Breakout Session: MBSE and Education

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Session Overview

- Main Question:

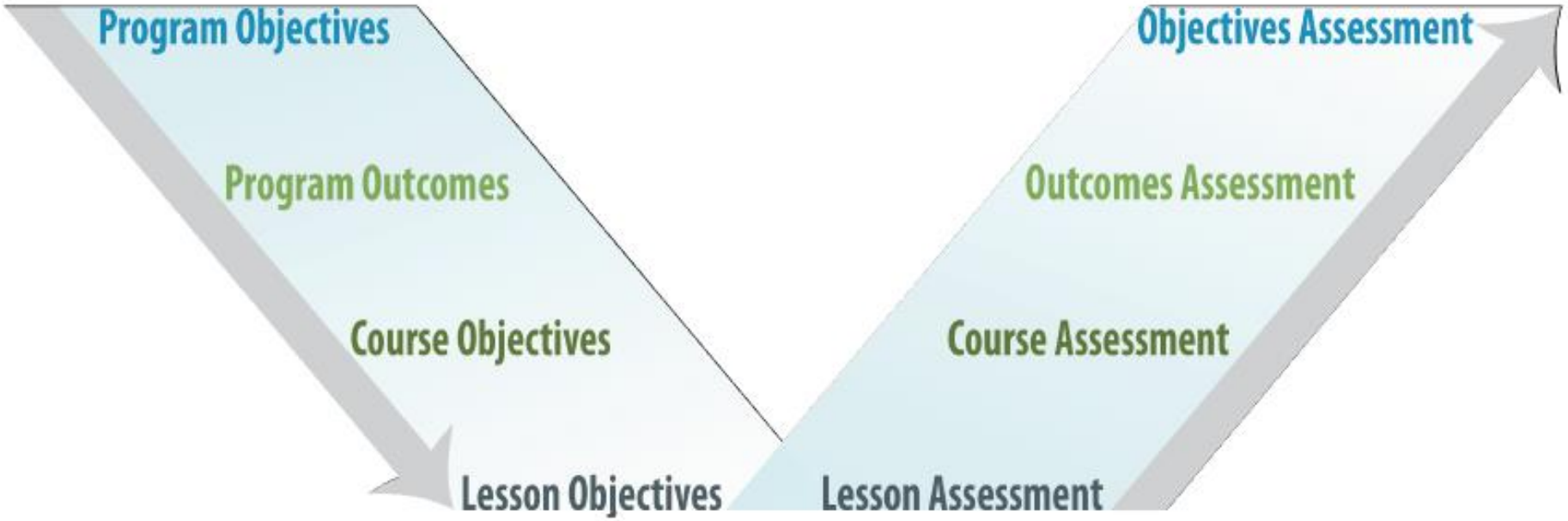
  How and to what extent should
  MBSE be included in SE curricula?

- Overview of GRCSE
- Discussion on MBSE in SE curricula
- 15 min before the end:
  Review and capture key points for outbrief

Graduate Reference Curriculum for SE

- http://www.bkcase.org/grcse/grcse-10/

Objectives and Outcomes



Objectives and Outcomes

- Objectives: *Program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation.*

- *Outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program.*

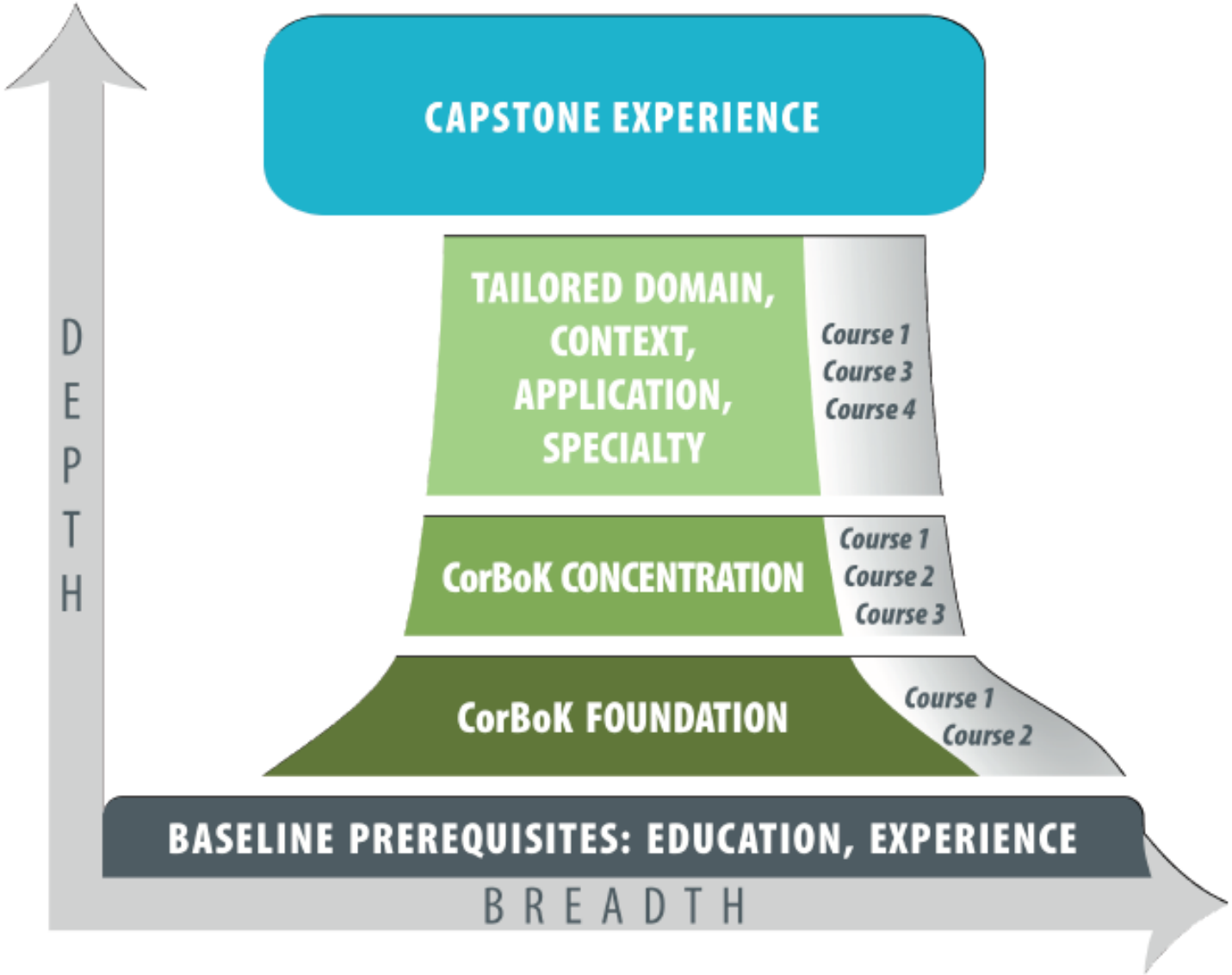
Generic SE Program Objectives (3-5 Years)

1. **SE Lifecycle:** Effectively analyze, design, or implement feasible, suitable, effective, supportable, affordable, and integrated system solutions to systems of products, services, enterprises, and system of systems, throughout the entire life cycle or a specified portion of the life cycle. This could be tailored by explicitly stating the types of systems that graduates develop and a given domain (e.g., aerospace).
2. **Multi-disciplinary:** Successfully assume a variety of roles in multi-disciplinary teams of diverse membership, including technical expert and leadership at various levels.
3. **Professionalism:** Demonstrate professionalism and grow professionally through continued learning and involvement in professional activities. Contribute to the growth of the profession. Contribute to society through ethical and responsible behavior.
4. **Communication:** Communicate (read, write, speak, listen, and illustrate) effectively in oral, written, and newly developing modes and media, especially with stakeholders and colleagues.

Outcomes — When a Student Graduates

- SE Concepts
  - Foundation
  - Concentration
  - Topic Depth
- SE Role
  - Application Domain
  - Specialty
  - Related Disciplines
  - Software in Systems
- SE Practice
  - Requirement Reconciliation
  - Problem/Solution Evaluation
  - Realism
- SE Professionalism
  - Professional Development
  - Teamwork
  - Ethics

Curriculum Architecture



CorBoK: Core Body of Knowledge

- Part of the SEBoK
  - Part 1: SEBoK Introduction
  - Part 2: Systems Topics
  - Part 3: SE and Management
  - Part 4: SE Applications
  - Part 5: Topics on Enabling SE
  - Part 6: Related Disciplines
  - Part 7: SE Implementation

CorBoK

- Concentrations
  - SE Management
  - Systems Design and Development

Part 2: System Topics

Knowledge Area	Part 2 Topic	Foundation	SEM	SDD
Systems Fundamentals	What is a System?	Comprehension		
	Types of Systems			
	Groupings of Systems			
	Complexity			
	Emergence			
Systems Science	History of Systems Science	Knowledge		
	Systems Approach			
Systems Thinking	What is Systems Thinking?	Knowledge		
	Concepts of Systems Thinking			
	Principles of Systems Thinking			
	Patterns of Systems Thinking			

Part 2: System Topics (cont'd)

Knowledge Area	Part 2 Topic	Foundation	SEM	SDD
Representing Systems with Models	What is a Model?	Knowledge		
	Why Model?			
	Types of Models			
	System Modeling Concepts			Application
	Modeling Standards			
Systems Approach Applied to Engineering	Overview of the Systems Approach	Knowledge*		
	Engineered System Context			
	Identifying & Understanding Problems & Opportunities			
	Synthesizing Possible Solutions			
	Analysis and Selection between Alternative Solutions			
	Implementing and Proving a Solution			
	Deploying, Using, and Sustaining Systems to Solve Problems			
	Stakeholder Responsibility			
	Applying the Systems Approach			

Part 3: SE and Management

Knowledge Area	Part 3 Topic	Foundation	SEM	SDD
Life Cycle Models	ife Cycle Characteristics	Application		
	System Life Cycle Process Drivers and Choices			
	System Life Cycle Process Models: Vee			
	System Life Cycle Process Models: Iterative			
	Integration of Process and Product Models			
	Lean Engineering			
Concept Definition	Mission Analysis	Application		Analysis
	Stakeholder Needs and Requirements			
System Definition	System Requirements	Application		Analysis
	Architectural Design: Logical			
	Architectural Design: Physical			
	System Analysis			
System Realization	System Implementation	Application		Analysis
	System Integration			
	System Verification			
	System Validation			

Part 3: SE and Management (cont'd)

Knowledge Area	Part 3 Topic	Foundation	SEM	SDD
System Deployment and Use	System Deployment	Comprehension		Application
	Operation of the System			
	System Maintenance			
	Logistics			
SE Management	Planning	Comprehension	Analysis	
	Assessment and Control			
	Risk Management			
	Measurement			
	Decision Management			
	Configuration Management			
	Information Management			
	Quality Management			
Product and Service Life Management	Service Life Extension	Comprehension	Analysis	Application
	Capability Updates, Upgrades, and Modernization			
	Disposal and Retirement			
SE Standards	Relevant Standards	Comprehension		
	Alignment and Comparison of the Standards			
	Application of SE Standards			

Part 4: SE Applications

Knowledge Area	Part 4 Topic	Foundation	SEM	SDD
Product SE	Product SE Background	Knowledge*		
	Product as a System Fundamentals			
	Business Activities Related to Product SE			
	Product SE Key Aspects			
	Product SE Special Activities			
Service SE	Service Systems Background	Knowledge*		
	Fundamentals of Services			
	Properties of Services			
	Scope of Service SE			
	Value of Service SE			
	Service SE Stages			
Enterprise Systems Engineering	Enterprise SE Background	Knowledge*		
	The Enterprise as a System			
	Related Business Activities			
	Enterprise SE Key Concepts			
	Enterprise SE Process Activities			
	Enterprise Capability Management			
Systems of Systems (SoS)	Architecting Approaches for Systems of Systems	Knowledge*		
	Socio-Technical Features of Systems of Systems			
	Capability Engineering			

Part 5: Enabling SE

Knowledge Area	Part 5 Topic	Foundation	SEM	SDD
Enabling Businesses and Enterprises	Systems Engineering Organizational Strategy	Knowledge	Comprehension	
	Determining Needed SE Capabilities in Business & Enterprises			
	Organizing Business and Enterprises to Perform SE			
	Assessing SE Performance of Business & Enterprises			
	Developing SE Capabilities within Businesses & Enterprises			
	Culture			
Enabling Teams	Team Capability	Application	Analysis	
	Team Dynamics			
Enabling Individuals	Roles and Competencies	Comprehension	Application	
	Assessing Individuals			
	Developing Individuals			
	Ethical Behavior			

Part 6: Related Disciplines

Knowledge Area	Part 6 Topic	Foundation	SEM	SDD
SE and Software Engineering (SwE)	The Nature of Software	Comprehension		Application
	An Overview of the SWEBOK Guide			
	Ten Things a Systems Engineer Needs to Know about Software Engineering			
	Ten Things a Systems Engineer Needs to Know about Managing a Software Team		Application	
SE and Project Management (PM)	The Nature of PM	Comprehension	Application	
	Overview of PMBOK® Guide			
	Relationships between SE & PM			
	The Influence of Project Structure and Governance on SE and PM Relationships			
SE and Industrial Engineering	SE and Industrial Engineering	Knowledge		
SE and Procurement/ Acquisition	SE and Procurement/Acquisition	Knowledge		

Part 6: Related Disciplines (cont'd)

Knowledge Area	Part 6 Topic	Foundation	SEM	SDD
SE and Specialty Engineering	Integration of Specialty Engineering	Comprehension	*	*
	Reliability, Availability, and Maintainability		*	*
	Human System Integration		*	*
	Safety Engineering		*	*
	Security Engineering		*	*
	System Assurance	Knowledge	*	*
	Electromagnetic Interference/Electromagnetic Compatibility		*	*
	Resilience Engineering		*	*
	Manufacturability and Producibility		*	*
	Affordability		*	*
	Environmental Engineering		*	*

Assessment

- Program
- Program objectives
- Program outcomes
- Course
- Student achievement relative to desired KSAs

Assessment Example

Program Outcomes	Course Outcomes	Bloom Level	Student Assessment Method
At the end of the program, students should be able to define and apply a Verification and Validation (V&V) strategy. (Bloom level 3)	Upon successfully completing the course, students describe and explain basic definitions and objectives of verification and validation processes	Knowledge	Multiple choice examination
	Upon successfully completing the course, students know the four basic means for supporting verification and validation processes: review, demonstration, analysis and test	Knowledge	Multiple choice examination
	Upon successfully completing the course, students are able to set up and apply a verification and validation plan, including: • the definition and justification of a V&V strategy • the identification of V&V activities life cycle • the specification of the environment • the definition of the organization	Application	Capstone (team) project, including: - Oral presentation - Product creation - Written reports
	Upon successfully completing the course, students possess in-depth knowledge in test techniques, including: • white-box and black box coverage • test tools and environment	Comprehension	- Problem-solving

Discussion Questions

1. What are the differences in the Knowledge, Skills and Abilities (KSAs) needed for MBSE vs. traditional SE?
2. What are specific KSAs desired for MBSE?
3. What is the relative importance that should be attributed to these Knowledge, Skills and Abilities in the curriculum?
4. How can these KSAs best be introduced in the curriculum?
5. How best to approach an “MBSE Course”?
6. How do we best assess MBSE proficiency?

Discussion Questions

7. Should MBSE become an integral, mandatory component of SE curricula?
8. Should MBSE be taught at the undergraduate level?