ECE180DA (Winter 2026)

Systems Design I

Lecture 4: Design reviews, part 3

Februrary 10, 2026

Design

- Fundamental questions:
  - **What** is a problem worth solving?
  - **Why** would a solution be meaningful?
  - (**NOT**: can I solve this problem)
- Design
  - **Given**: real world (universe of tools, universe of problems)
  - **Do**: identify requirements, capabilities, and dependencies of problems and tools
  - **Goal**: validate optimality of problem + tool combination

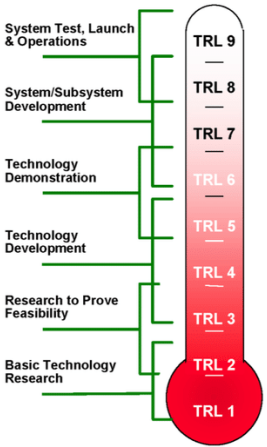
Solving real-world problems

technologies $\rightarrow$ **solution** $\rightarrow$ **application** $:=$ project

The design process ensures that the **best** technologies are engineered in the **best** way to address the **best** problem.

. . . understanding resource constraints along the way.

Design process metric: Technology Readiness Level (TRL)



TRL 9 — Actual system "flight proven" through successful mission operations

TRL 8 — Actual system completed and "flight qualified" through test and demonstration (Ground or Flight)

TRL 7 — System prototype demonstration in a space environment

TRL 6 — System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)

TRL 5 — Component and/or breadboard validation in relevant environment

TRL 4 — Component and/or breadboard validation in laboratory environment

TRL 3 — Analytical and experimental critical function and/or characteristic proof-of-concept

TRL 2 — Technology concept and/or application formulated

TRL 1 — Basic principles observed and reported

(NASA / source unknown)

Design risk

Top level risk: total reward (benefit) does not justify total investment (cost)

- Rewards:
  - Productivity / efficiency
  - Physical or mental health
  - Quality of life
  - Social / societal benefit
- Costs:
  - Design + development
  - Fixed / setup
  - Marginal
  - Operational

Forward risk management

- **Risks to mitigate:** No generated value, no source of investment
  → Concept reviews = P0-P1 ✓
- **Risks to mitigate:** Value improperly quantified, confounding factors on value, Unassessed costs, integration mismatch
  → Requirements Review / System Design Review (RR/SDR) = P2-P4 ✓
- **Risks to mitigate:** Incomplete solution, insufficient resources
  → Preliminary Design Review (PDR) = P5-6
- **Risks to mitigate:** Insufficient technical capabilities
  → Critical Design Review (CDR) = P8
- **Risks to mitigate:** Real-world uncertainties, better value proposition from competitors
  → Final Design Review (FDR) = P9
- **Risks to mitigate:** Manufacturing / scaling uncertainties
  → Production Readiness Review (PRR) = Out of scope

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RR/SDR feedback

- Value quantification
  - Get total stakeholder numbers
  - Justify user-facing metrics (including thresholds)
- Costs
  - Quantify stakeholder distribution across alternatives
  - Justify available resources
- Integration (dependency diagram)
  - Hard vs. soft constraints
  - Internal vs. external constraints
  - Tradeoff analysis
    - Yes/no questions vs. Quantified relationships

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- **Sources:** Low fidelity experiments, past experience
- **Process:**
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  - Identify evaluation methods
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Incremental justification

- **To whom?** "stakeholders"
- **When?** "early and often"
- **How?** "design review":
  - Identify risks that have been mitigated
  - Thoroughly characterize risks that will be mitigated with new resources
  - Acknowledge remaining / outstanding risks
  - Break down spent and required resources
  - **Show your work**

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Validation

- **Interactive** validation discussion
  - Define assumptions / preconditions / constraints
  - Describe methods / processes
  - **Live demo** > recorded video > static images > text
  - Explain results in context of high level problem
  - Highlight failures, risks, uncertainty / unknowns, concerns
  - Precisely formulate next and future **questions**
  - Organized for optimal communication

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Next up

- This week in lab:
  - Physical evalutaion of design decision
- To be done by next Monday:
  - Shark tank blurbs
- Next week in “lab”:
  - Shark tank!

Design review format

- Agenda
  - Introduction
    - People, purpose, process (of review)
  - Background
    - Summary of + changes from previous reviews
    - Necessary underlying knowledge
  - **Interactive** validation discussion
  - Past and future resource allocation / project management
  - Wrap-up
    - Suggested conclusions
    - Action items for audience (stakeholders) and design team

Stakeholder responsibility: judgement

- Do the data and results support the conclusions drawn?
- Are the assumptions reasonable and complete?
- Are the design methods / processes appropriate to the questions?
- Are the upcoming risks well-grounded, complete, and acceptable?
- Is this still moving towards the original problem?
- Are resources being well managed?
- "Devil's advocate", but **constructive feedback**

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Keep in mind

- Show, don't tell
- Know your audience
  - Stakeholders are likely domain experts but not necessarily technical experts
- Stakeholders are allies
  - Be open and forthcoming
  - Solicit feedback; don't pitch or persuade
  - Failures identified now prevent bigger failures later
- Communicate
  - Have an agenda
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Design review reminders

- Don't assume the answer going in
  - Evaluate to **eliminate**, not justify—finding supporting evidence is not enough; only stop once you've contradicted all refuting evidence.
- **Process** is more important than product
  - Justification is the key deliverable
  - Don't build what you don't have to
- Leave any preconceived expectations at the door
- **Analyze and validate** your choice of technologies, solution, and application

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Comparative analysis

Isolated evaluations are not enough

- Identify candidates and alternatives
- Determine the metric / figure of merit (FOM)
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- Execute the method to **validate** a choice based on FOM

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