

Systems Engineering Principles Applied to Basic Research and Development



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William Nolte

Electronics Engineer

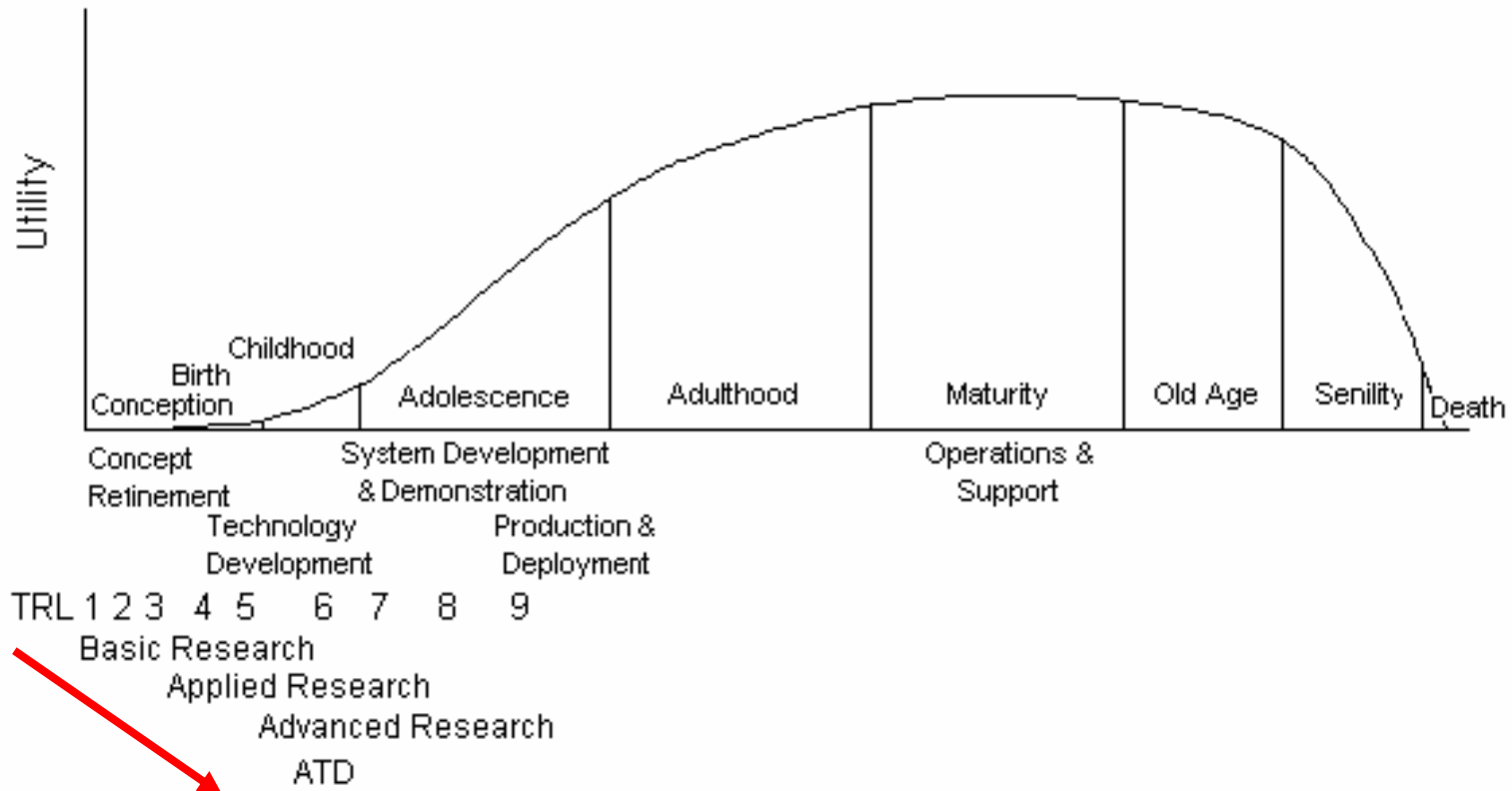
Col Norman Anderson

Chief Engineer, Space Vehicles

Air Force Research Laboratory



Technology Life Cycle The Whale Chart



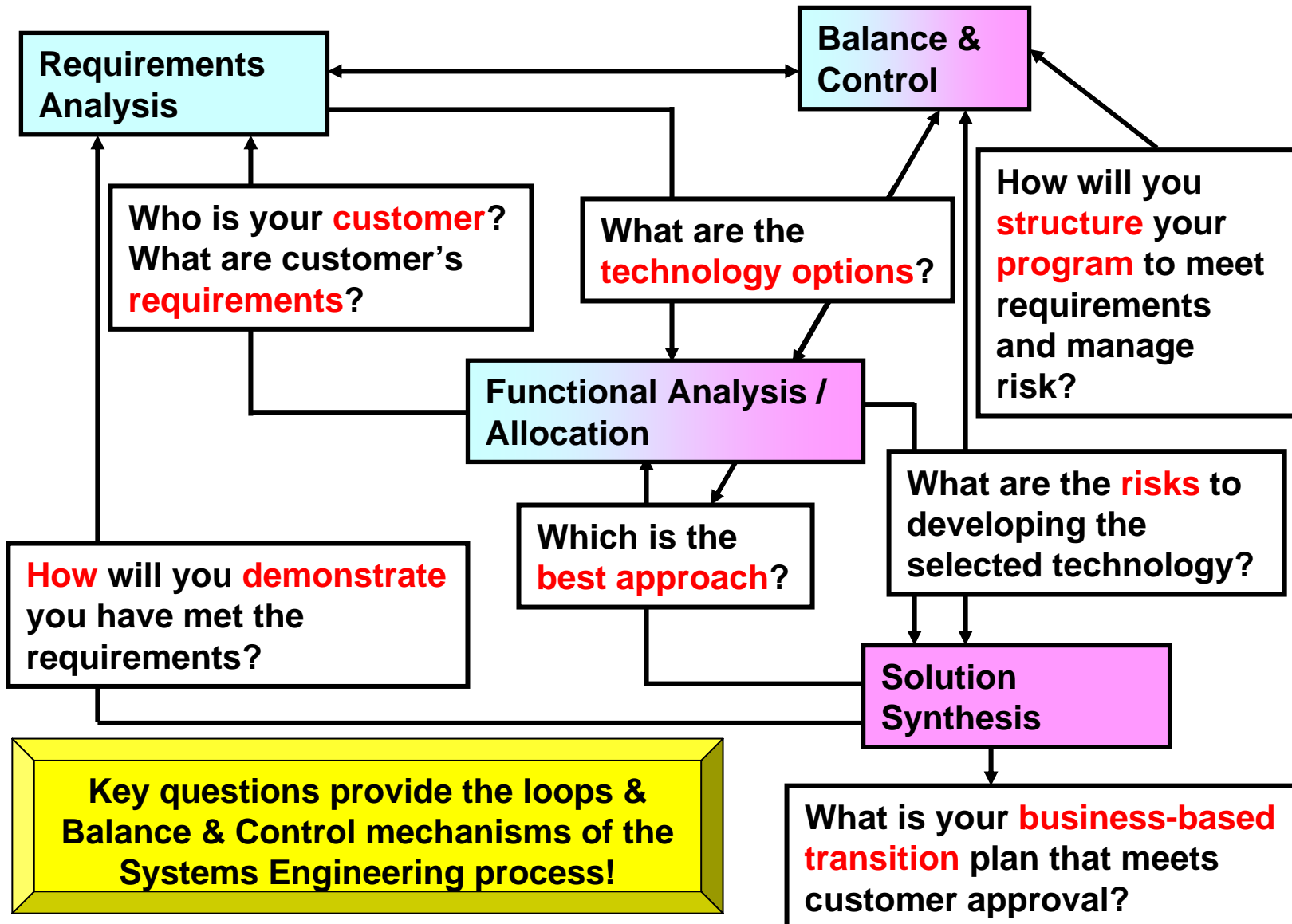
- The Whale Chart maps the Life Cycle to the Readiness Levels and R&D Stages
- A technology's usefulness changes over time
 - Utility increases as a technology matures
 - Utility decreases as a technology becomes obsolete



Knowledge Growth



Key Question	<u>Basic Research</u>	<u>Applied Research</u>	<u>Advanced Research</u>	<u>ATD</u>
Who is your customer ?	Partial	Nearly Complete	Complete	Complete
What are customer's requirements ?	Partial	Partial	Nearly Complete	Complete
How will you demonstrate you have met the requirements?	Partial	Partial	Nearly Complete	Complete
What are the technology options ?	Extremely Limited	Nearly Complete	Complete	Complete
Which is the best approach ?	Extremely Limited	Nearly Complete	Complete	Complete
What are the risks to developing the selected technology?	Partial	Partial	Nearly Complete	Complete
How will you structure your program to meet requirements and mitigate risk?	Partial	Nearly Complete	Complete	Complete
What is your business-based transition plan that meets customer approval?	Extremely Limited	Partial	Nearly Complete	Complete





R&D Focus on Risk



Two of the Key Questions Focus on Risk in R&D:

- **What** are the risks to developing the selected technology?
- **How** will you structure your program to meet requirements and manage risk?



RM Tailored to R&D Goals



- **Three Distinct Levels of Research and Development**
 - **Basic Research – develop a fundamental understanding of selected physical properties**
 - **Applied Research – investigate application of physical properties to selected technical needs**
 - **Advanced Technology Development – explore application of technology to assess military relevance**



Philosophy of RM in Basic Research



What Are the Risks?

- Develop cost estimates for advancement of technology to useful level
- Identify development options and relative difficulty of options
- Maintain budget within pre-defined boundaries

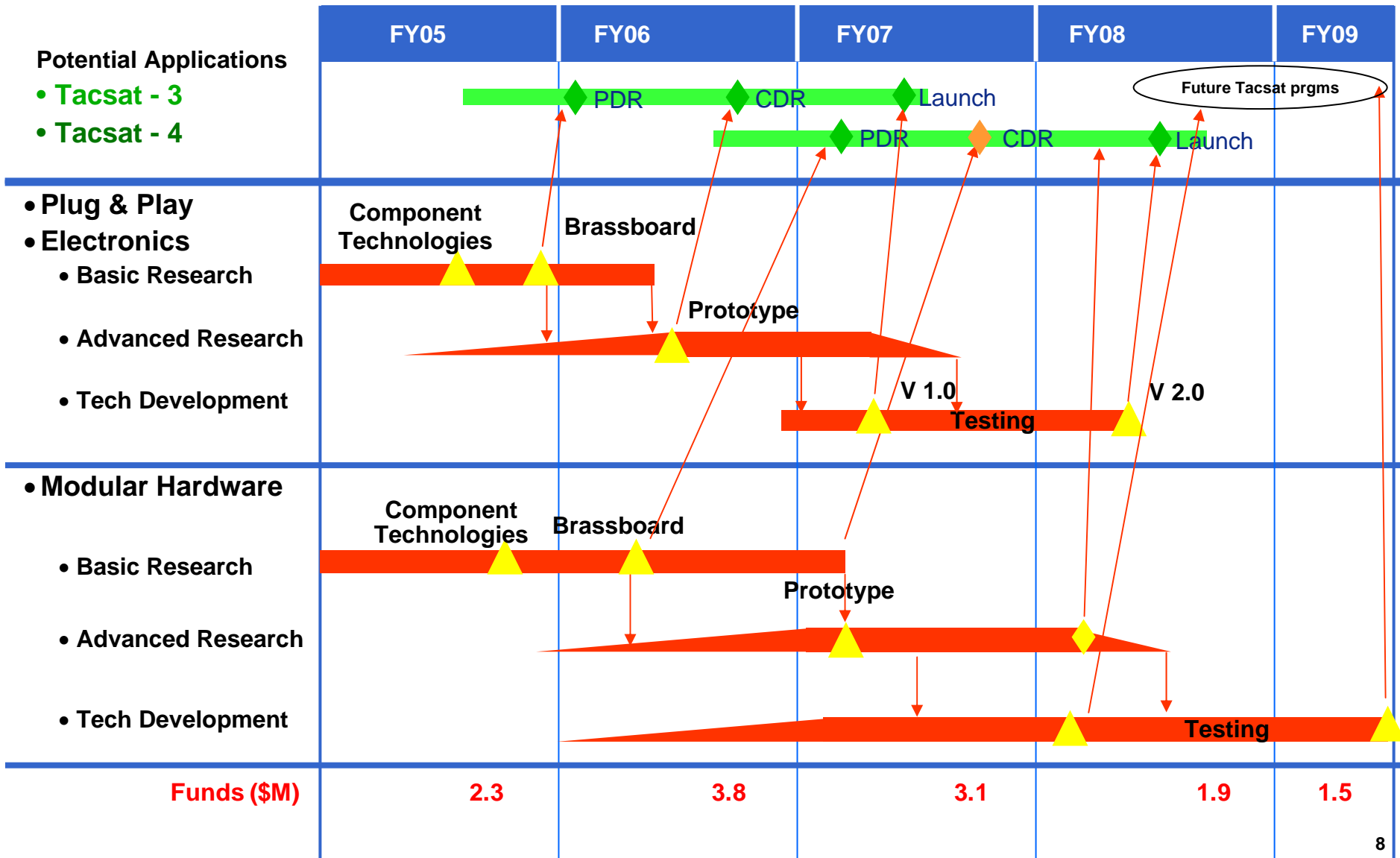
How Will You Structure the Program?

- Establish knowledge incremental goals
- Estimate cost/time needed to achieve
- Determine risks associated with maintaining cost/schedule
- Track variances for periodic cost/schedule replan

Primary purpose of RM in Basic Research is to refine development roadmap



Investment Roadmap for Modular Spacecraft Technologies





Philosophy of RM in Applied Research



What Are the Risks?

- Develop technology into a repeatable engineering capability
- Identify extent of applicability of technology to military needs
- Determine the cost/benefit parameters of this new capability

How Will You Structure the Program?

- Explore range of application of technology
- Refine development roadmap for specific applications
- Determine risks associated with achieving required performance at known cost/schedule
- Identify issues of repeatability and define mitigation approaches

Primary purpose of RM in Applied Research is to balance cost & performance



Philosophy of RM in Advanced Technology Development



What Are the Risks?

- Apply engineering capability to specific military need
- Identify issues causing uncertainty in application
- Refine cost/performance relationship.

How Will You Structure the Program?

- Manage to cost/schedule
- Provide mitigation options and go/nogo gates
- Determine risks early, maintain constant awareness
- Identify potential of cost/schedule failure early (precursors), manage proactively

Primary purpose of RM in ATD is to balance cost, performance, schedule



Summary



- Key Questions (**What** Are the Risks and **How** Will You Structure the Program?) provide the basis of the AFRL Risk Management process
- Questions apply to R&D programs at all stages of maturity
- Knowledge available to the program manager changes with program maturity
- Risk Management philosophy changes with program maturity



Conclusion



The AFRL Systems Engineering Initiative is a method of managing risk in Science and Technology

Risk Management is applicable early in the technology life cycle



Discussion / Questions

