Subsystem Engineering

Creating design artifacts by working backwards from the desired outcomes

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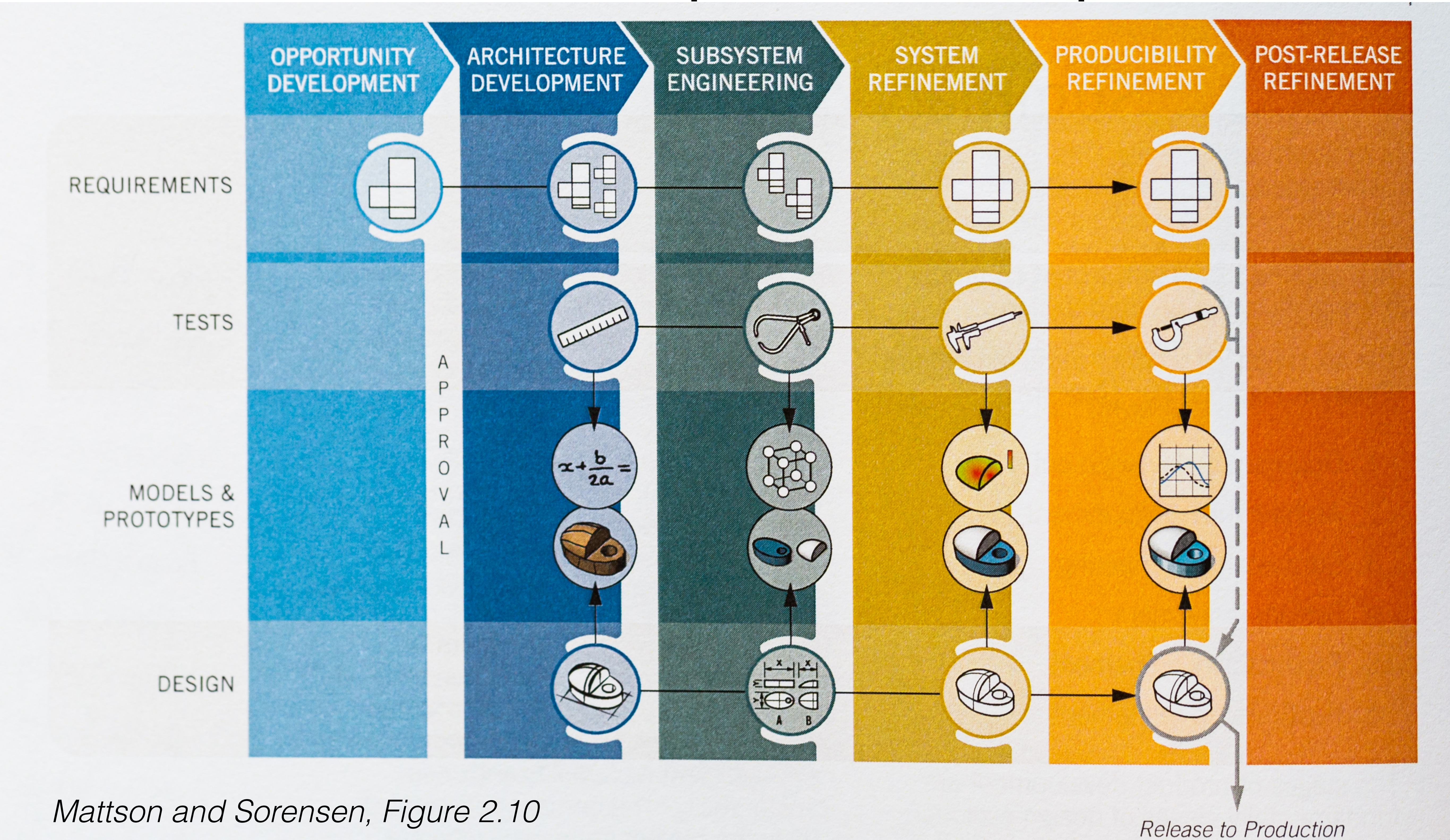
Subsystem engineering follows concept development



Mattson and Sorensen, Figure 2.10

Requirements are updated as the design evolves

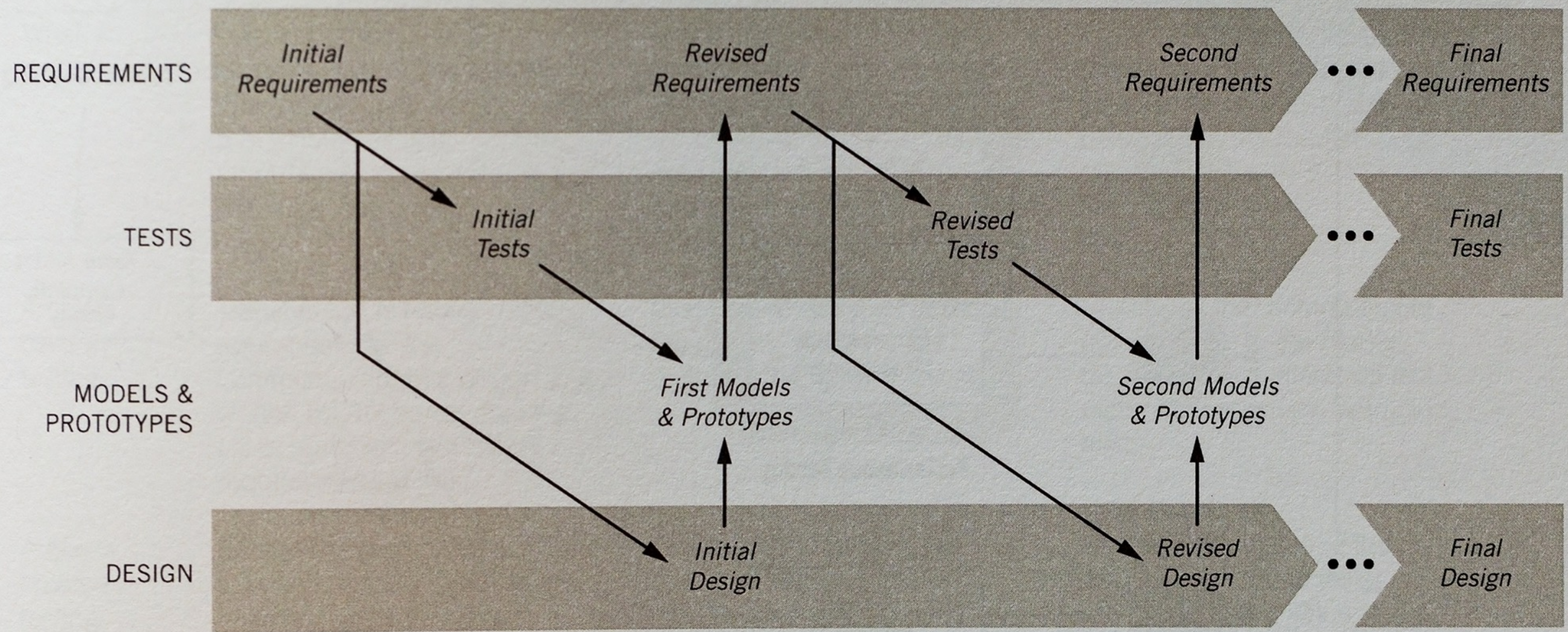


Figure A.2: The co-evolution of the requirements, the tests and the design as aided by prototypes and models. Prototypes and models are created as a snapshot consistent with the current design and tested to measure and predict the performance of the design to compare with the requirements.

Subsystem Engineering Creates Details

1. Each subsystem identified in concept development is developed in detail
    - CAD models, BOM, wiring diagrams, performance tests
2. Requirements for each subsystem are refined
    - Identify performance metrics
    - Develop models for performance prediction
    - Measure performance
3. Results from performance measurements on subsystems are used to update system performance measures
    - Use both predicted and measured performance

Mattson and Sorensen, sections 6.1, 6.2

Final outcome of ME 493 is a major report and a collection of design artifacts

Final Report

Body

1. Executive Summary
2. Client/Market Requirements
3. Design Concept Summary
4. Subsystem Highlights
5. Performance Summary
6. Final Status

Appendices

1. Concept analysis
2. System RM matrix
3. Subsystem A RM matrix
4. ...
5. Subsystem A design analysis
6. Subsystem A performance
7. Subsystem B design analysis
8. Subsystem B performance
9. ...
10. BOM

Design Artifacts (digital repository)

1. CAD Models
   a. Parts
   b. Assemblies
2. Schematics
3. Block diagrams
4. Wiring diagrams
5. Physical prototypes
6. Analysis codes
7. Analytical models and results
8. Test data & analysis
9. ...

How does your team organize its work activity to achieve the outcomes required by the project?

Work on one feature of one subsystem at a time (per person)

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Draft

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Start here

Warm-up Exercise Part 1: Work on a plan to achieve a short-term goal

In your design notebook, write down

- The next important task for the group
- The next important task for yourself

Warm-up Exercise Part 1: Work on a plan to achieve a short-term goal

In your design notebook, write down

- The next important task for the group
- The next important task for yourself

Be SMART

- **S**pecific: clear and unambiguous to others
- **M**easurable: “done” is well-defined
- **A**chievable: you have the necessary skills, resources, time, support
- **R**ealistic: the goal, which is achievable, is an appropriate goal given other constraints, limits, upcoming commitments
- **T**ime-bound: has a specific and reasonable end date, or duration

Exchange your design notebook with the notebook of someone else in your group.

Silently read their two tasks and decide whether those tasks are SMART.

Discuss whether the tasks are appropriate and whether the tasks are SMART.

Warm-up Exercise Part 2: Work on a plan to achieve a short-term goal

For the same two tasks identified in the first step, write down

- The unambiguous evidence that the group task is complete
- The unambiguous evidence that the individual task is complete

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Exchange notebooks again

If your tasks were SMART, it should be easy to identify the unambiguous evidence that will indicate that the task is complete.

Break

In-class Exercise: Work on a plan to achieve a long-term goal

Pick an important performance metric for your project.

- Prefer a subsystem performance metric
- Prefer a metric that can be quantified

Decide as a group on the performance metric you will work on during class.

Design the “Last Slide” in your final presentation for June 2017

Consider the performance metric you have identified in the preceding step.

- What are the units of the performance metric?
- What is a key design variable that influences that metric?
    - ➡ Try to pick a quantitative variable.

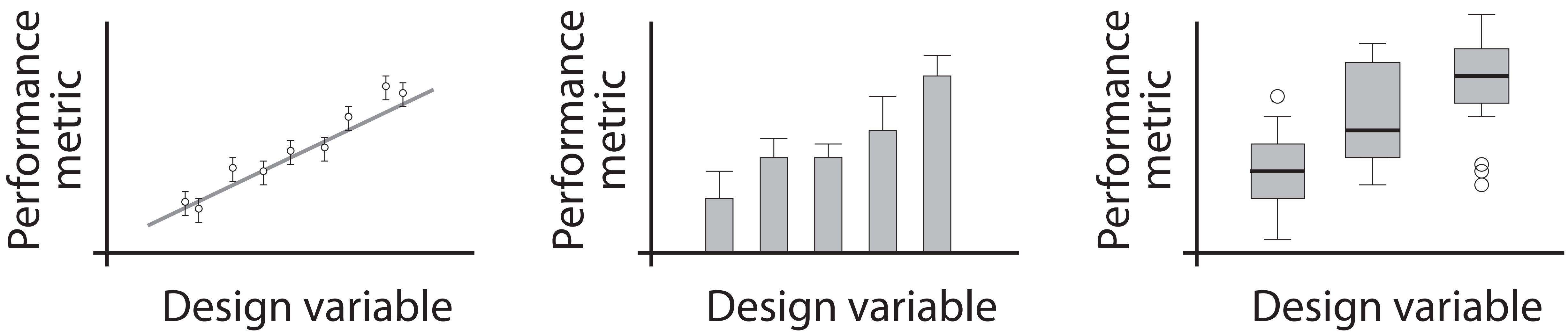
Design the “Last Slide” in your final presentation for June 2017

Consider the performance metric you have identified in the preceding step.

- What are the units of the performance metric?
- What is a key design variable that influences that metric?
  - ➡ Try to pick a quantitative variable.

Sketch the graph or table that shows the relationship between your design variable and the performance metric.

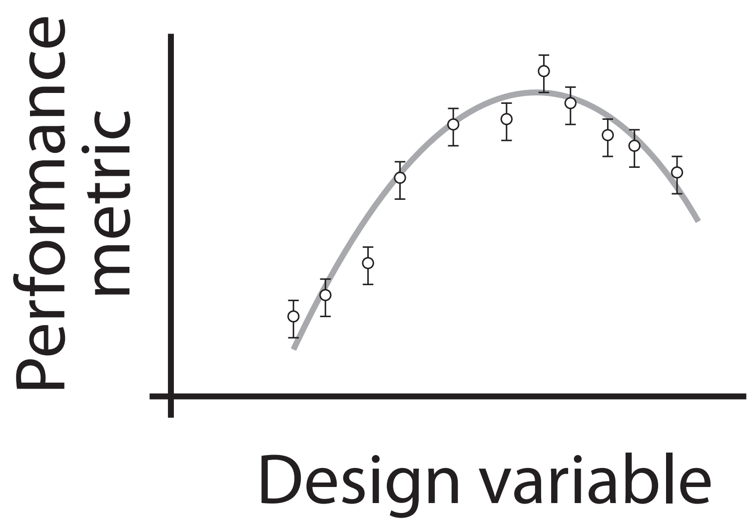
Predict outcome of your performance testing — Now

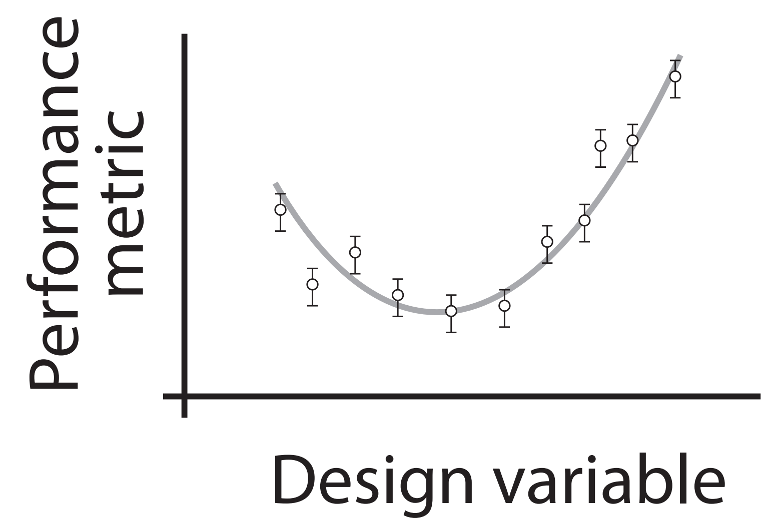


Why predict outcome of your performance testing?

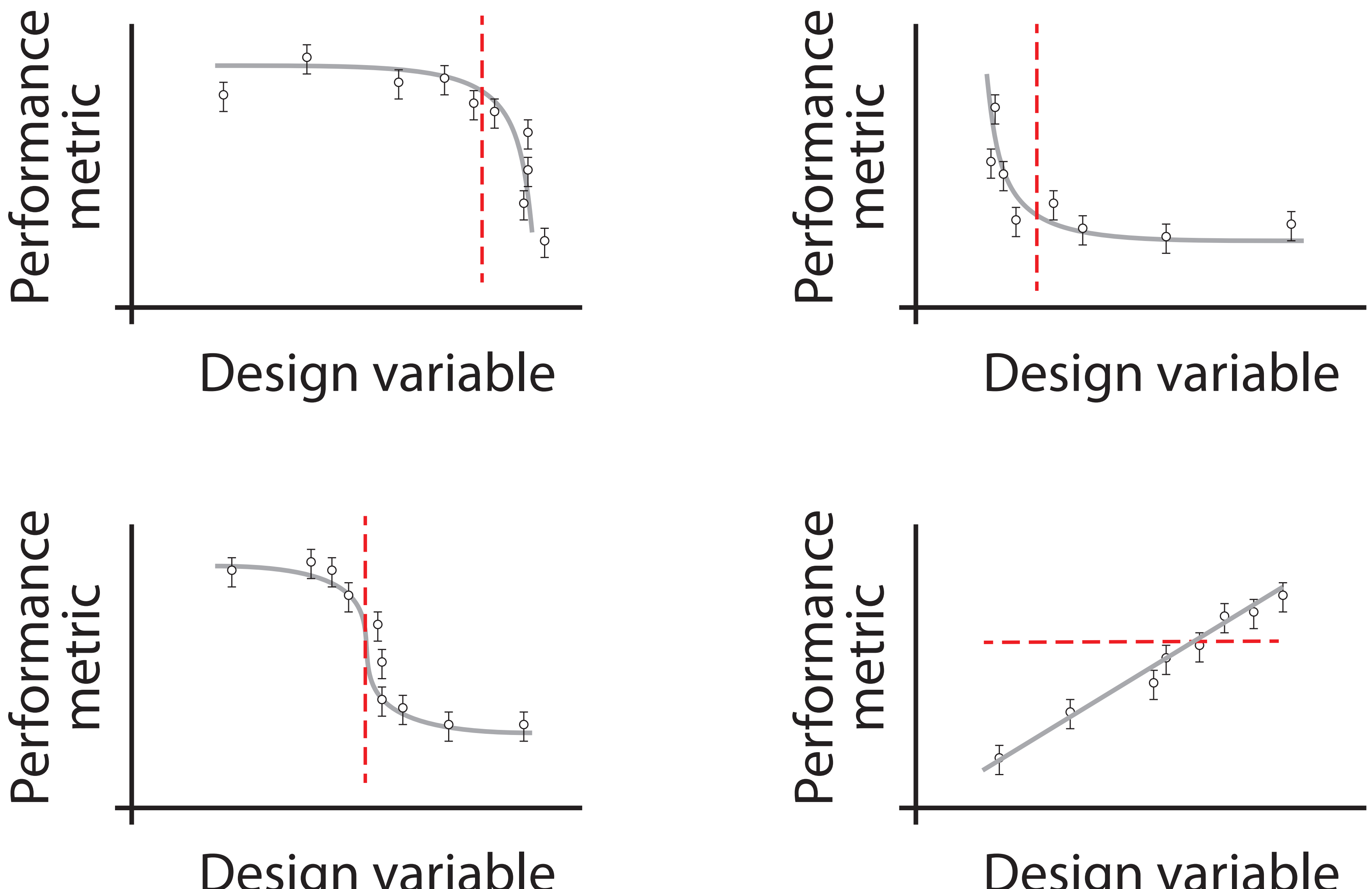
1. ~~Game the performance testing~~
2. Anticipate potential benefit from testing — What is the goal of testing?
3. Use and verify design models
4. Predict parameter range necessary for useful results
5. Anticipate errors in testing
6. Perform uncertainty analysis before testing
7. Allocate resources
8. Anticipate budget for testing
9. Coordinate design activities between subsystems
10. Manage performance envelop for subsystem
11. Understand what "done" means

Do you anticipate an optimum in performance?

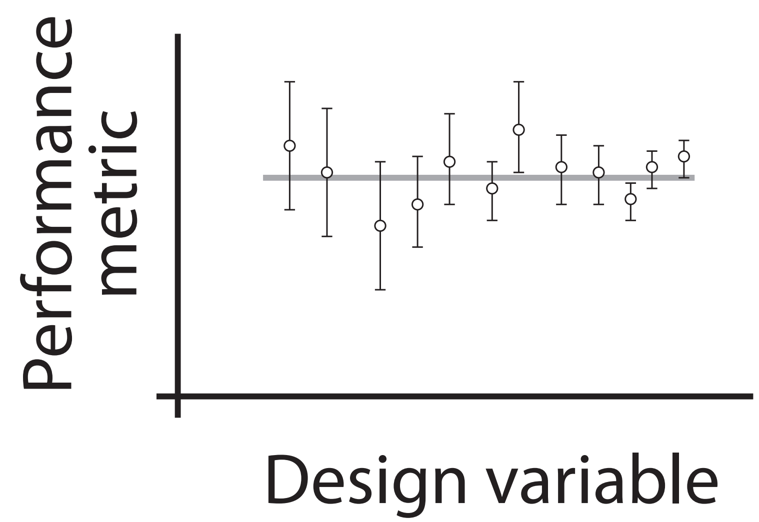




Is there a threshold, and is it important to find?



Or is there no change in the design variable that has meaningful impact on performance?



In-class Exercise

1. Pick a client market requirement
2. Pick a performance metric for the requirement — best to use a subsystem performance metric for this exercise
3. Define the test to verify that metric is or is not achieved
4. Create the design activity that will yield a subsystem that meets the performance metric