

Concept Maturity Framework (CMF)

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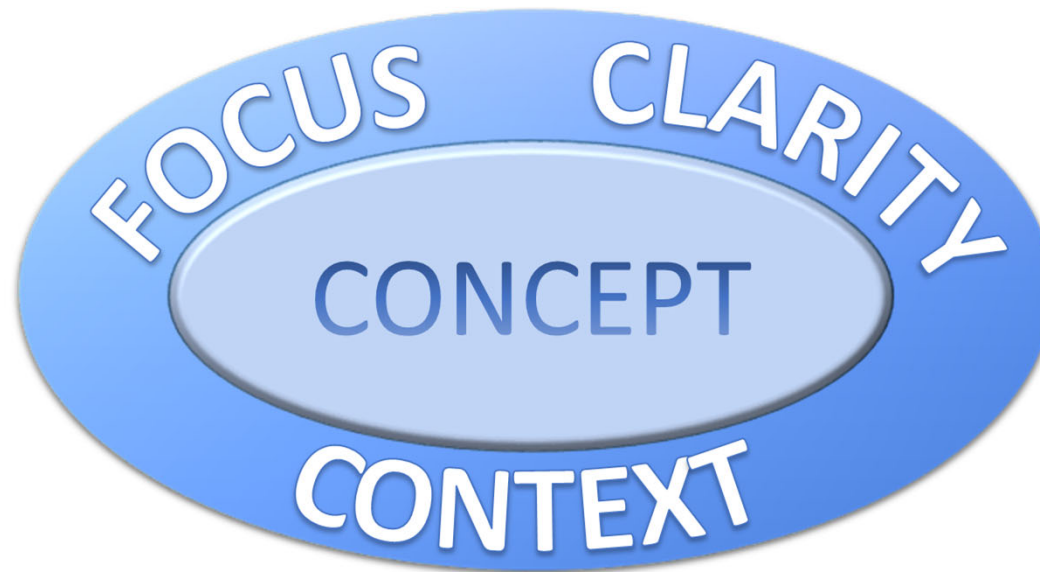
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What is the Concept Maturity Framework (CMF)?

A framework best practice that yields:

1. Transparent and shared understanding about the progress and gaps of maturing the concept
2. Clarity and consistency throughout the concept research, engineering, and development process
3. Information for decision-making and budgeting



Background of the CMF

FAA's Initial Request

New Concepts & Associated Capabilities

Concept Development: Exploration, Validation, Evaluation



What is the maturity of a concept?

Current Approaches

Process: Technology Readiness Assessment (TRA)

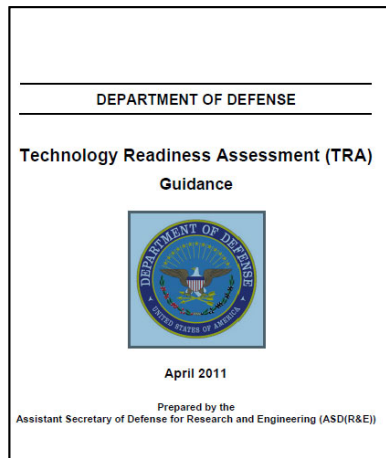
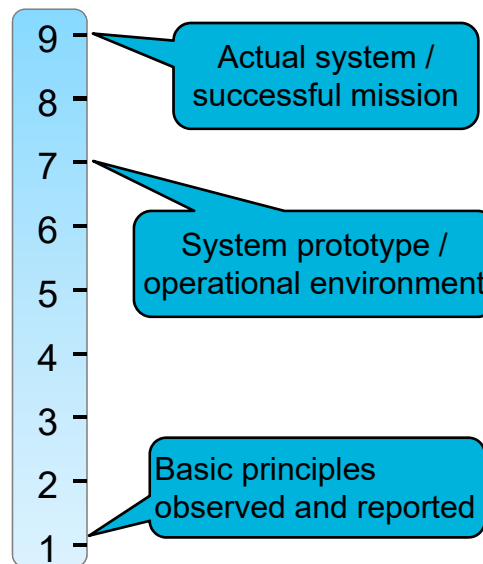


Image Source: DOD [1]

FAA System Engineering Manual [2] specifies 2 TRAs to be conducted for Mission Analysis and for In-Service Analysis

Measure: Technology Readiness Levels (TRLs)



FAA's Levels of Maturity (LOMs) [2]

Measure: FAA Concept Maturity Levels (CMLs)

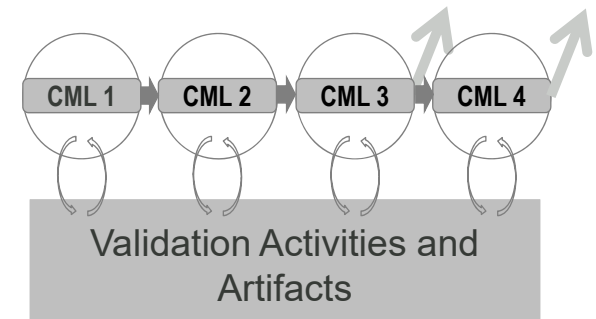


Image Source: FAA [3]

FAA Concept Development and Validation Guidelines [3] identify Concept Maturity Levels: Validation activities, key participants and work products and exit criteria

Responding to Limitations

Today's Limitations	Addressed by CMA
A single readiness level describing multiple components [4]	Components of concept and prototype capabilities assessed
Illusion of objectivity with a numerical scale (observations)	Standard criteria and responses
Subjectivity introduced without defined terms and process [5]	Definitions based on concept documentation
Not enough focus on results/findings of concept development activities [5]	Results include user perspective, functionality, and data/data interface issues
Time-intensive process to find and extract pertinent information from documents and reports [6]	Can be executed by researchers, checked by sponsor

Concept Maturity Assessment

- **Objective**
 - **How much** has been completed/not completed for each component
 - **In what context**
 - **With what results:** User feedback, Issues

- **Framework**
 - **High-level** criteria and standard responses
 - **Applied to a decomposition** of the concept representing both the operation and the capability
 - **Bullets for significant issues**
 - **Evidence** supporting each response

Notional Concept Element Assessment

Concept Element	1	2	3	4	5
Concept Documentation Completeness	Green	Green	Green	Green	Green
	Green	Green	Yellow	White	Green
	Green	Green	Green	Green	Green
	Green	Green	Yellow	Yellow	Green
Validation Methods	Green	Green	Green	Green	Green
	Green	Green	Yellow	Red	Green
	Green	Green	Yellow	Red	Green
	Green	Green	Yellow	Red	Green
ConOps Updates	Green	Green	Yellow	Red	Green
Issues	•		•	•	

Gaps: ■ ■ Significant Issues: ●

Notional Capability Assessment

Capabilities	1	2	3	4	5	6	7
Functionality Scope	Green	Green	Green	Green	Green	Red	Yellow
Validation Methods	Green	Green	White	Green	White	Red	Green
Operational Situations	Green	Green	Green	Green	Green	Red	Green
Integration	Green	Green	Green	Green	Green	Red	Green
Issues	Black dot	Black dot		Black dot		Red dot	Red dot

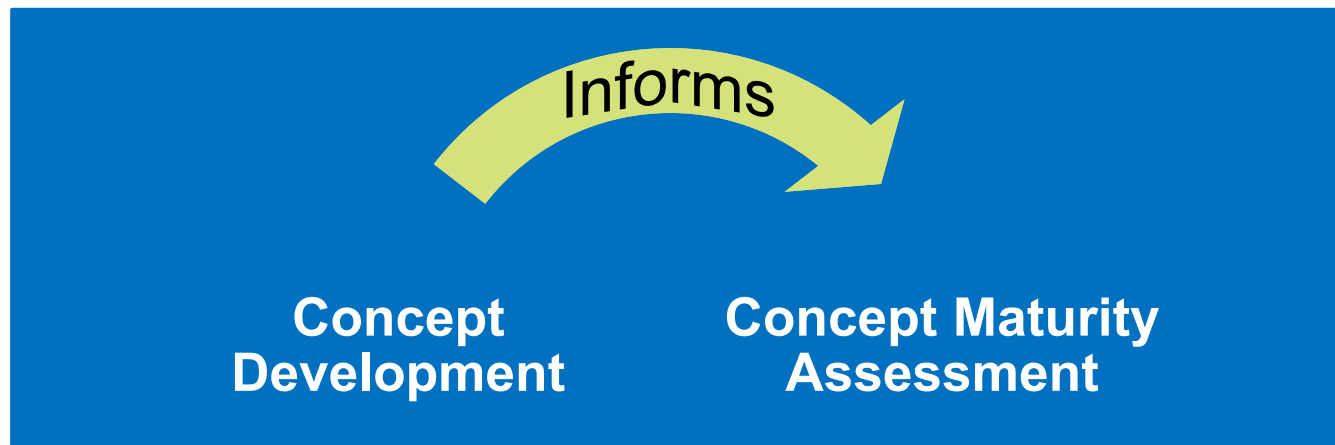
Gaps: ■ ■ Significant Issues: ●

Evolution of the CMF

**Extending the CMF throughout the
Concept Research, Development
and Engineering Process**

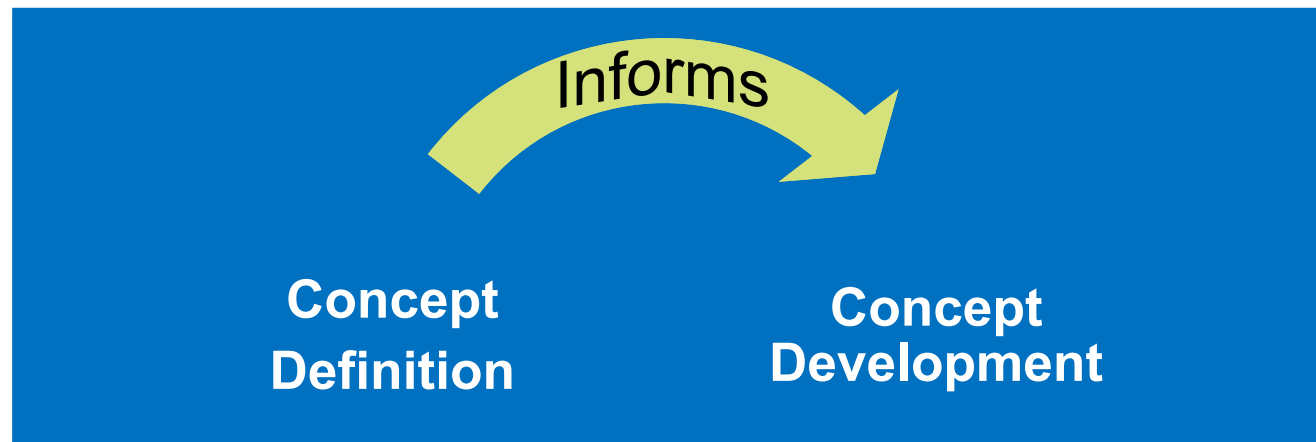
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Concept Development



- **Scope:** Full and Partial concept elements and capabilities
- **Fidelity**
 - **Operational:** simple, typical, complex situations
 - **Activity:** validation technique
 - **Integration:** none, internal, external, end-to-end
- **Results:** user feedback, outstanding issues

Concept Definition



- **Operational concept elements and capabilities:** Scope
- **Relevant operational environment:** Fidelity and technique
 - Operational characteristics
 - Operational connections
 - Technology connections
- **Scenarios** – simple, typical, complex: Fidelity

The Concept Maturity Framework

CONCEPT DEVELOPMENT PLAN

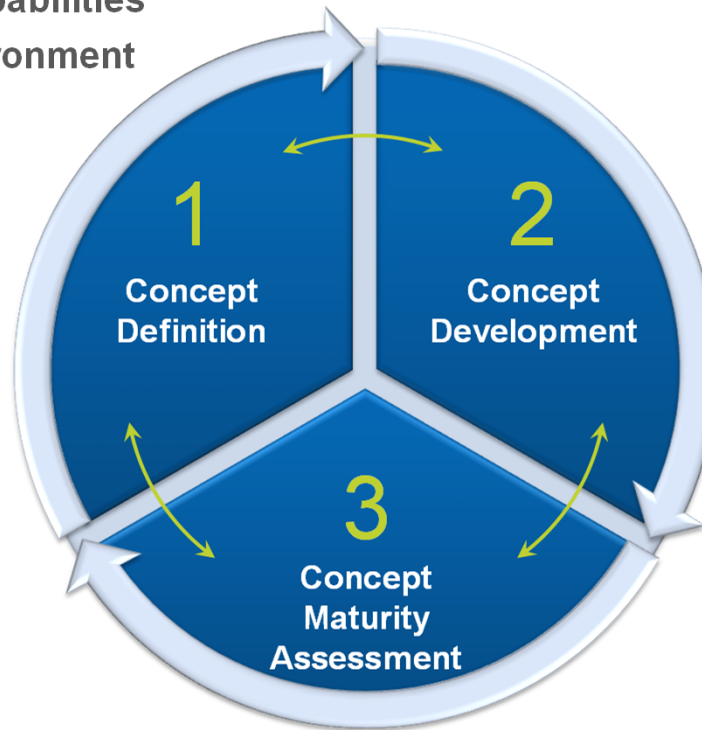
Defines the following:

- Concept elements and capabilities
- Relevant operational environment
- Operational and technical integration



Addresses the following:

- Scope of elements
- Fidelity of environment
- Characteristics of problem space
- Extent of integration



Capability Element	Capability Maturity Level
Operational Environment	1
Concept Elements and Capabilities	1
Operational and Technical Integration	1
Scope of Elements	1
Fidelity of Environment	1
Characteristics of Problem Space	1
Extent of Integration	1
Development Activity Plan	1
Development Activity Report	1

For Each Component: Evidence

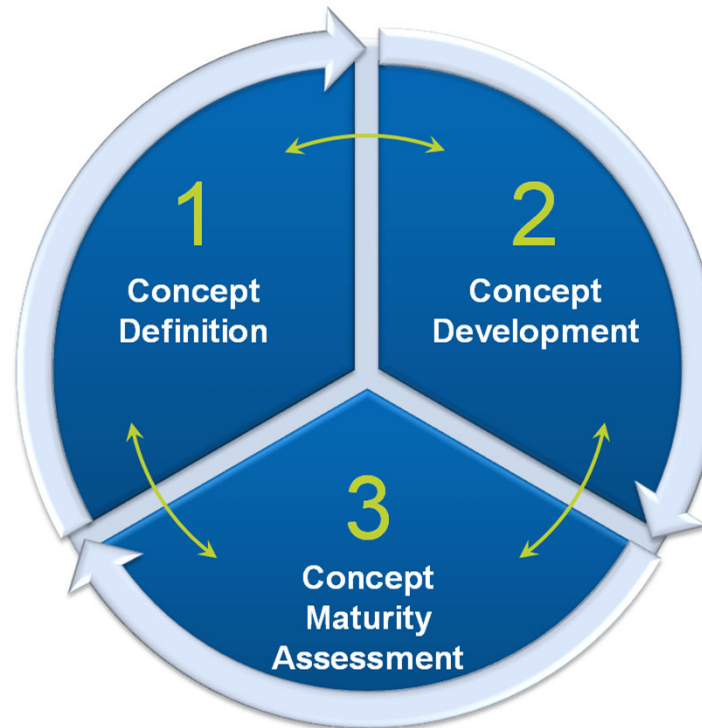
- How much has been completed?
- In what context?
- What issues were found (user, functionality, data)?
- Summarize maturity

Value of the CMF

- ✓ **Simple**
- ✓ **Easy to understand**
- ✓ **Easy to maintain and repeat**

CONCEPT DEVELOPMENT PLAN

- **Key artifact for stakeholder engagement, risk identification, consensus building**
- **Focus on the operation**
- **Concept in context**
- **Foundation for concept development activities**

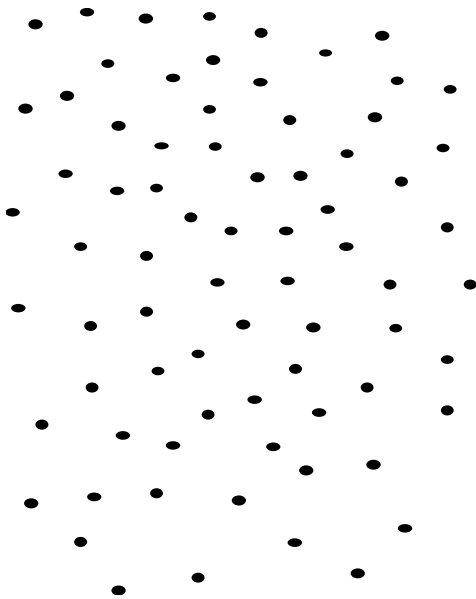


- **Focus on the concept, not the activity**
- **Information supports a maturity assessment and concept modifications**

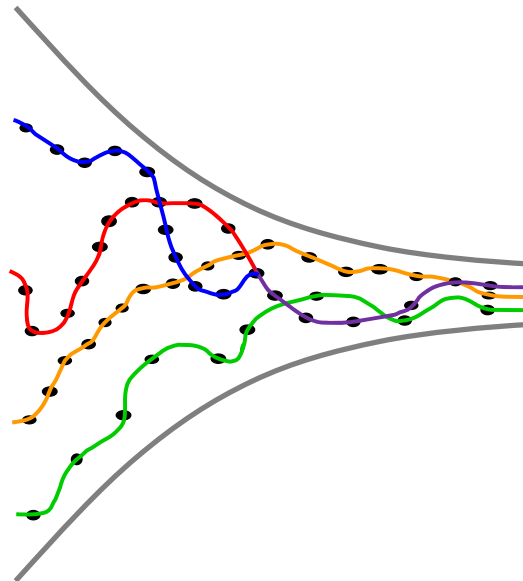
- **Evidence-based assessment**
- **Easy-to-understand information in a few tables**
- **Makes transparent and clear: what has and has not been done, what issues remain relative to concept components**

Bottom Line

From This...



To This...



Outcome

Better
Faster
Cheaper

How CMF Supports “The Right Things Done Right”

Concept Research, Engineering,
and Development

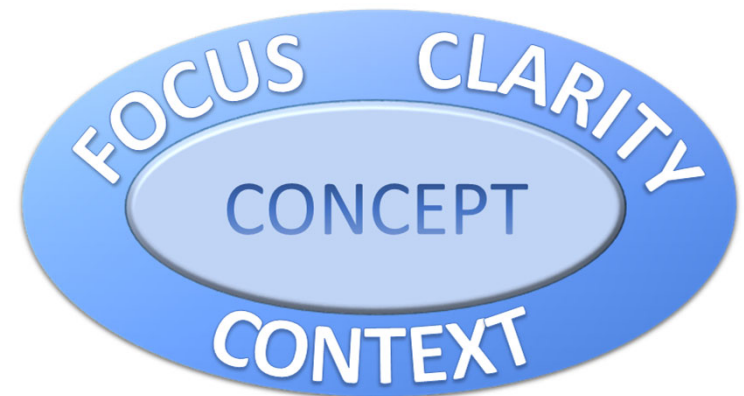
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CMF Maintains Focus on the “Right Things”

- **Decomposition**
 - Operational concept elements
 - Technology capabilities that support them

- **Scenarios starting with simple and typical, then layering on complexities**

- **Concept in context**
 - Assumptions
 - Connections
 - Integration



CMF Supports “Done Right”

CONCEPT DEVELOPMENT PLAN

- **Engaging with Operational Subject Matter Experts**
 - Confirmation of the problem
 - Evaluations during concept development
 - User feedback reporting
- **Planning and Execution**
 - Operational Context
 - Need-driven technique and activity fidelity
 - Outcome reporting
 - Informing and refining across the 3 CMF components
- **Decision-making**
 - Insight for prioritizing future activities to maximize ROI
 - Gaps, significant issues, integration
- **Traceability**
 - Concept research, engineering and development
 - Acquisition life cycle

Questions?

References

- 1. Assistant Secretary of Defense for Research and Engineering, (2016, August 22), "Technology Readiness Guidance," Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics, available <http://www.acq.osd.mil/chieftechologist/publications/docs/TRA2011.pdf>.**
- 2. Federal Aviation Administration, "Systems Engineering Manual," Version 1.1, FAA, Washington, DC, Sept. 2015.**
- 3. Federal Aviation Administration, "Concept Development and Validation Guidelines," FAA, Washington, DC, May 2011.**
- 4. Edward J. Copeland, "Technology Readiness Assessment Process, Introduction to the NAVAIR Process," presented to the Defense Acquisition University, April 2007.**
- 5. N. Azizian, S. Sarkani and T. Mazzuchi, "A Comprehensive Review and Analysis of Maturity Assessment Approaches for Improved Decision Support to Achieve Efficient Defense Acquisition," in *Proceedings of the World Conference on Engineering and Computer Science*, San Francisco, CA, 2009.**
- 6. C. Graettinger et al., "Using the Technology Readiness Levels Scale to," Support Technology Management in the DoD's ATD/STO Environments," Carnegie Mellon University Software Engineering Institute, Pittsburgh, PA, 2002.**

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