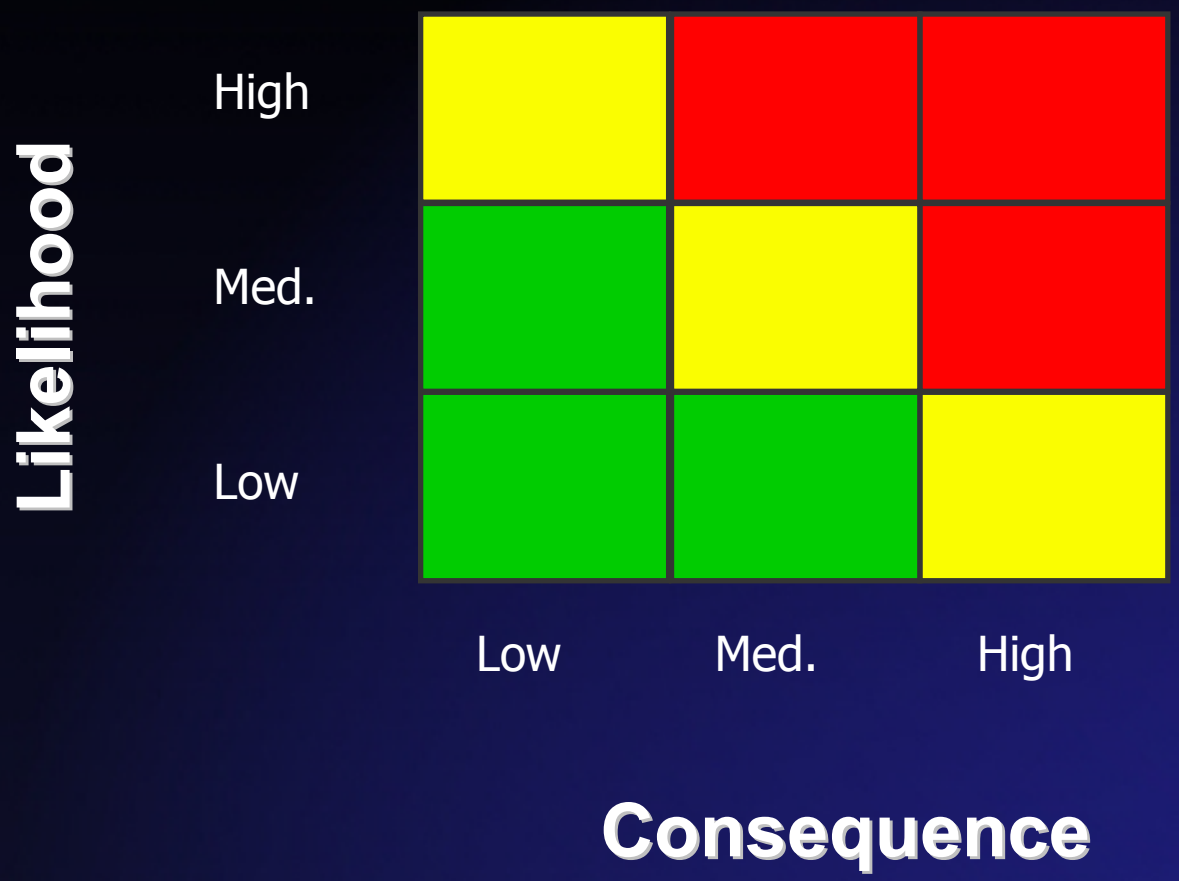


- Total Requirements
- Requirements Reviewed
- Requirements Quantified
- Requirements Changed

2. Risk Management Metric

- Proactive
- Dynamic
- Reviewed Regularly
- Tangible Reduction Plan
- Tracked

Basic Risk Rating Chart



RISK ASSESSMENT

HIGH - Unacceptable. Major disruption likely. Different approach required.

MODERATE - Some disruption. Different approach may be required.

LOW - Minimum impact. Minimum oversight needed to ensure risk remains low.

Risk Assessment Metric

Likelihood	Low	Med.	High
High	0	4	2
Med.	6	1	4
Low	3	4	3

Consequence

# of Risks

10

4

13

Risk Management Metric

Likelihood	Low	Med.	High
High	0	2/4	1/2
Med.	1/6	0/1	3/4
Low	1/3	2/4	2/3

Consequence

% With Plan

60%

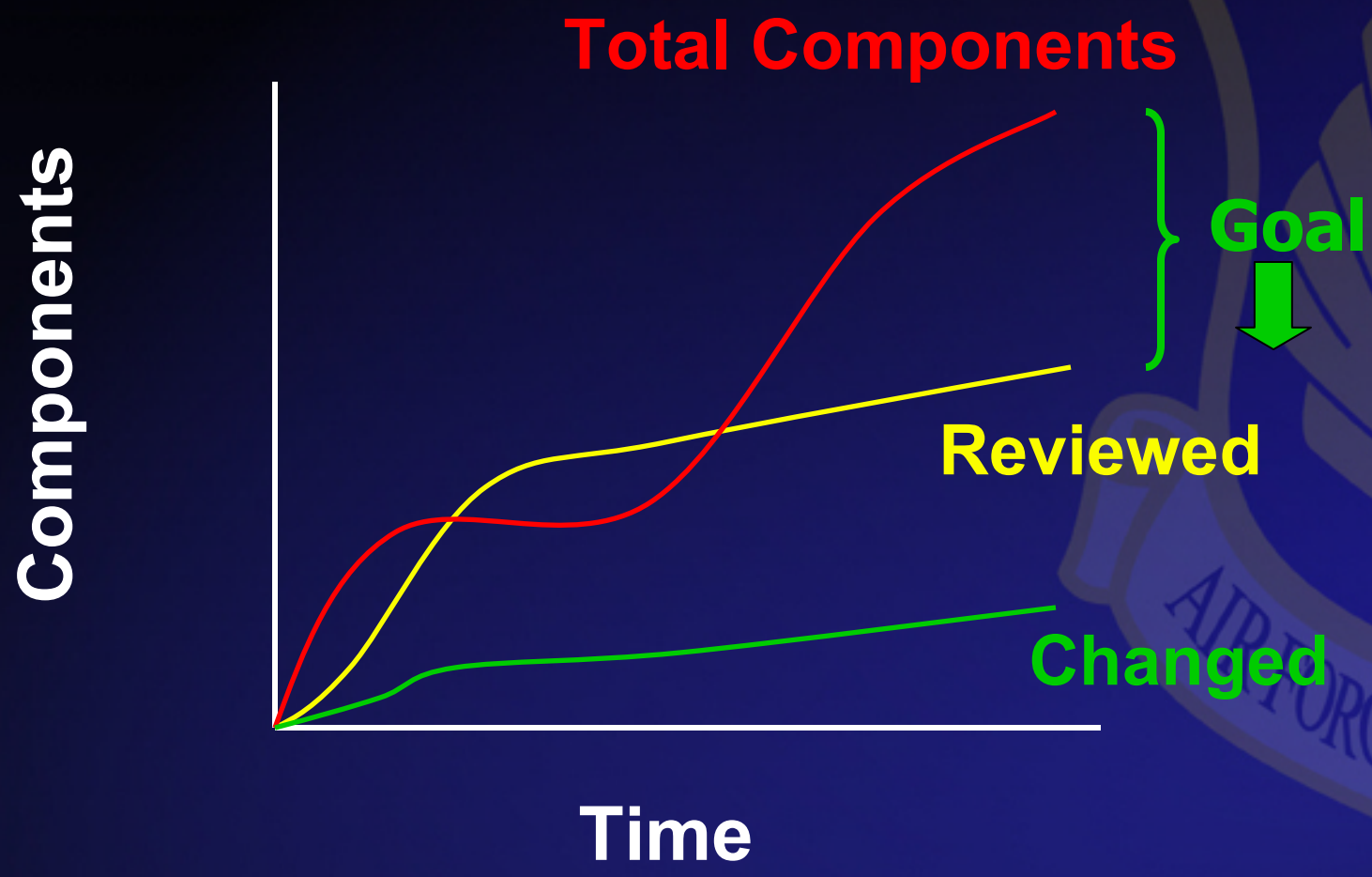
50%

30%

3. Robustness/LCC Metric

- Hard to Measure
- Measures More the "Attempt" or Effort
- Can Include Underlying Processes
  - Example: Type of paint <u>or</u> the paint application process
- Need "Toolbox" Vice One Approved Way
  - Lean processes
  - Trade studies
  - Benchmarks
  - Combining components
  - COTS
  - Paredo Charts
  - Etc.

Robustness/LCC Metric



4. Incentivizing Contractors Metric

- Required for USAF by Policy
  - Policy Memo 03A-005, 9 Apr 03
  - Subject: "Incentivizing Contractors for Better Systems Engineering"
  - Signed by Marvin R. Sambour, Assistant Secretary of the Air Force (Acquisition)
- "A more robust SE environment can only be achieved through joint cooperative efforts with our contractors."
- "…incentivize your contractors to perform robust SE…"

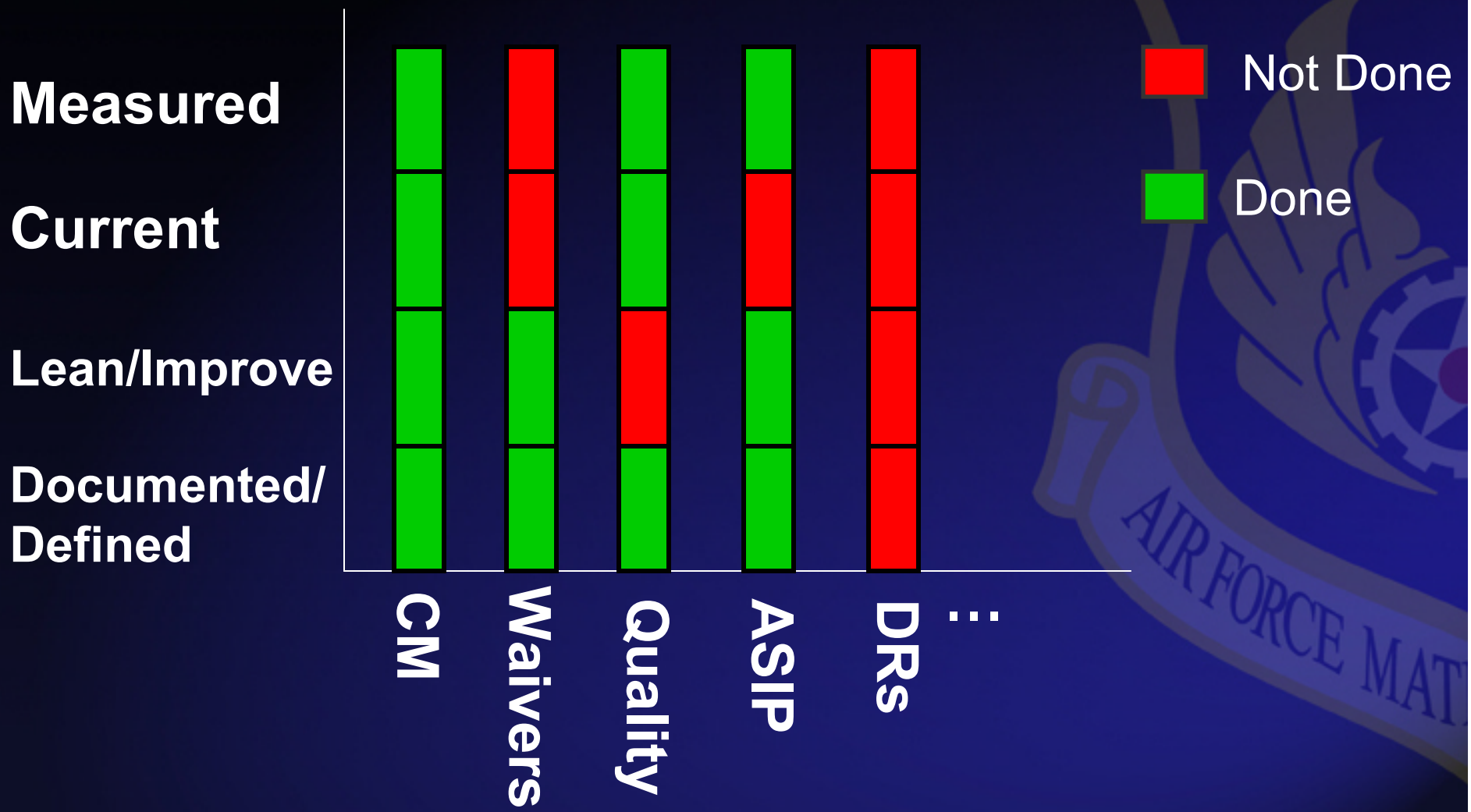
Incentivizing Contractors Metric

% of Contracts with Sys Eng Incentives

5. Process Management Metric

- List Program's Key Processes
  - Configuration Management
  - Waivers
  - Quality
  - Aircraft Structural Integrity Program
  - Deficiency Reviews
  - Etc.
- Each Program Does Own Processes
- For Each Process, 4 "Steps"
  - Define & Document
  - Lean, Improve or Refine
  - Keep Current by Periodic Reviews
  - Measure the Process

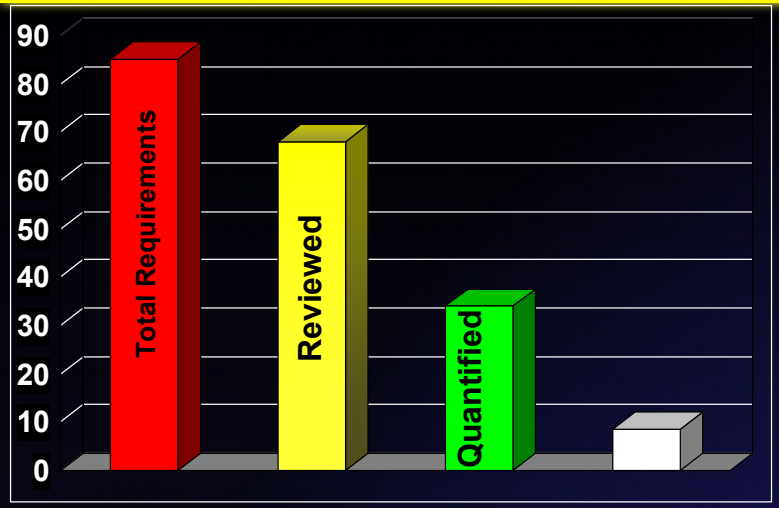
Process Management Metric



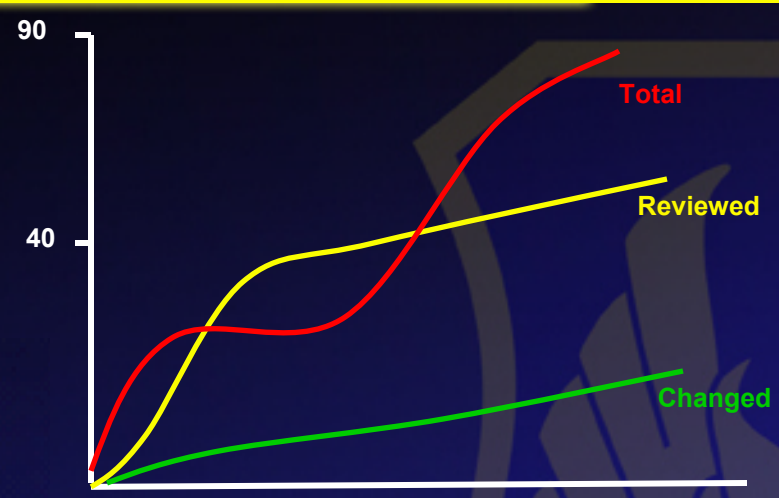
Program Sys Eng Dashboard

- Developed Individual Metrics for the Five Key Areas of Systems Engineering:
  - Requirements Management
  - Risk Management
  - Incentivizing Contractors
  - Robustness/LCC
  - Process Management
- Now Put it All Together For the Proposed Program's Sys Eng Dashboard…

Program Sys Eng Dashboard



Requirements

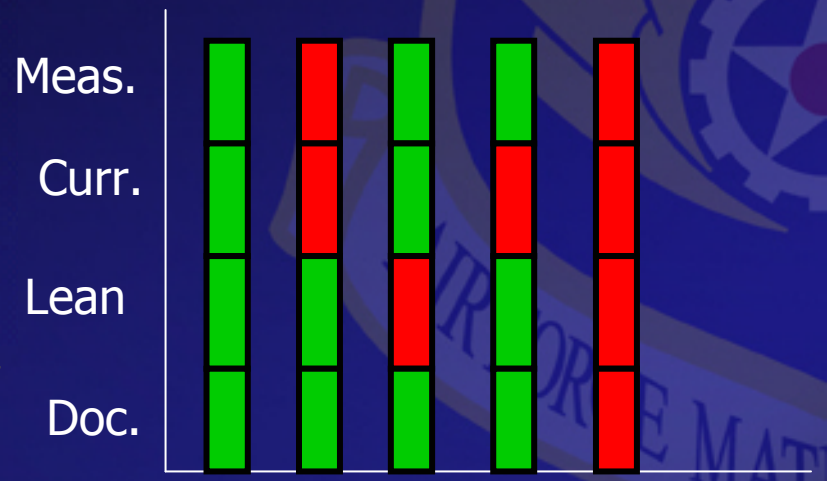


LCC/Robust

Contracts

	Low	Med.	High
High	0	2/4	1/2
Med.	1/6	0/1	3/4
Low	1/3	2/4	2/3

Risk

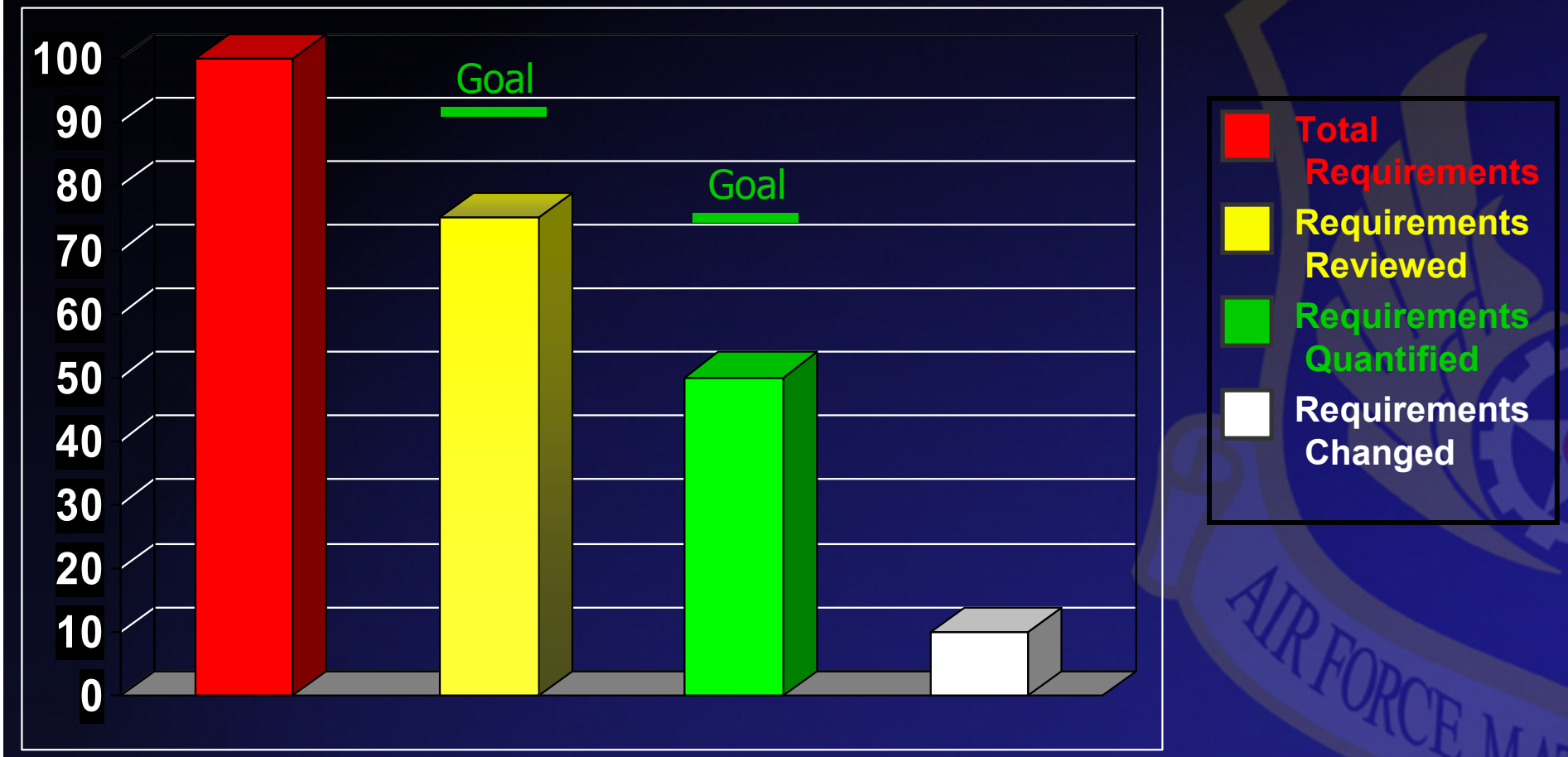


Processes

How to Roll-Up from Program to Organization

- Requirements Management
  - Convert each program to a percentage
  - Display average (each program has equal weight)
- Risk Management
  - Convert each program "square" to percentage
  - Display average "square's" percentage (equal weight)
- Incentivizing Contractors
  - Bottom number equals sum of contracts
  - Depict percentage of contracts (program independent)
- Robustness/LCC
  - Calculate reveiwed/changed as a percentage
  - Display avg percentage (equal weight)
- Process Management
  - Depict overall percentage for each category (process/program independent)

Organization Requirements Metric (%)

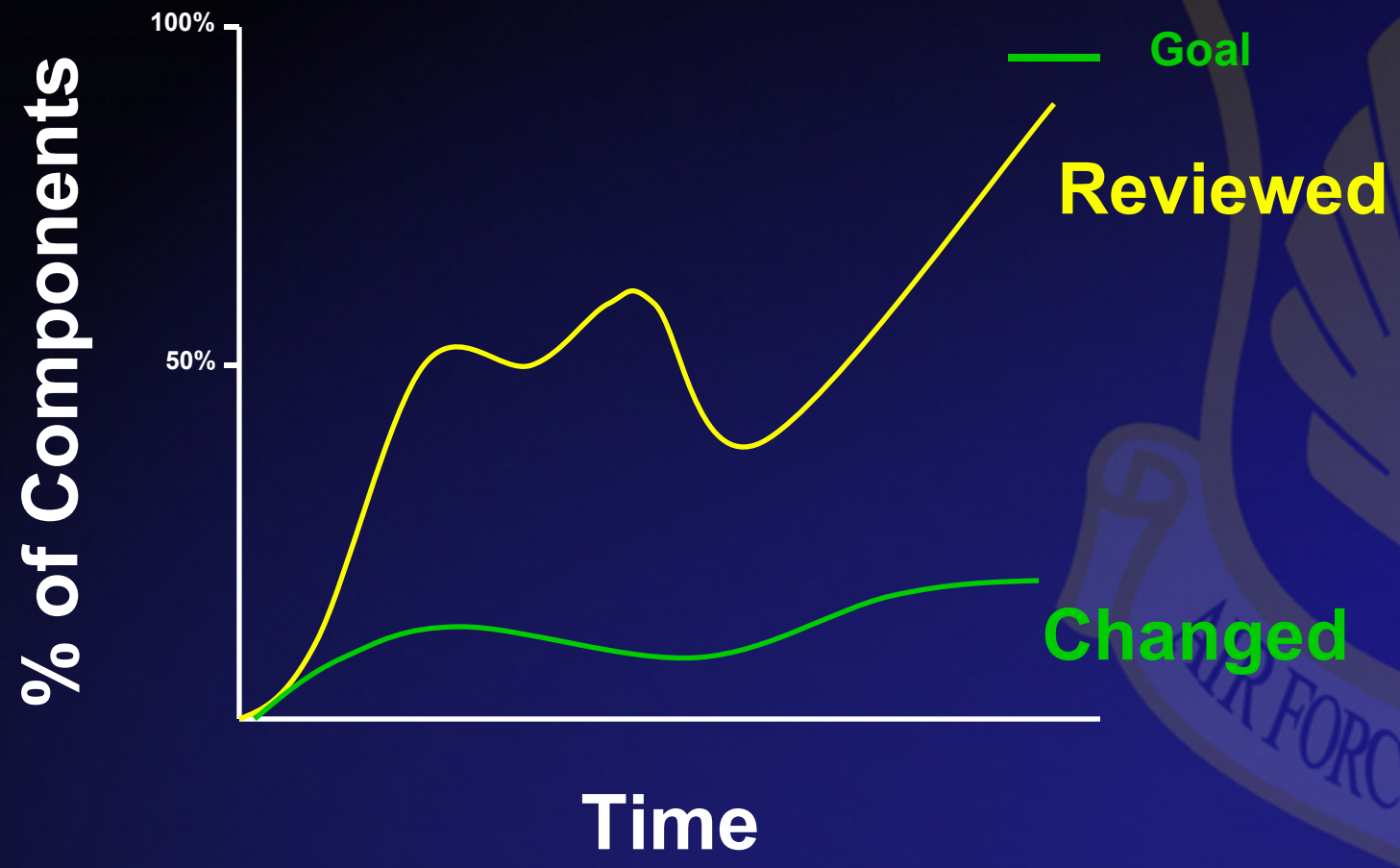


Organization Risk Metric (%)

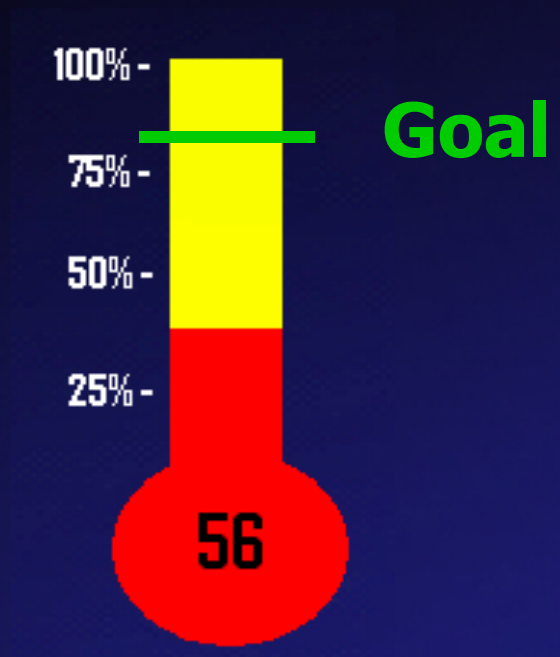
Likelihood	Low	Med.	High	% w/ Plan
High	20	40	80	60%
Med.	5	50	60	36%
Low	10	5	40	7%

Consequence

Organization Requirements Metric (%)

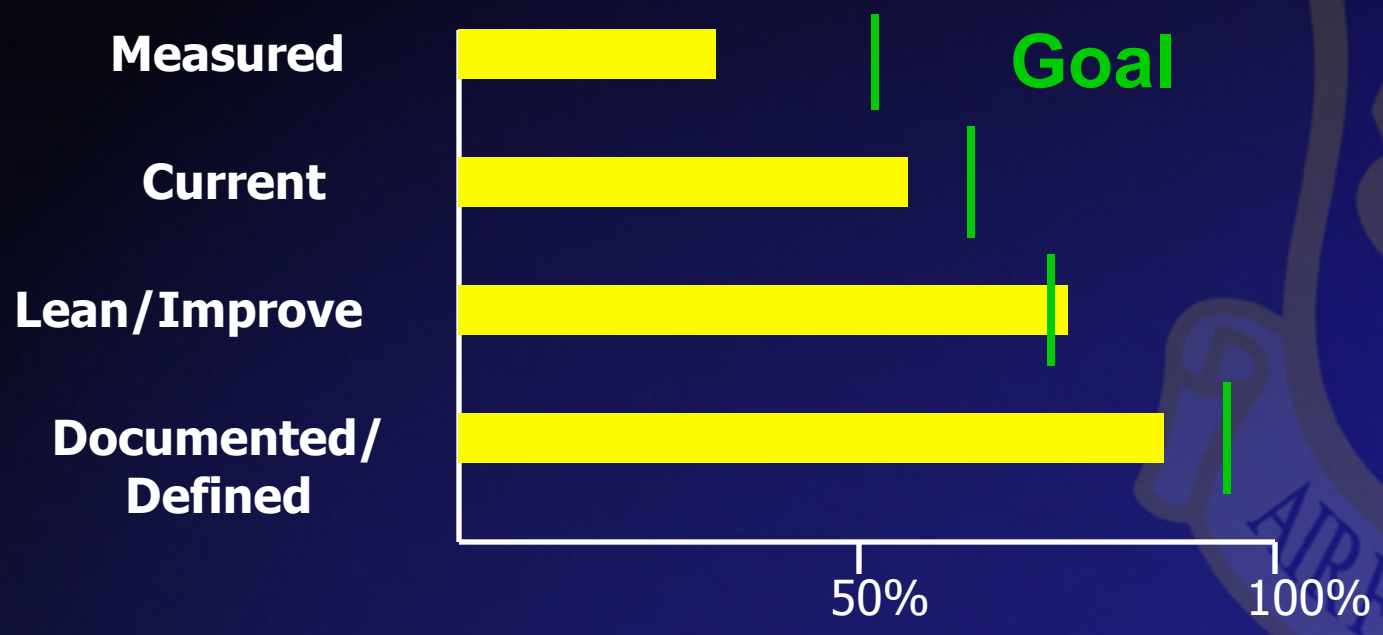


Organization Incentivizing Contractors Metric

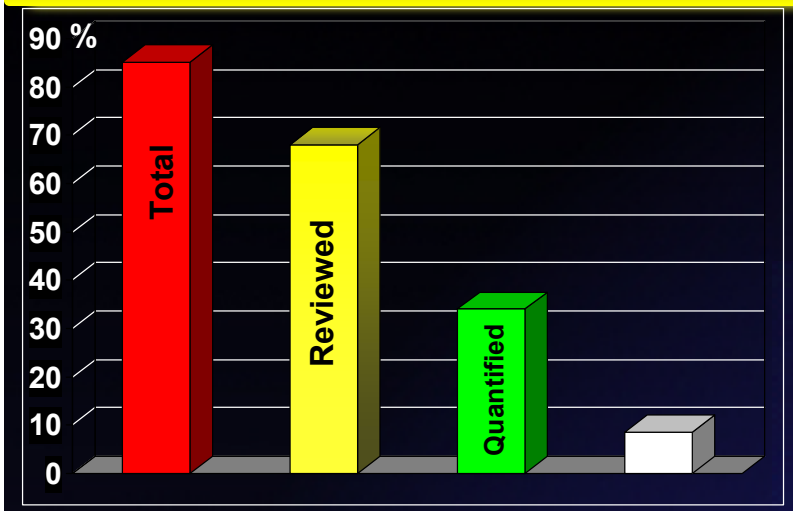


% of Contracts with Sys Eng Incentives

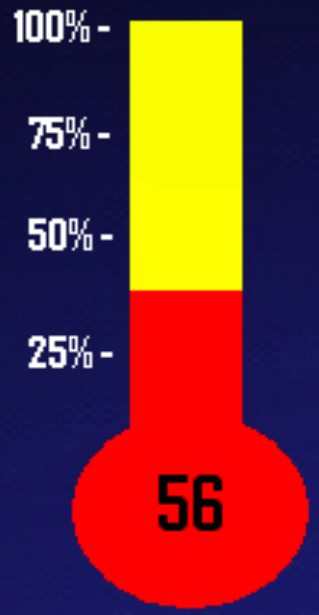
Organization Process Metric (%)



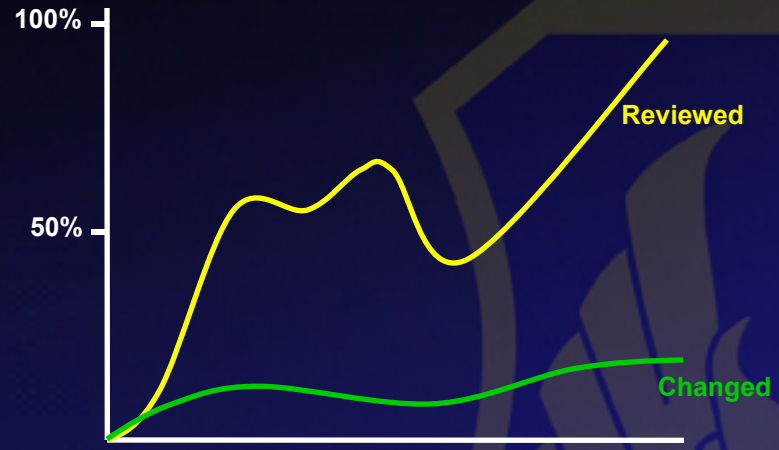
Organization Sys Eng Dashboard



Requirements



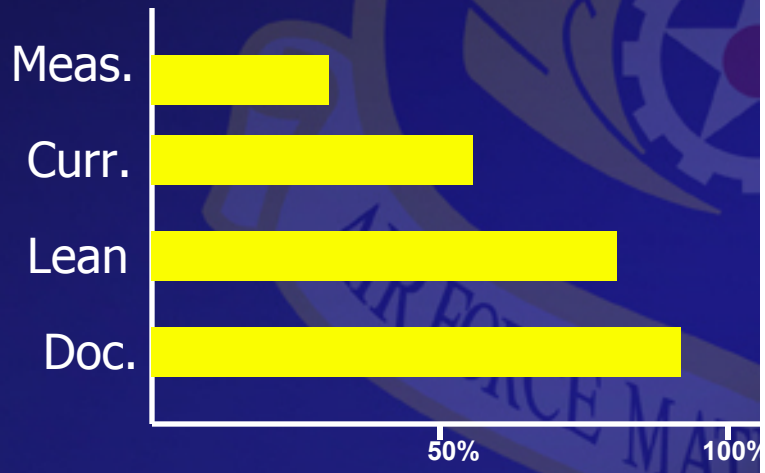
Contracts



LCC/Robust

	Low	Med.	High
High	20	40	80
Med.	5	50	60
Low	10	5	40

Risk



Processes

Summary

- Sys Eng Important, but No Consistent Way to Measure…Until Now
- Need Concurrent Metrics…Not Lagging
- Metrics For Management…Essential to Drive Action
- What to Measure…Sys Eng "Dashboard"
- Means To Use…Regular Part of an Organization's Overall Management Indicators

- **Allows Comparison…Drives Improvement**

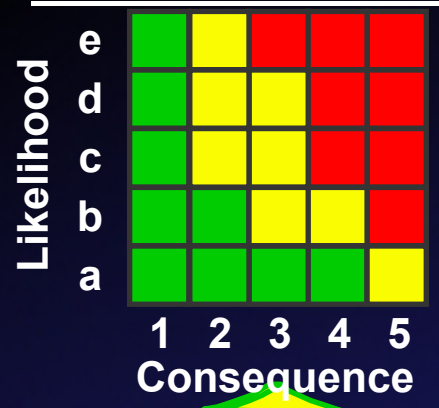
Questions?

Sample: 5 - Level Risk Rating Chart

***LIKELIHOOD*:**

Level	What Is The Likelihood The Risk Will Happen?
a	Remote
b	Unlikely
c	Likely
d	Highly Likely
e	Near Certainty

ASSESSMENT GUIDE



RISK ASSESSMENT

- **HIGH - Unacceptable. Major disruption likely. Different approach required. Priority management attention required.**
- **MODERATE - Some disruption. Different approach may be required. Additional management attention may be needed.**
- **LOW - Minimum impact. Minimum oversight needed to ensure risk remains low.**

***CONSEQUENCE*:**
Given The Risk Event is Realized, What is the Magnitude of the Impact?

Level	Technical Performance	and/or	Schedule	and/or	Cost	and/or	Impact on Other Teams
1	Minimal or no impact		Minimal or no impact		Minimal or no impact		None
2	Acceptable with some reduction in margin		Additional resources required; able to meet need dates		< 5%		Some impact
3	Acceptable with significant reduction in margin		Minor slip in key milestone; not able to meet need dates		5 - 7%		Moderate impact
4	Acceptable, no remaining margin		Major slip in key milestone or critical path impacted		> 7 - 10%		Major impact
5	Unacceptable		Can't achieve key team or major program milestone		> 10%		Unacceptable

Risk Handling Plan - "Waterfall"