Module 5:
An introduction to managing risk and uncertainty in the SLC
Session 2 of 3

Version 1.8.11

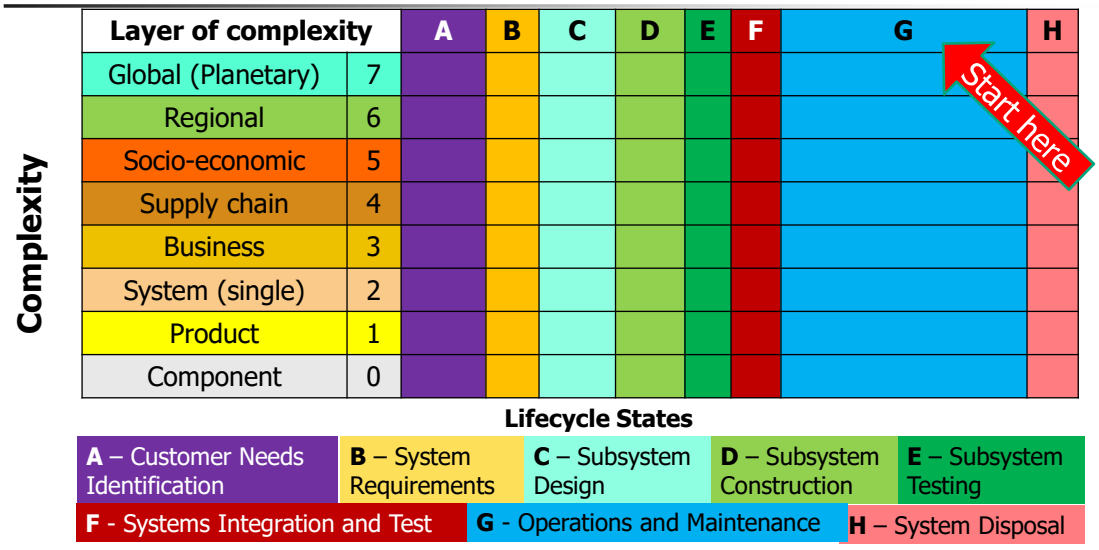
Knowledge

- Lecture
  - Risks and uncertainties
- Readings
  - ~~0502 Systems Engineering (SE) Chapter 5 An introduction to managing risk and uncertainty over the project life cycle~~
  - ~~0503 FUSE Chapter 10, Systems engineers are from Mars, software engineering are from Venus.~~
    - How easy it is to miscommunicate and not realize it
  - 0504 SE Chapter 19, Jumping to the wrong conclusions: A case study on optimizing a postgraduate learning environment.
    - How easy it is to go wrong
  - ~~0505 Malotaux N., Controlling project risk by design, Aug 2018, https://www.malotaux.eu/doc.php?id=5~~
  - ~~0506 Barnard A., Reliability Engineering: Value, Waste, and Costs, INCOSE International Symposium, 2016, posted with permission (https://www.researchgate.net/publication/308092972_Reliability_Engineering_Value_Waste_and_Costs)~~
- ~~Exercises~~

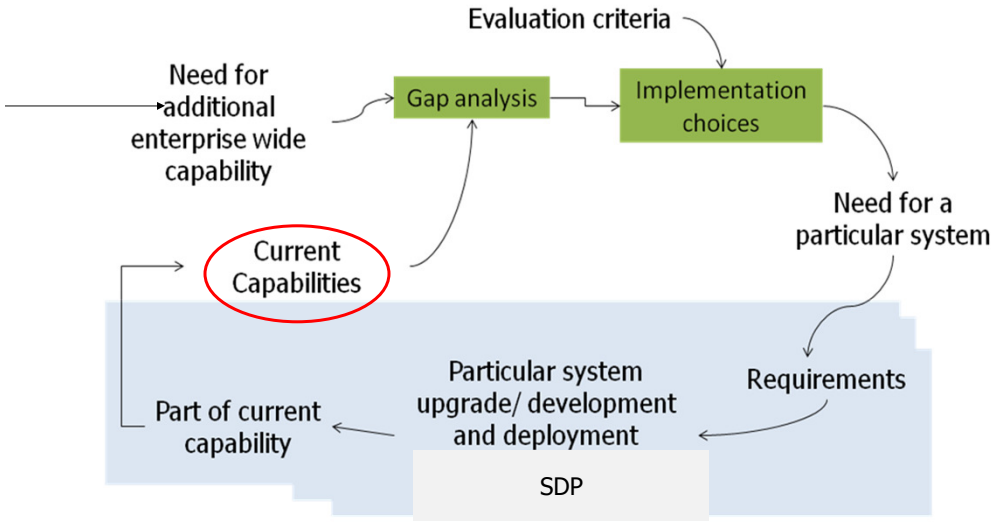
Topics

- Definitions
- Risks and uncertainty
- Risk management
- **Risks in the SDP**
- Managing uncertainty
- Risks based on technology
- Estimating/measuring risks
- Primary and secondary risks
- Contingencies and contingency plans
- Exercises
- Summary

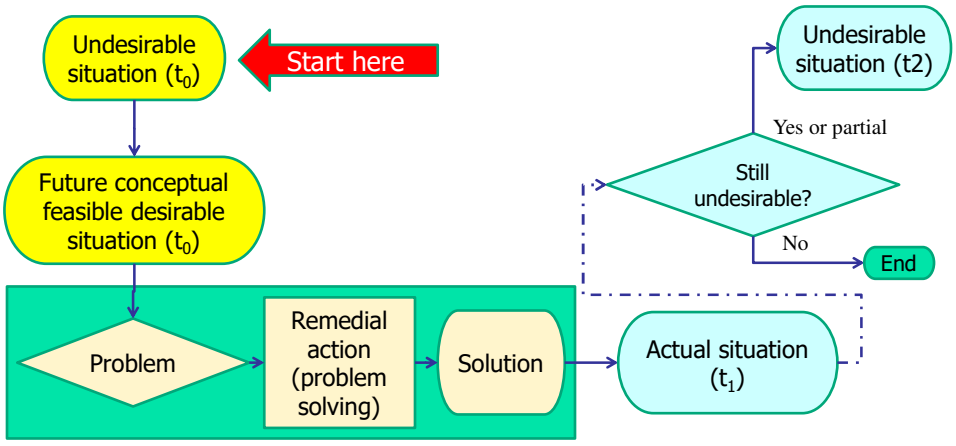
The Hitchins-Kasser-Massie-Mabelo Framework - (HKM²F)



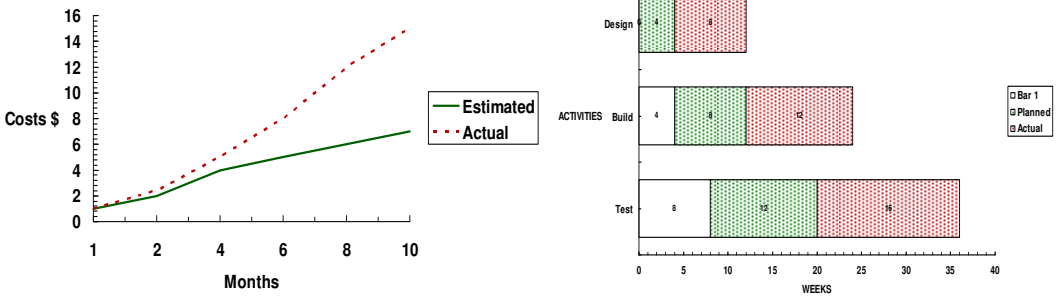
Big Picture perspective: closing the loop



Temporal perspective

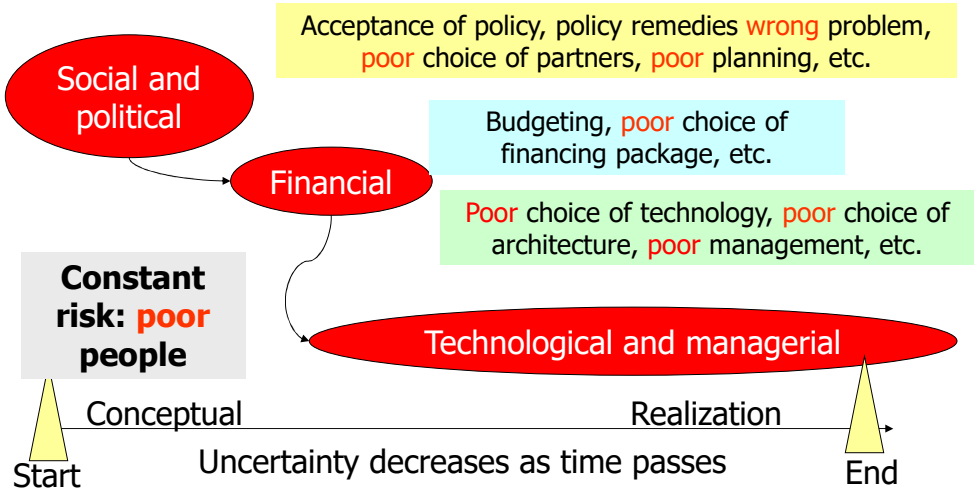


Risks cause deviation from plans



Deviations from plans arise from risks and opportunities

Risk emphasis changes over time

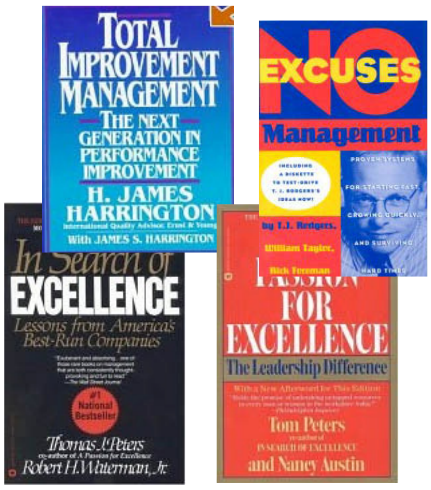


A cause of project failures (reminder)

- Tom DeMarco conducted an annual survey of real world development projects between 1977 and 1987 (DeMarco et al. 1987)
  - DeMarco, Tom , and Lister, Timothy, Peopleware, Dorset House Publishing Company, 1987.
- Over 500 project histories
- Reported that 15% of all projects studied came to naught
  - they were canceled, aborted, "postponed" or delivered products that were never used
- Fully 25% of projects that lasted 25 person-years or longer failed to complete.
  - In the majority of projects *there was not a single technological issue to explain the failure*.
- The cause of failure most frequently cited were people related, including:
  - staffing problems
  - disenchantment with management or the client
  - lack of motivation and high turnover
  - communications (inter-personal) problems.

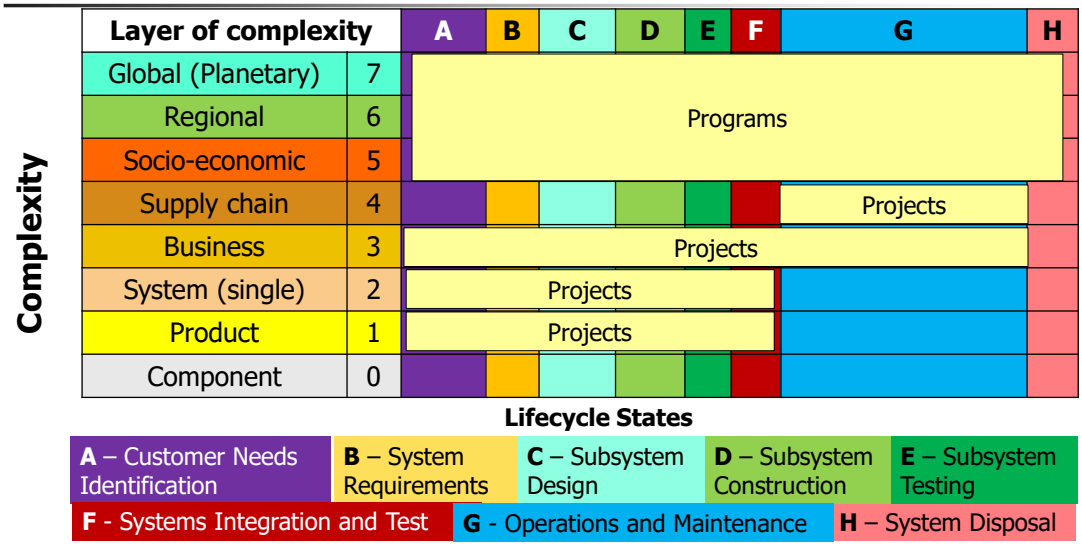
The focus is on people not process*

- Literature
  - Is full of advice as to how to make projects succeed
  - Has little if anything to say about the proliferating process standards
- Garbage-in-garbage-out



* Kasser, J. E., "*The Certified Systems Engineer - It's About Time!*" proceedings of the 10th Annual Symposium of the INCOSE, Minneapolis, MN, 2000.

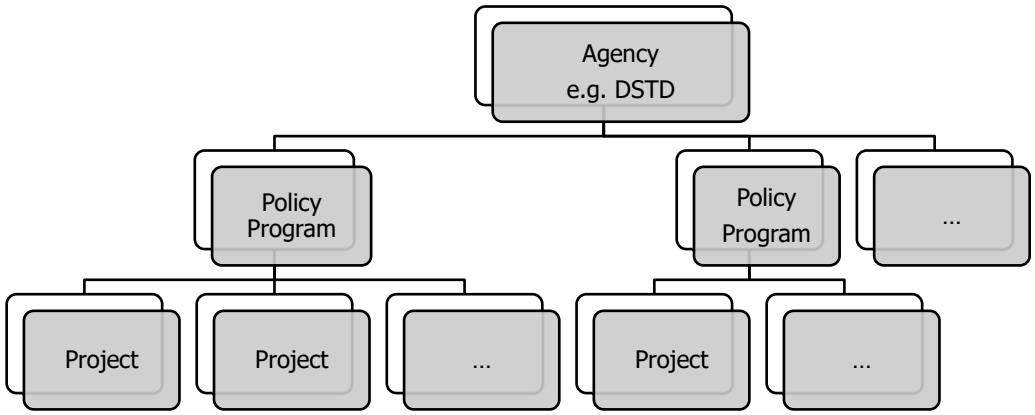
Problem-solving in the HKM²F



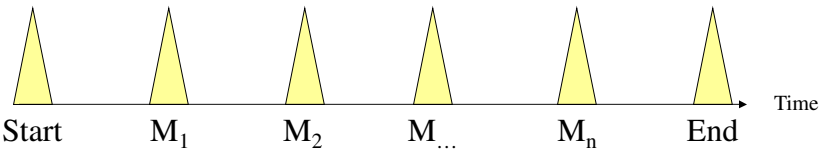
Programs and projects

- Program is the enveloping (meta) system or context for a project
- Identical in concept
  - Compare system and subsystem
    - *Generic* perspective
- Risks and opportunities
  - Same and different
- Skills and competencies
  - Same and different

Structural view: hierarchy



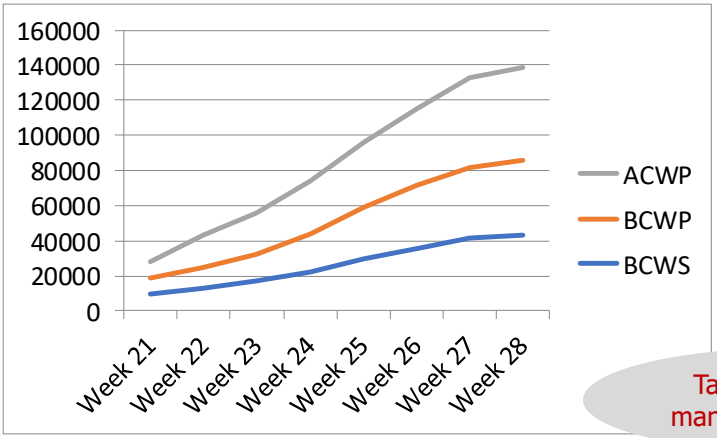
Milestone reviews



- Look at progress
- Provide consensus that
  - Work completed is satisfactory
    - cost, schedule and scope
  - The solution still remedies the needs
    - As they are at the milestone review
    - As they are projected to be in the future (to the best of knowledge)
      - if not, provide consensus on what needs to be changed
- Provide excuses for unsatisfactory work and remedial actions
  - *Continuum* HTP
- Show planned work for next phase
- Provide risk and opportunity analysis for remainder of project
  - With emphasis on near term future

P D C A

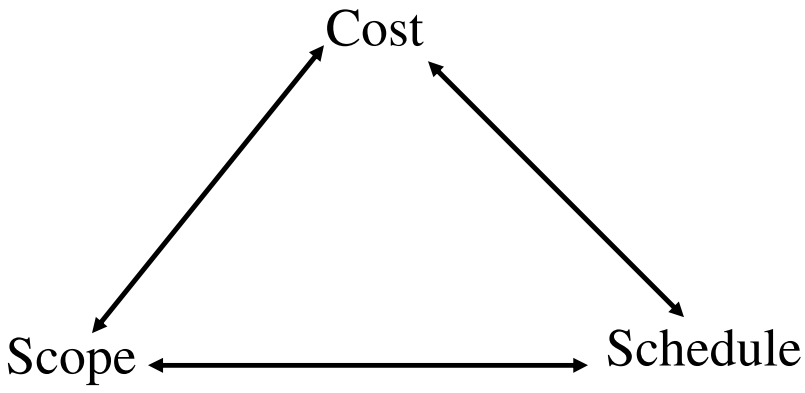
Earned value analysis (typical)



Taught in project management classes

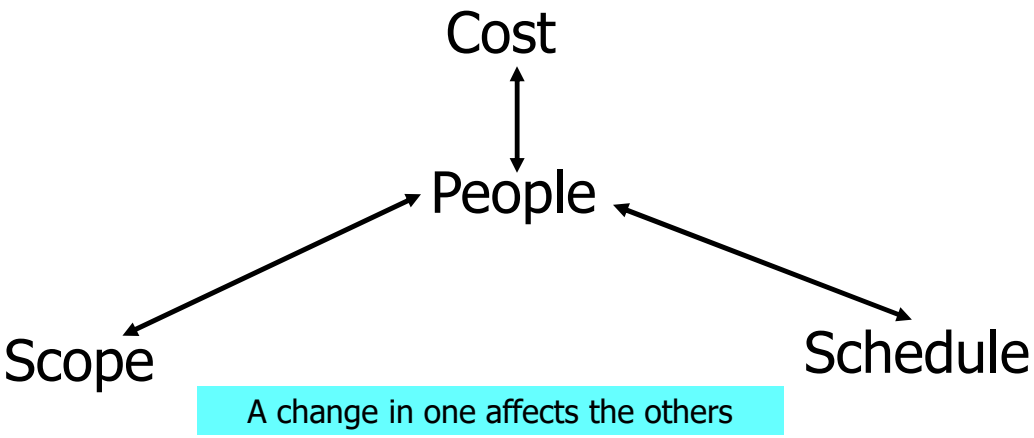
Provides, cost, time and schedule variances

Triple constraints (traditional)



A change in one affects the others

Quadruple constraints (systems)



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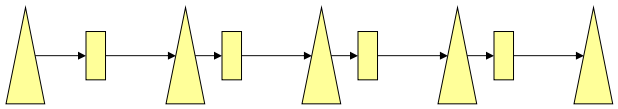
Approaches to manage uncertainty

- Gather and use information to fill gaps in knowledge
- People
  - Open communications between stakeholders
  - Trust and respect
  - Domain expertise
  - Who know what they don't know
- Technology
  - Robust design
    - Solutions continue to function if conditions change
    - Based on work of R.A. Fisher (1935) and Taguchi methods
- Simulations and models
  - Provide understanding, not solutions
  - Only as good as assumptions underlying models

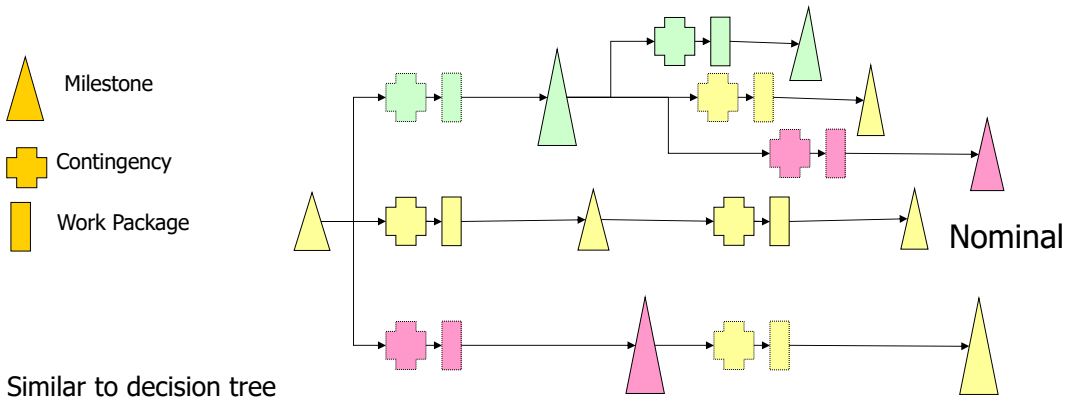
Project network (reminder)



- Traditional view
- Work done between milestones
- Project management
- Risk management
- Systems engineering
- Other streams of activities

- Critical path
  - Schedule estimates
- Cost estimates
- Measure actual costs as time goes by
- Earned Value Analysis
  - Compares estimates with actual

Contingency planning



- Similar to decision tree
- Probabilities and impact severities
- Revise contingency plans before each milestone
- Focus on the 6-8 that have maximum impact

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Risks based on technological uncertainty*

- **Type A—Low-Tech Projects:** projects that rely on existing and well-established technologies to which all industry players have equal access.
- **Type B—Medium-Tech Projects:** projects that rest mainly on existing technologies and incorporate a new technology or a new feature of limited scale.
- **Type C—High-Tech Projects:** projects in which most of the technologies employed are new, but existent — having been developed prior to the project's initiation.
- **Type D—Super-High-Tech Projects:** projects based primarily on new, not entirely existent, technologies

* Shenhar, A. J. and Bonen, Z., "*The New Taxonomy of Systems: Toward an Adaptive Systems Engineering Framework*", IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans, Vol. 27 (1997), no. 2, 137 - 145.

NASA's TRL*

9	Actual system "flight proven" through successful mission operations
8	Actual system completed and "flight qualified" through test and demonstration (ground or space)
7	System prototype demonstration in a space environment
6	System/subsystem model or prototype demonstration in a relevant environment (ground or space)
5	Component and/or breadboard validation in relevant environment
4	Component and/or breadboard validation in laboratory environment
3	Analytical and experimental critical function and/or characteristic proof-of concept
2	Technology concept and/or application formulated
1	Basic principles observed and reported

* TECHNOLOGY READINESS LEVELS A White Paper, April 6, 1995, John C. Mankins, Advanced Concepts Office, Office of Space Access and Technology, NASA

The TAWOO (reminder)

TAWOO		TRL	Comments
6	Antique	12	Few if any spares available in used equipment market
5	Obsolete	11	Some spares available, maintenance is feasible
4	Approaching obsolescence	10	Use in existing products but not in new products
3	Operational	9	Available for use in new products (in general).
2	Development	8	Actual system completed and "flight qualified"
		7	System prototype demonstration
		6	System/subsystem model or prototype demonstration
1	Research	5	Component and/or breadboard validation
		4	Component and/or breadboard validation in laboratory environment
		3	Proof-of concept
		2	Technology concept and/or application formulated
		1	Basic principles observed and reported

Exercise 5-21 knowledge reading

1. Prepare a brief on two main points in reading 0504 (< 5min)
2. Presentation to contain
    1. Formulated problem per COPS problem formulation template
    2. A summary of the content of the reading (<1 minute)
    3. The compliance matrix
    4. This slide and the version number of the session
    5. A list of the two main points
    6. The two briefings
    7. Reflections and comments on reading (<2 minute)
    8. Comparisons of content with other readings and external knowledge
    9. Why you think the reading was assigned to the module
    10. Lessons learned from module and source of learning e.g. readings, exercise, experience, etc. (<2 minutes)
3. Save as a PowerPoint file as Exercise5-21-abcd.pptx
4. Post/email presentation as, when and where instructed
5. Brief on one main point

Any questions ?

1. Best
2. Worst
3. Missing

Email:
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Subject: <class title> BWM Session #