



Better Requirements Decomposition Guidelines Can Improve Cost Estimation of Systems Engineering and Human Systems Integration

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Outline

Motivation

Research Questions

Background

Data Collection Workshop

Design

Results

Conclusions/Future Work

Motivation-HSI



HSI requirements include, but are not limited to, any requirement pertaining to one or more domains of HSI, or the integration of those domains. Broadly, the term encompasses any requirement that contributes to the integration of human considerations into the system being developed.

*Air Force HSI Office (2009).
Human Systems Integration
Requirements Pocket Guide.*

Research Questions

Hypothesis: Human Systems Integration effort can be estimated as a function of total Systems Engineering Effort

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Existing counting rules can be adapted to better account for Human Systems Integration requirements

Research Questions

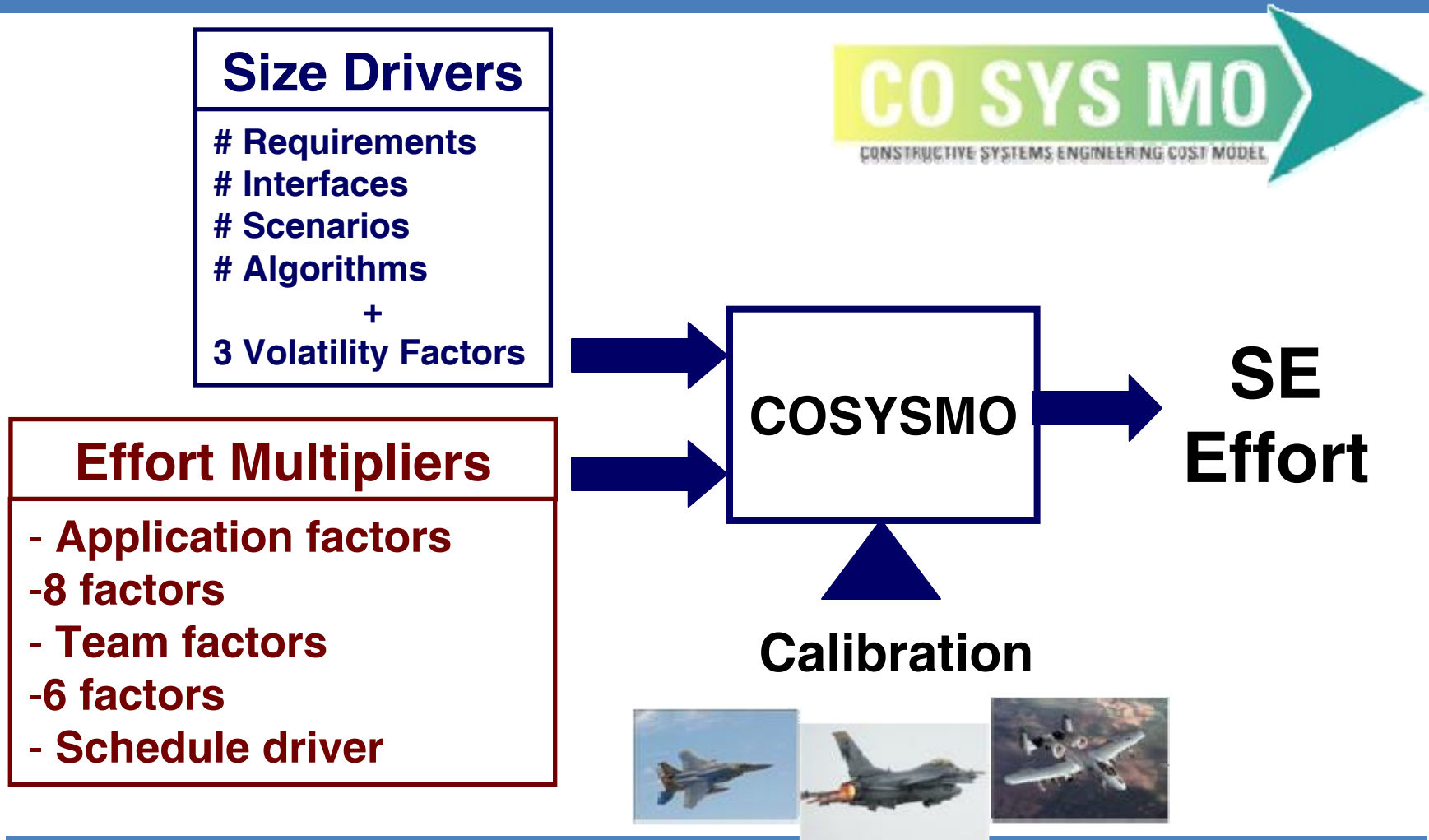
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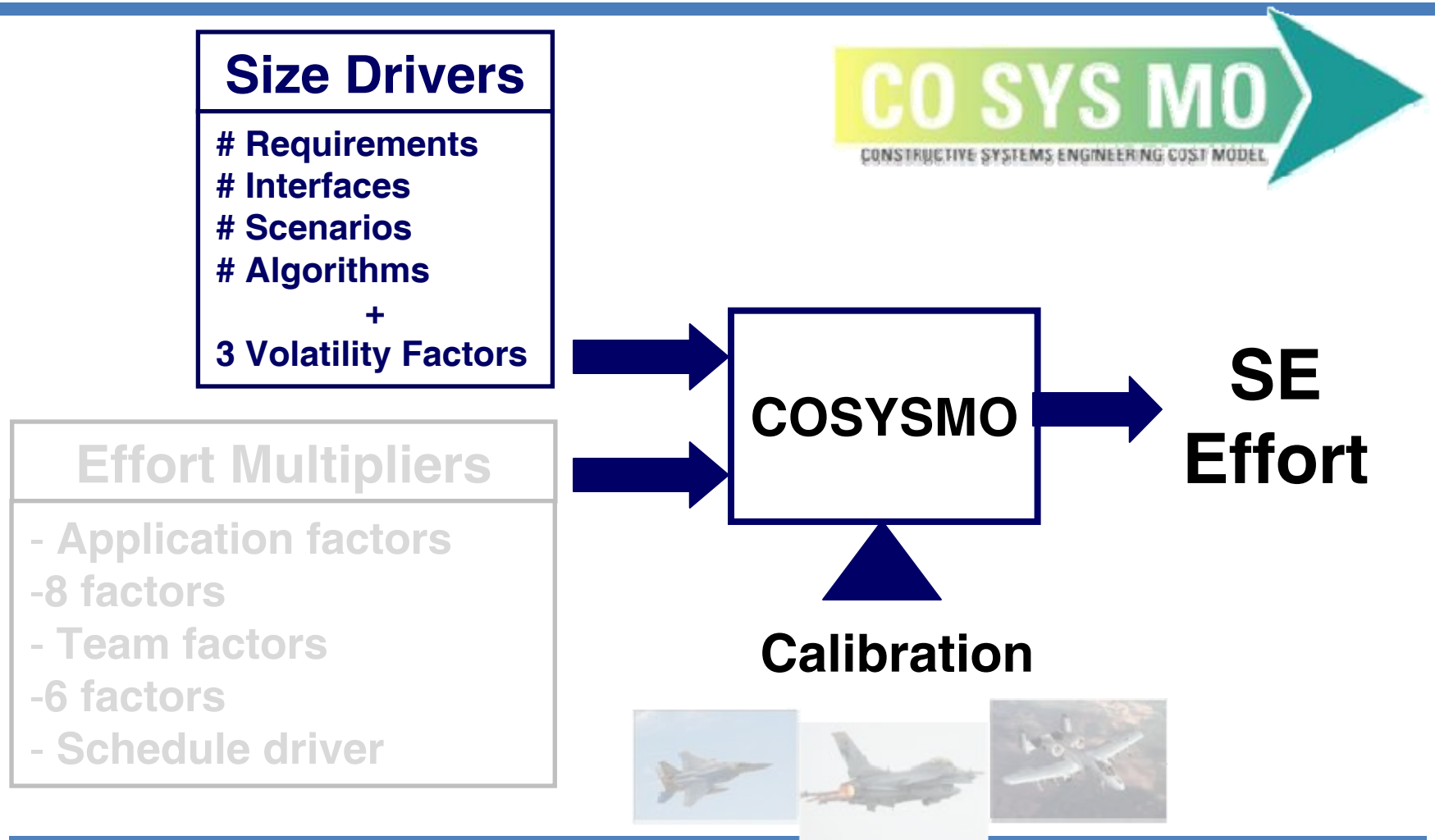
Existing counting rules can be adapted to better account for Human Systems Integration requirements

Research Question: How can existing COSYSMO decomposition guidelines be modified to improve counting of HSI requirements?

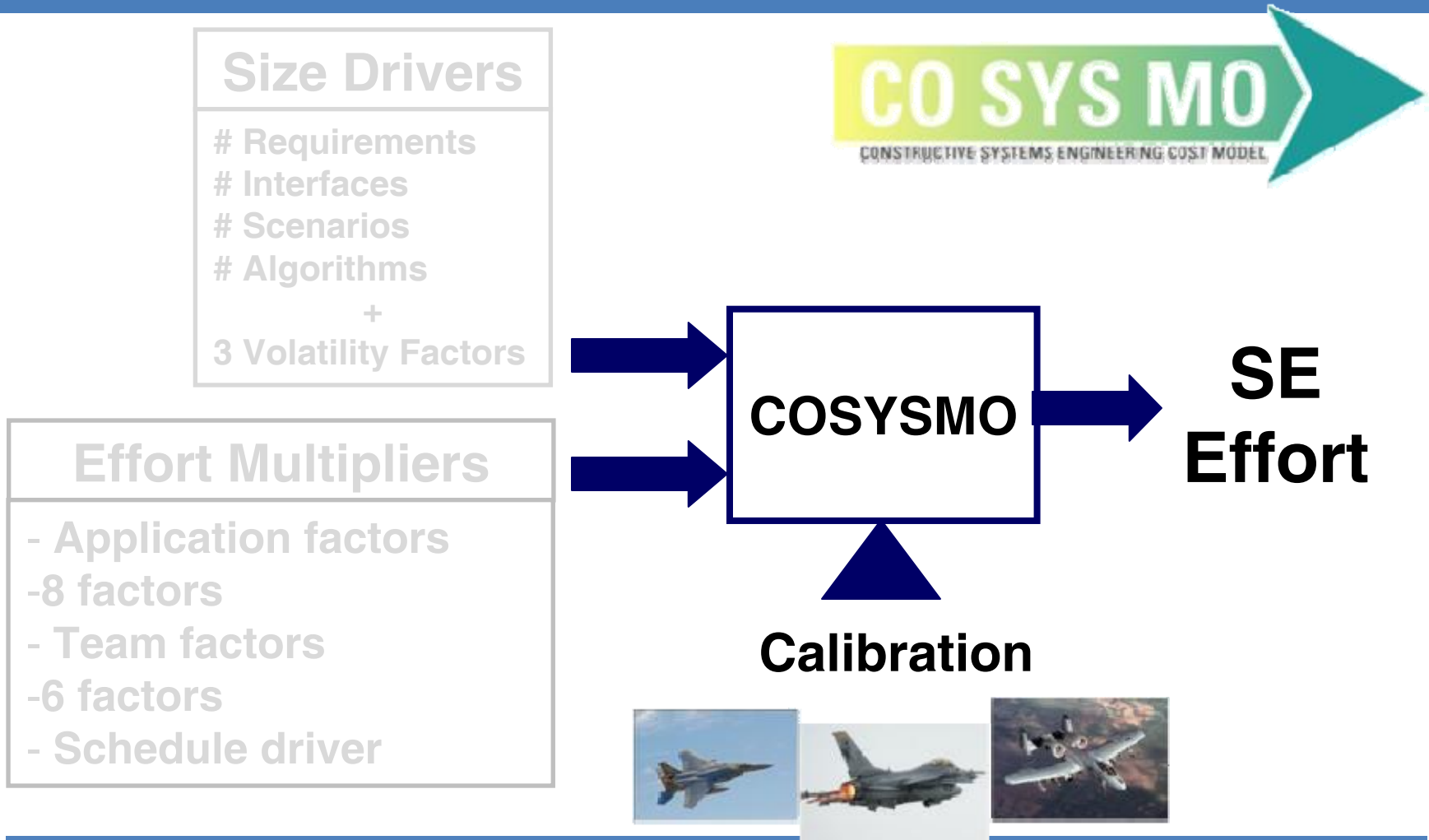
Background-Cost Model



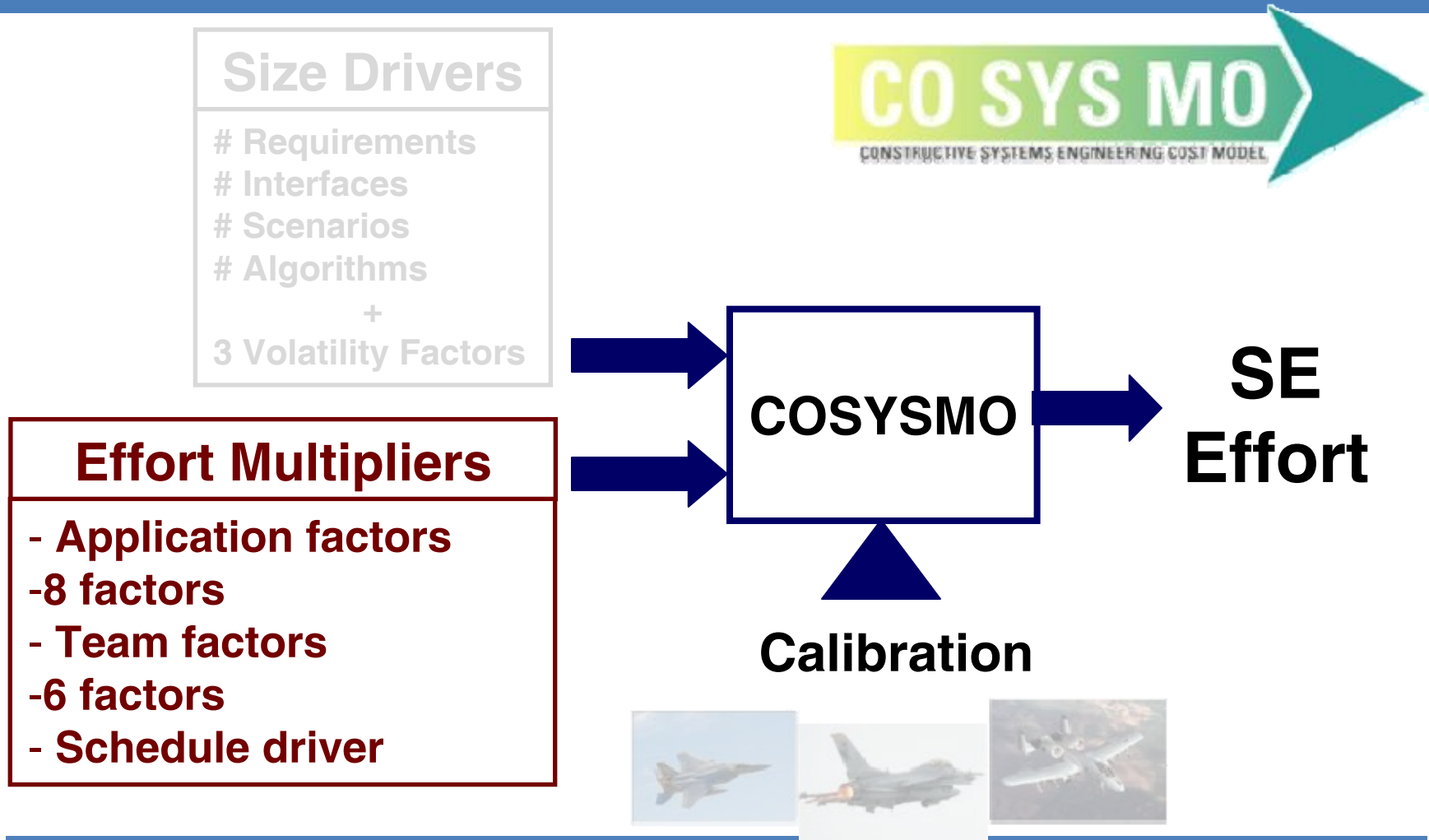
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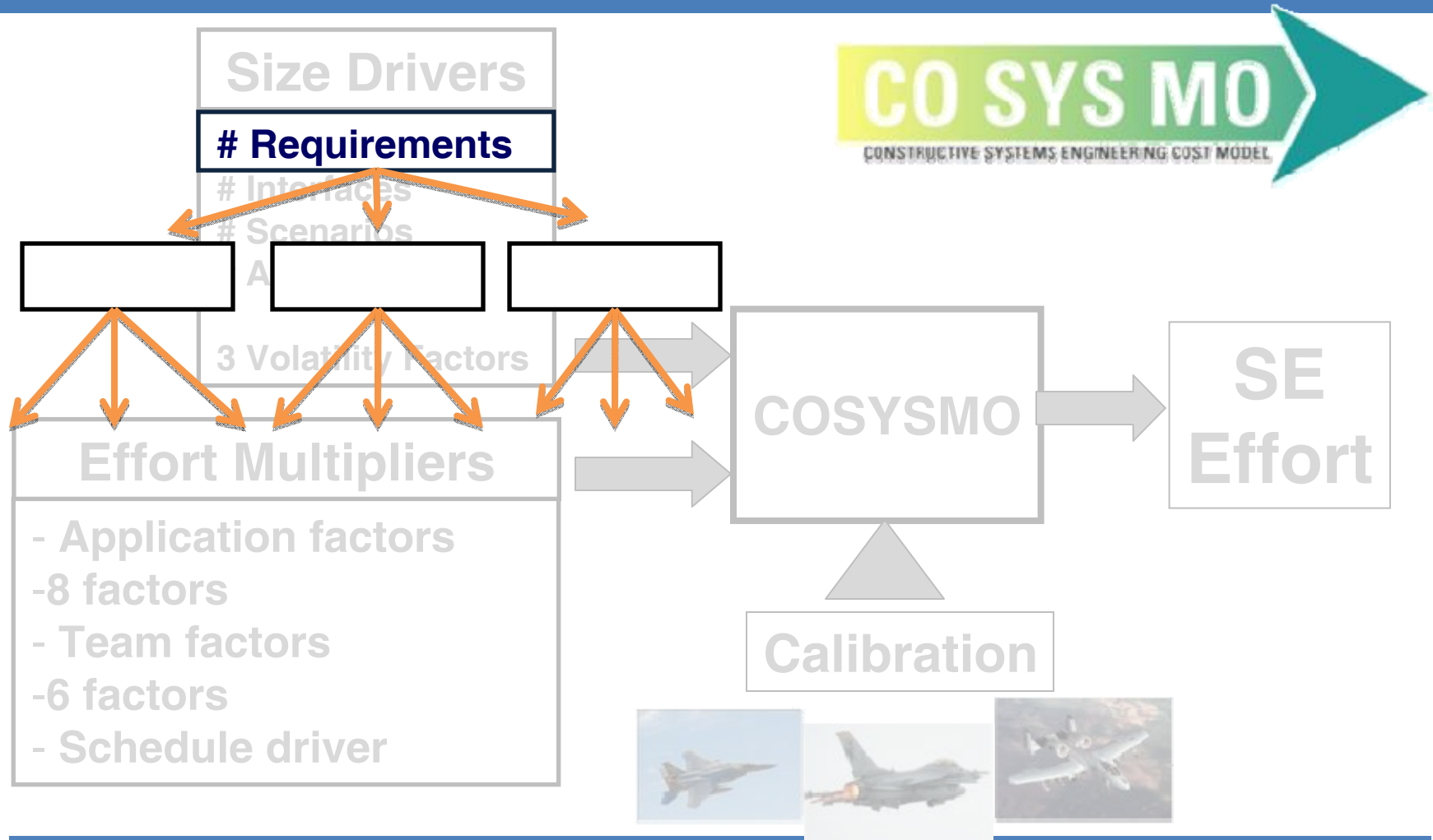
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Background-Cost Model



Background-Cost Model





Workshop Research Design

Research Question: How can existing COSYSMO decomposition guidelines be modified to improve counting of HSI requirements?

*24th International Forum on COCOMO and
Systems/Software Cost Modeling, MIT, Nov 2-5
2009*

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Method:

- Provide sample requirements related to example system
- Ask participants to analyze using existing guidelines

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Contribution:

- Identify improvements to COSYSMO decomposition guidelines
- Assess impact of HSI requirements on SE effort

Criteria Used to Judge Requirements

1. Determine the system of interest.



Is the requirement at the level of the system-of-interest?

2. Decompose system objectives, capabilities, or measures of effectiveness into requirements that can be tested, verified, or designed.



Can the requirement be tested, verified or designed?

3. Provide a graphical or narrative representation of the system of interest and how it relates to the rest of the system.



Does the HSI requirement decompose to none, one, or many requirements?

4. Count the number of requirements in the system/marketing specification or the verification test matrix for the level of design in which systems engineering is taking place, given the desired system of interest.

5. Determine the complexity of requirements.

Requirements Counting Workshop

16 Participants
Split into 8 groups of 2

3 Phases
8 requirements/phase

Cautions and Warnings. Method for displaying system warnings, cautions, and alarms must be appropriate given the importance of the situation (**Threshold**).



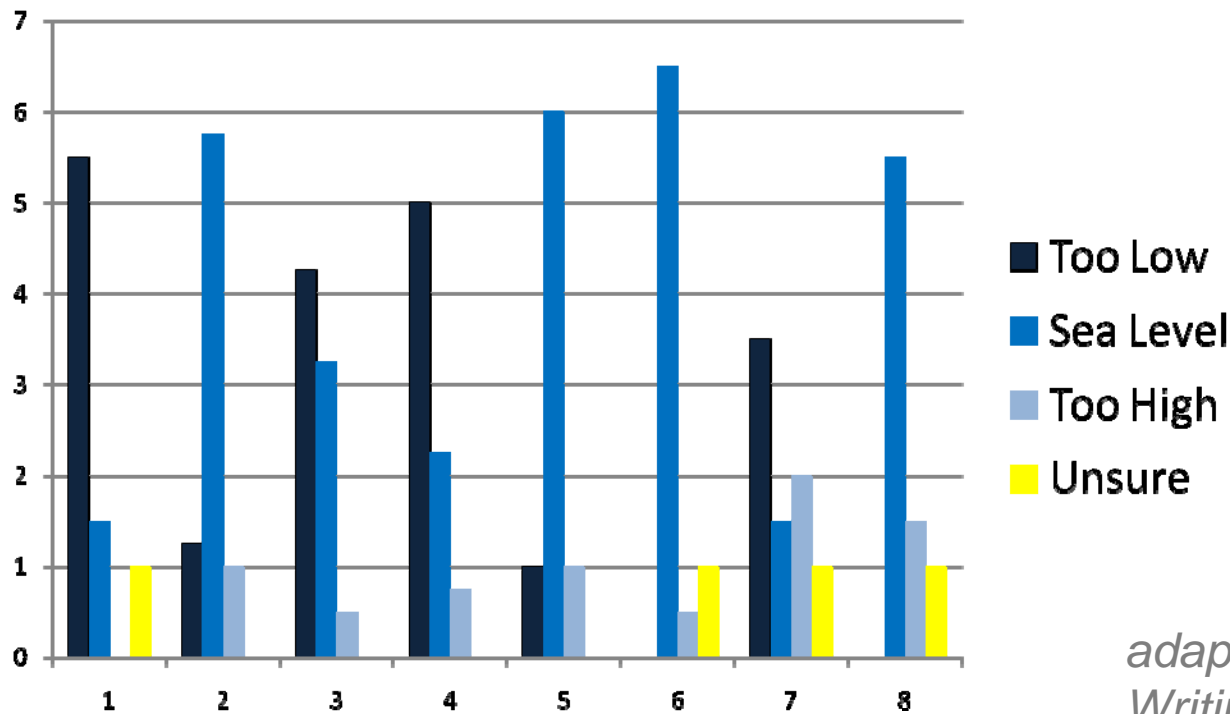
Hypothesis #1

Research Question: How can existing COSYSMO decomposition guidelines be modified to improve counting of HSI requirements?

Hypothesis #1: Using the cost estimation decomposition steps will produce requirements counts with high reliability across respondents.

Workshop-Question 1

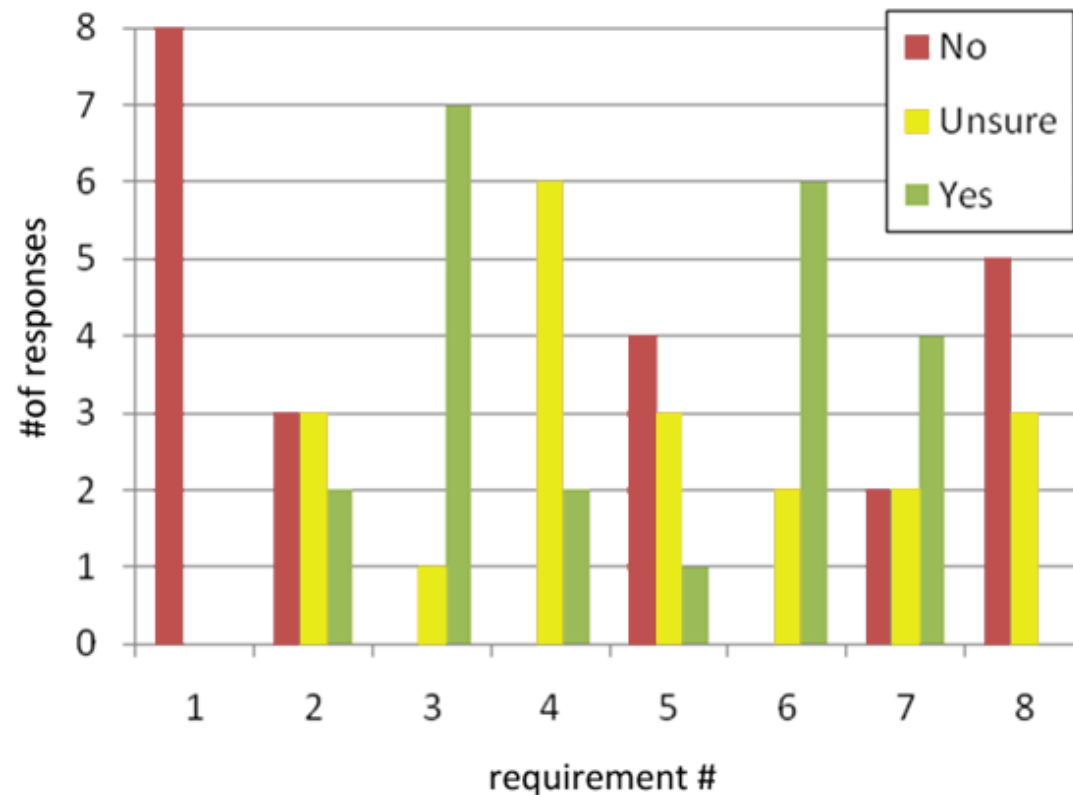
Is the Requirement at the Sea Level?



*adapted from Cockburn (2001).
 Writing effective use cases*

Workshop-Question 2

Can the Requirement be Tested, Designed, or Verified?



Conclusions #1

Hypothesis: Using the cost estimation decomposition steps will produce requirements counts that are common across users.

Partially supported

Discussion:

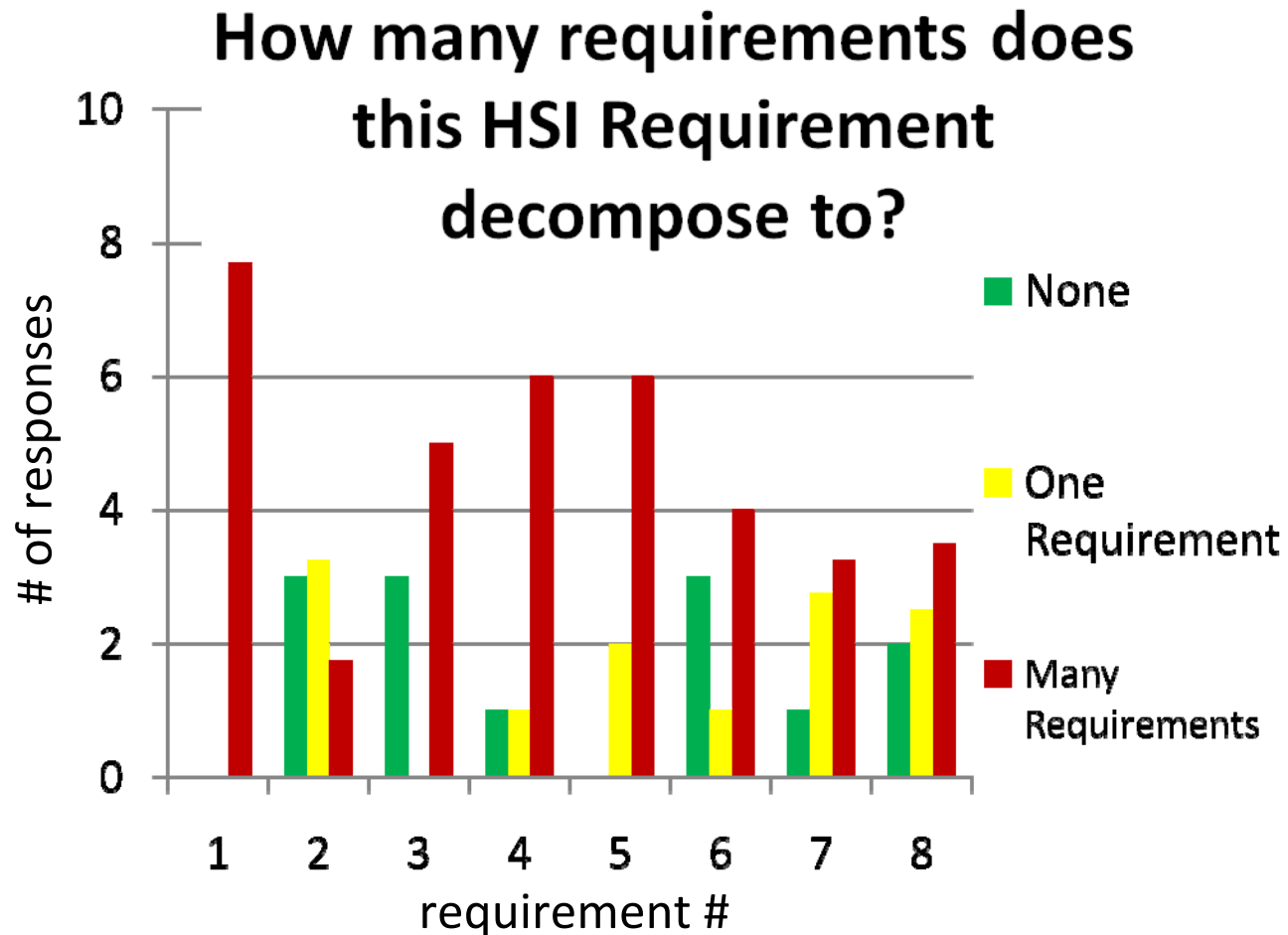
- Understanding of “sea level”
- Differences in test and verify
- How to deal with “bad” requirements

Hypothesis #2

Research Question: How can existing COSYSMO decomposition guidelines be modified to improve counting of (HSI) requirements?

Hypothesis #2: The cost estimation decomposition steps will help users quantify the number of HSI requirements to be input into COSYSMO.

Workshop-Question 3



Conclusions #2

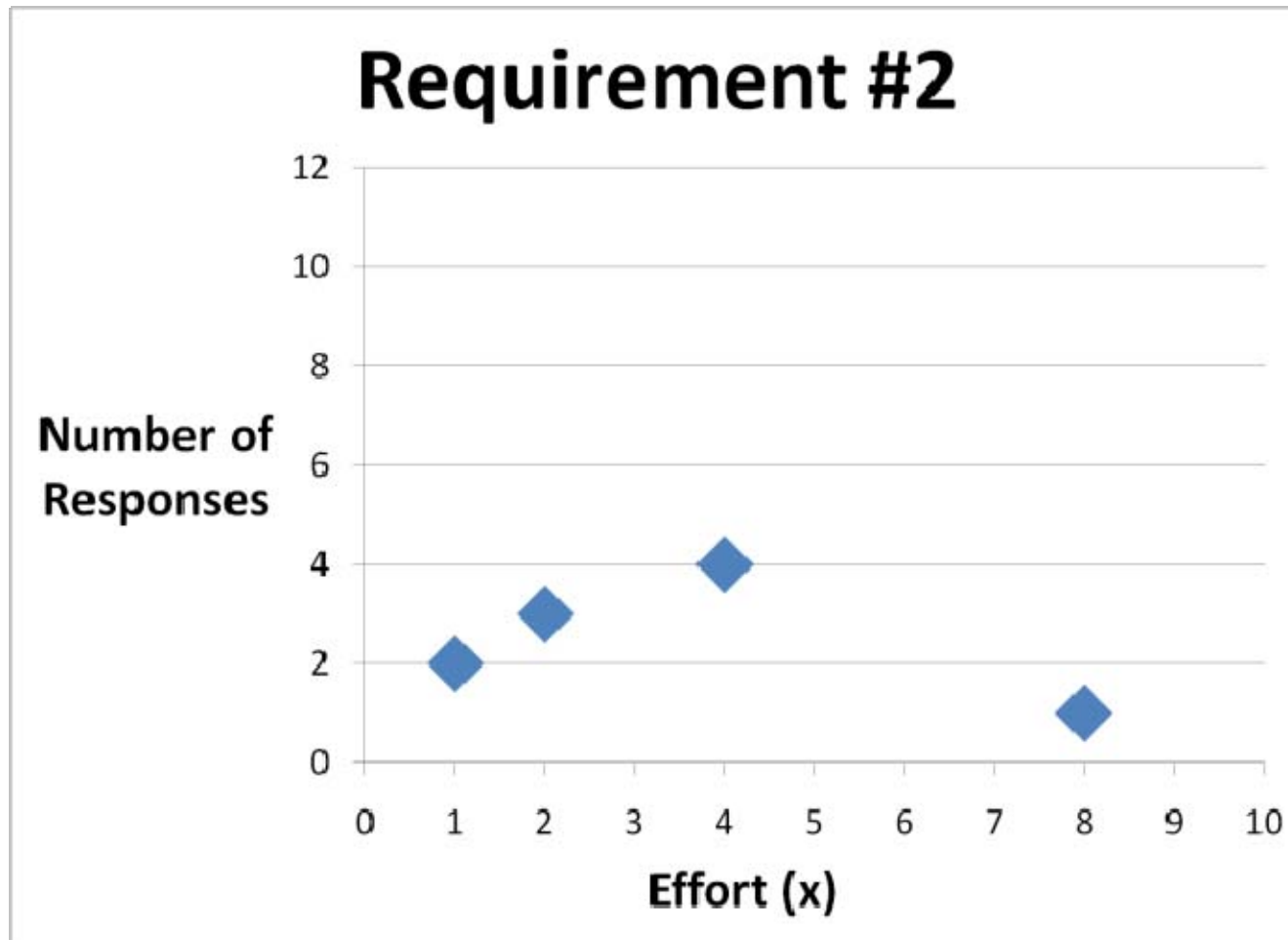
Hypothesis: The cost estimation decomposition steps will help users quantify the number of HSI requirements to be input into COSYSMO.

Partially supported

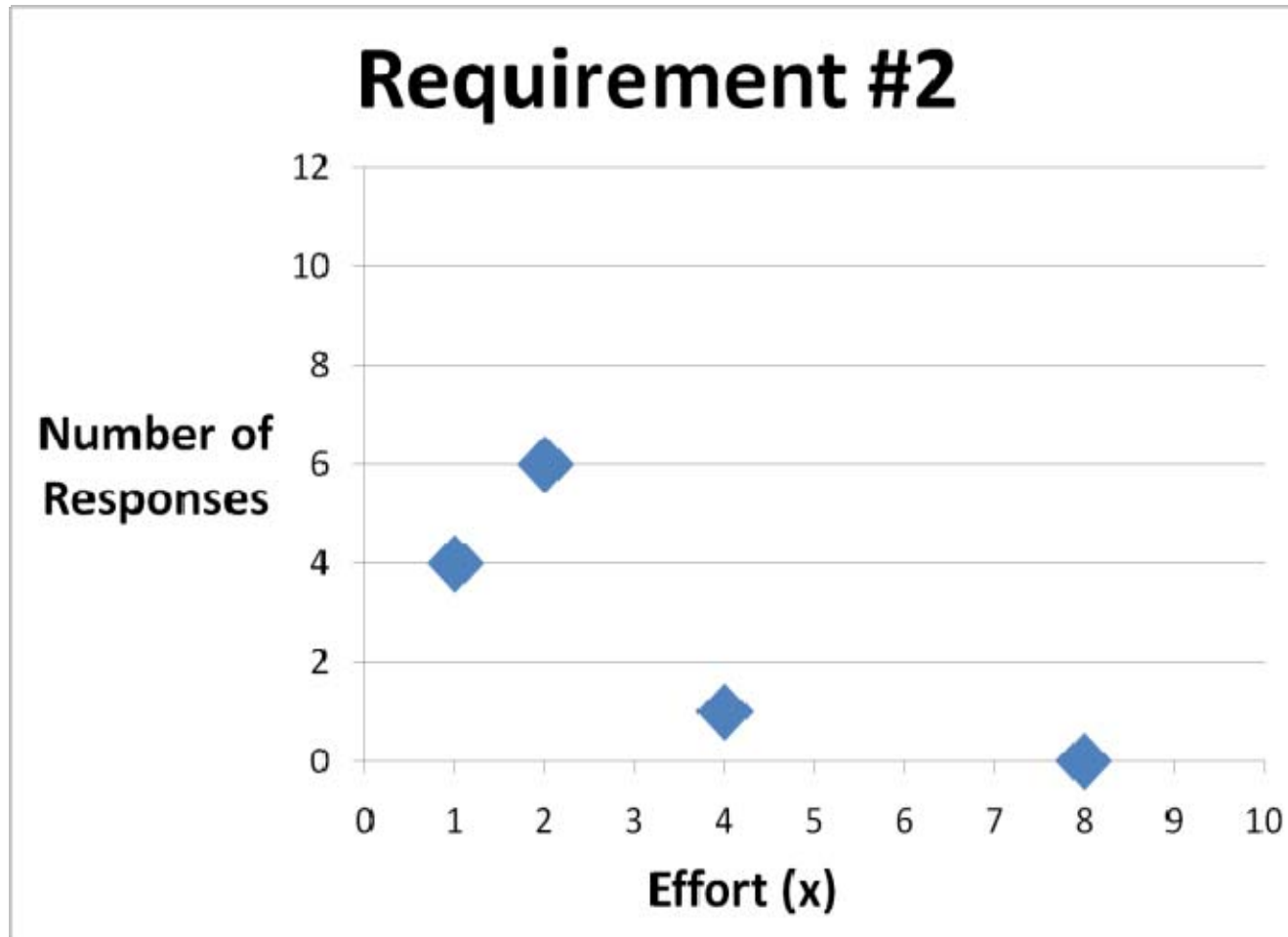
Discussion:

- HSI requirements could be a major driver of cost.
Many respondents answered “many requirements”

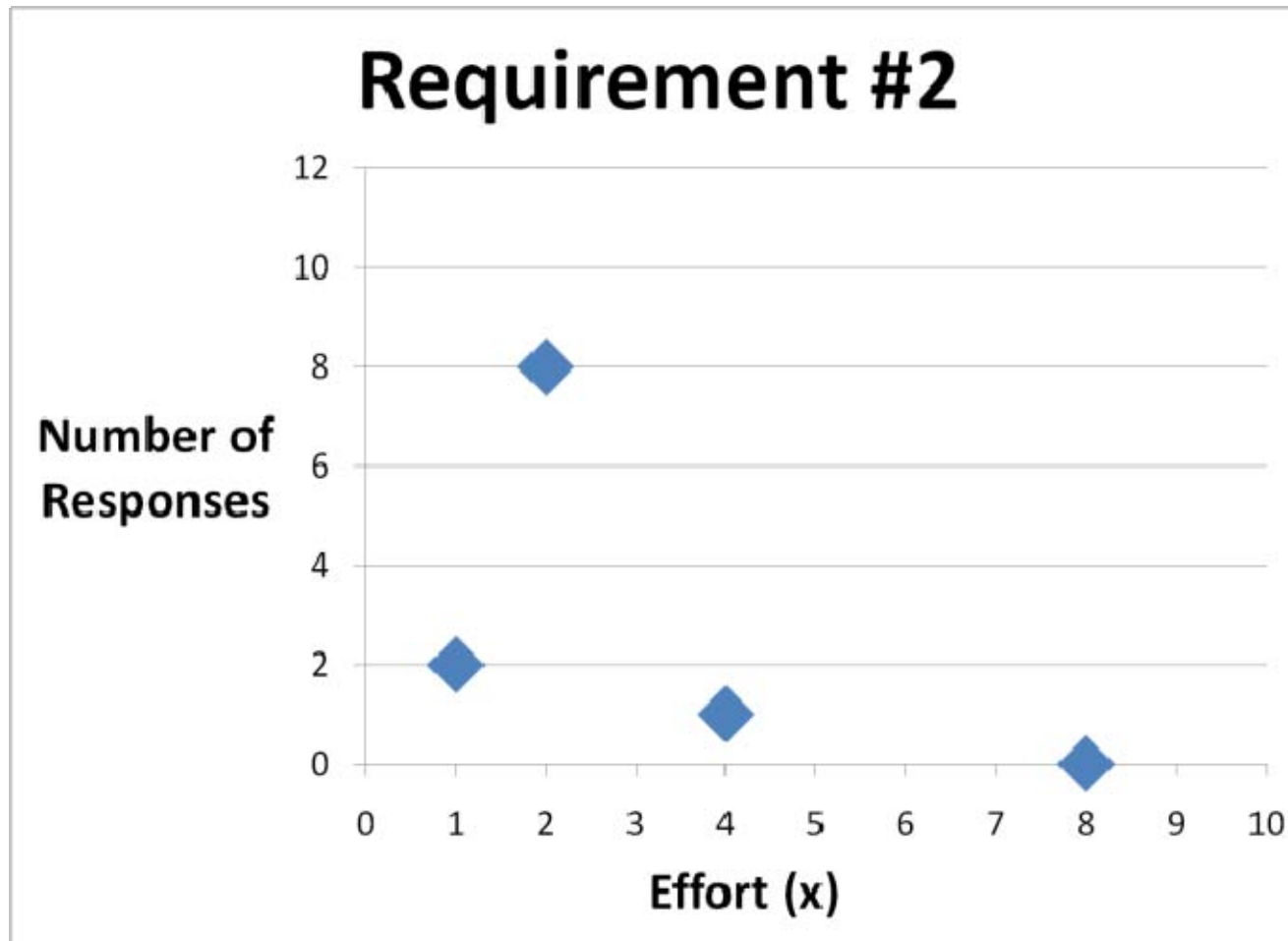
What is the impact of the HSI requirement compared to a nominal requirement?



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Conclusion

Next Steps

- Provide more guidance on “sea level”
- Adopt Defense Acquisition Guide definition of “verify”, remove “test”
- Perform additional analysis of impact of nonfunctional/HSI requirements



How can Human Systems Integration effort can be estimated as a function of total Systems Engineering Effort?