Curriculum for the Life Cycle of the Systems Engineer

Carlee A. Bishop, PhD and Tommer R. Ender, PhD

Georgia Tech Research Institute

400 10th St., N.W., Atlanta, GA 30332

Overview

- The Need and Development
- The Life Cycle of the Systems Engineer
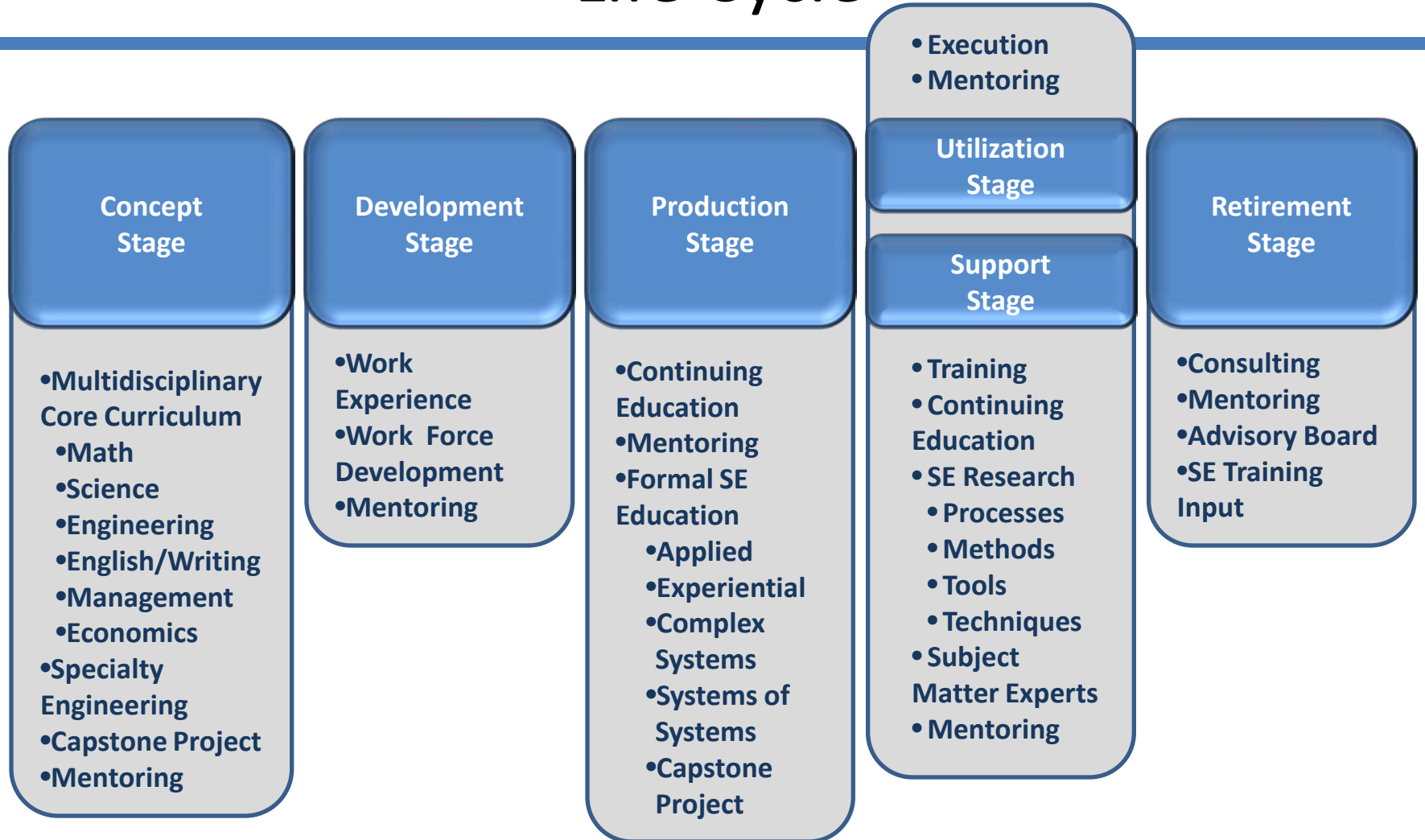- Georgia Tech's Contribution to the Life Cycle
- Mentoring

The Need

- *"The quantity and quality of systems engineering expertise is insufficient to meet the demands of the government and the defense industry"*

  (Top 5 Systems Engineering Issues - NDIA 2006)

- *"We have jobs going begging in systems engineering right now."* (Boeing)

  (ICPA Market Study - Georgia Tech 2005*)

- *"Every company is short of systems engineers. Really good systems engineers are worth their weight in gold."* (Raytheon)

  (ICPA Market Study - Georgia Tech 2005*)

  * >2400 respondents

The Development

- **Life Cycle Approach**
  - Systems engineering stresses a focus on the life cycle of a system
  - Training/educational programs must address the entire life cycle of the systems ENGINEER

- **Holistic Approach Proposed**
  - Purposeful development of the systems engineer from early undergraduate education through retirement
  - Employment of programmed activities at each stage of their career

The System Engineer Life Cycle

Concept Stage

Development Stage

Production Stage

- Execution
- Mentoring

Utilization Stage

Support Stage

Retirement Stage

- Multidisciplinary Core Curriculum
  - Math
  - Science
  - Engineering
  - English/Writing
  - Management
  - Economics
- Specialty Engineering
- Capstone Project
- Mentoring

- Work Experience
- Work Force Development
- Mentoring

- Continuing Education
- Mentoring
- Formal SE Education
  - Applied
  - Experiential
  - Complex Systems
  - Systems of Systems
- Capstone Project

- Training
- Continuing Education
- SE Research
  - Processes
  - Methods
  - Tools
  - Techniques
- Subject Matter Experts
- Mentoring

- Consulting
- Mentoring
- Advisory Board
- SE Training Input

The SE Education Initiative

- **Systems Engineering Research**
  - Processes, Methods, Tools, Techniques
- **Continuing Education**
  - Short courses, Certificates, Custom programs
- **Formal Systems Engineering Education**
  - Professional Masters in Applied Systems Engineering (PMASE)

Life Long Learning Opportunities

Concept Stage

Development Stage

Production Stage

Support Stage

Utilization Stage

Retirement Stage
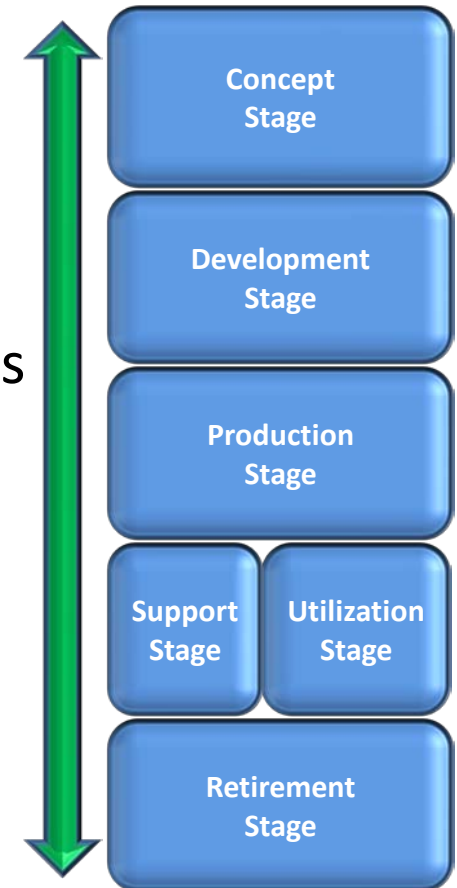
INCOSE Reference Curriculum (2007)

- Masters Project or Seminar
- Engineering Ethics & Legal Considerations
- Organizational Leadership
- Manufacturing, Production, & Operations
- Finance, Economics & Cost Est
- General Proj Mgt
- Software SE

- Decisions, Risks and Uncertainty
- Modeling, Simulation & Optimization
- Quality, Safety, & Systems Suitability
- System Integration & Test
- Systems Design & Analysis

- Intro to SE Mgt
- Fundamentals of SE

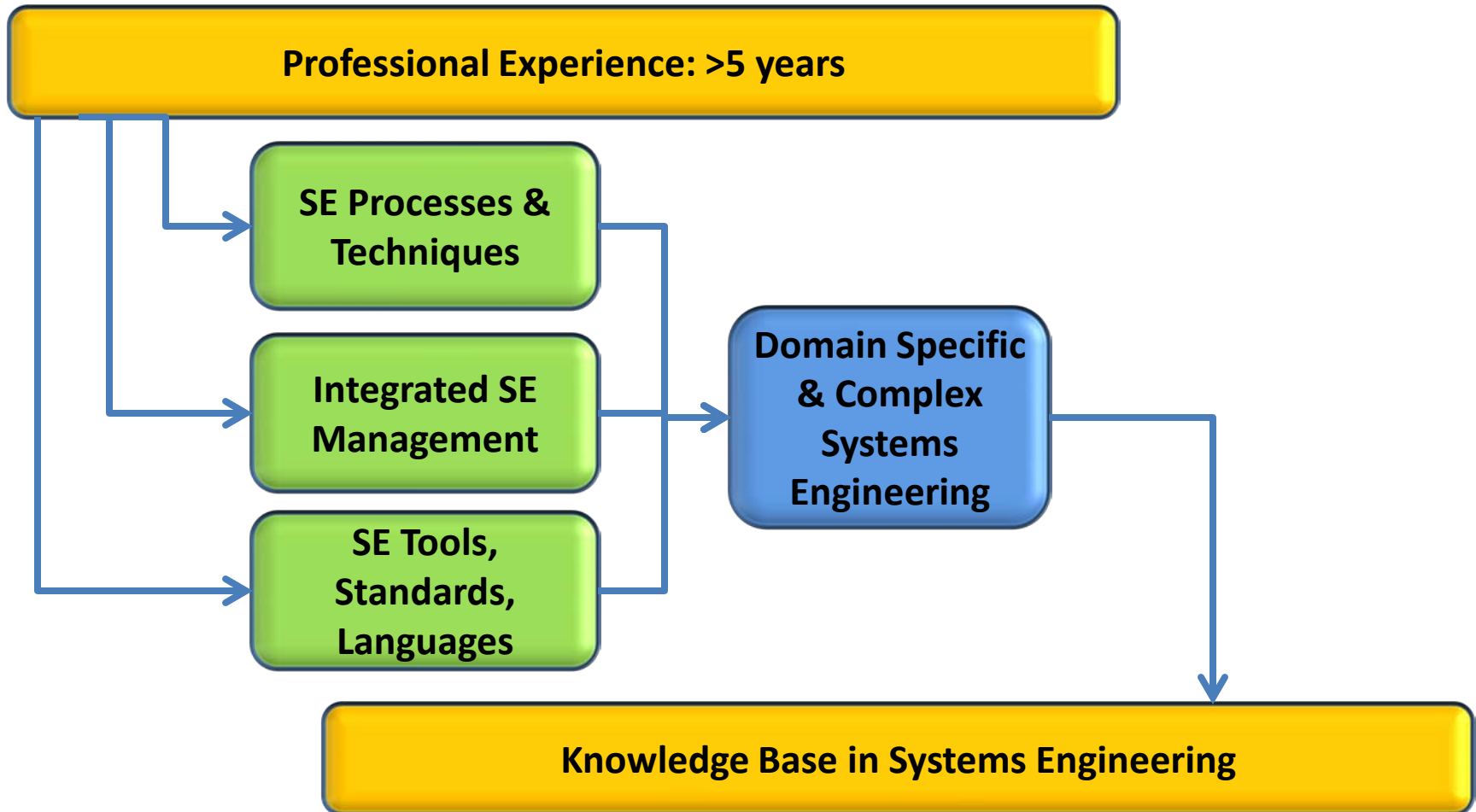- Probability & Statistics
- General Mathematics

Level 3: Specialization Courses (9 Credits)

Level 2: Core Courses (12 Credits)

Level 1: Introductory Courses (9 Credits)

Level 0: Foundational Courses

Stakeholder Inputs to Curriculum

- Industry Required Competencies*
  - Systems Thinking
  - Holistic Life Cycle View
  - SE Management

*From INCOSE Reference Curriculum 2007
**From GT ICPA Market Study 2005

- Curriculum Interest**
  - Workplace applications
  - Interdisciplinary approach
  - System of systems oriented
- Domain Applications
- Core Courses
  - Systems Engineering Principles
  - Technical Program Management
  - System Modeling, Design, and Optimization
- Strong interest in:
  - Supply chain mgt / Logistics
  - Software
  - Business mgt
  - Information Systems
  - Integrated Engineering Design

The PMASE Program

Professional Experience: >5 years

SE Processes & Techniques

Integrated SE Management

SE Tools, Standards, Languages

Domain Specific & Complex Systems Engineering

Knowledge Base in Systems Engineering

The PMASE Curriculum

Core Curriculum

ASE 6001: Fund in Modern SE

ASE 6002: Sys Design & Analysis

ASE 6003: M&S for SE

ASE 6004: Leading SE Teams

ASE 60X5: Advanced Topics in SE
- SysML
- HSI

ASE 6006: SE Lab

SE Processes & Techniques

Integrated SE Mgt

SE Tools, Standards, Languages

Domain Specific Engineering

Complex Systems

Complex Systems Curriculum

**ASE 61X1: Domain Elective in Synthesis & Analysis**
- Vehicles
- Sensors
- Info Systems
- HSI

ASE 6102: SOS & Architectures

ASE 6103: Lifecycle & Integration

ASE 6104: Complex Systems Capstone

Complex System
Capstone Project Development

- **Capstone course** in lieu of MS thesis

- Project developed through integration of **domain elective** courses

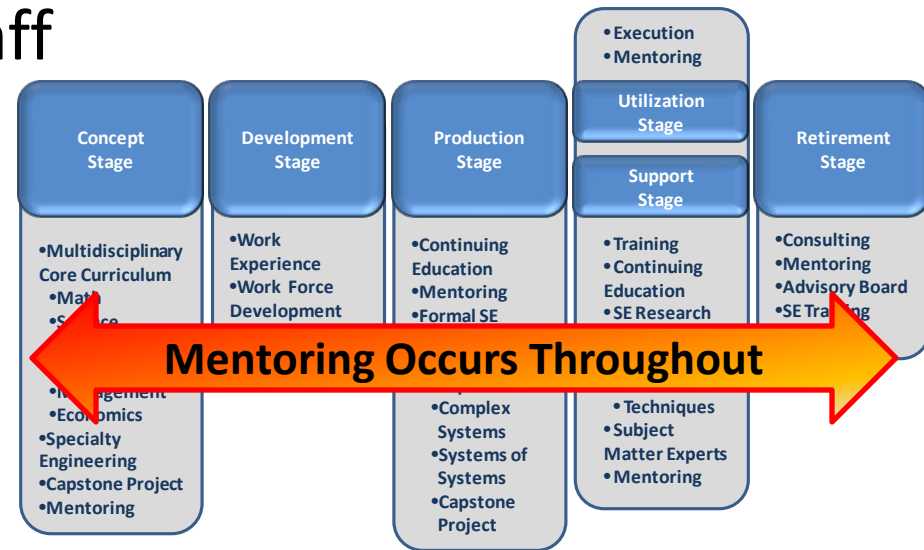- Complex system carried through the SE lifecycle process
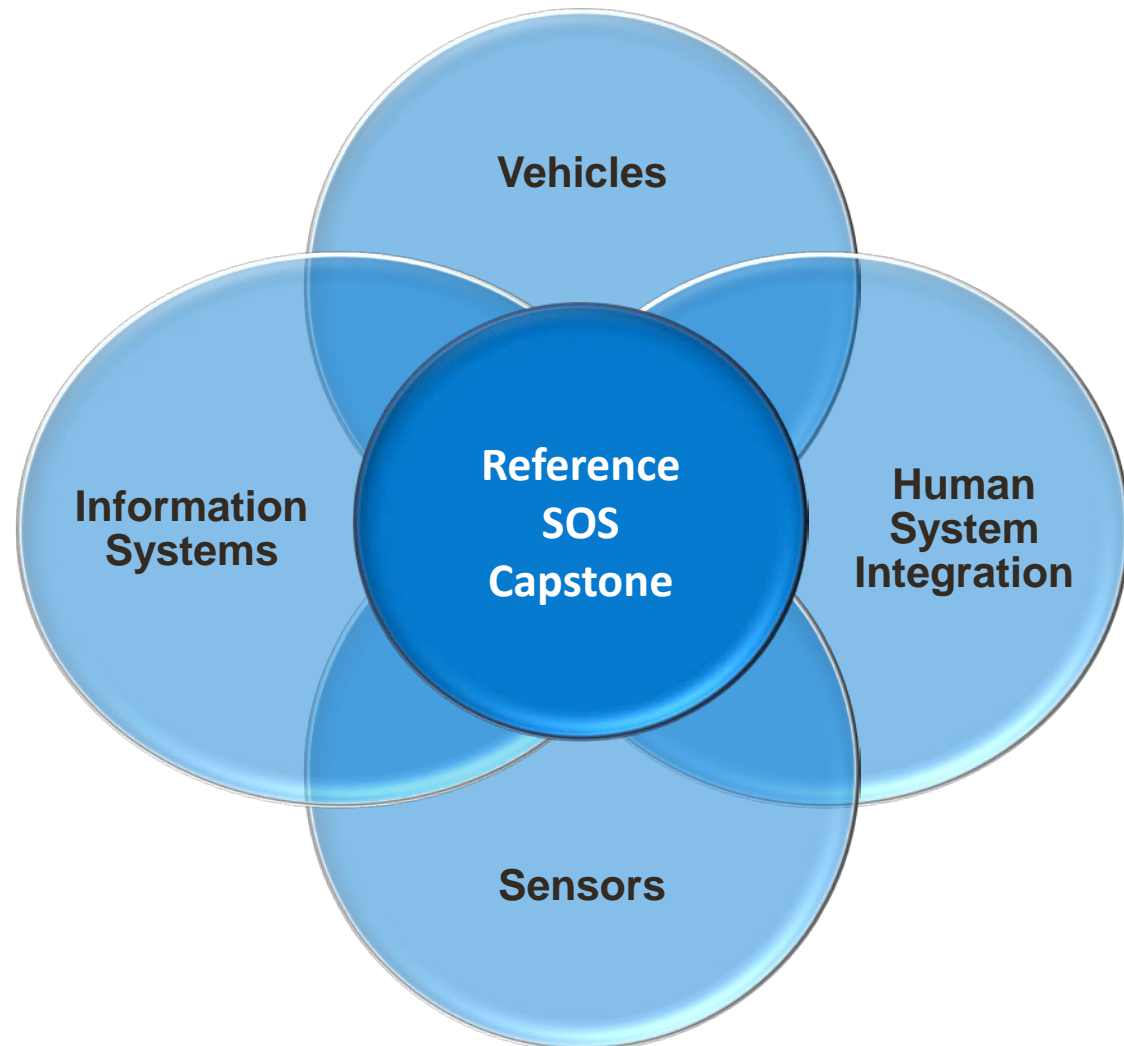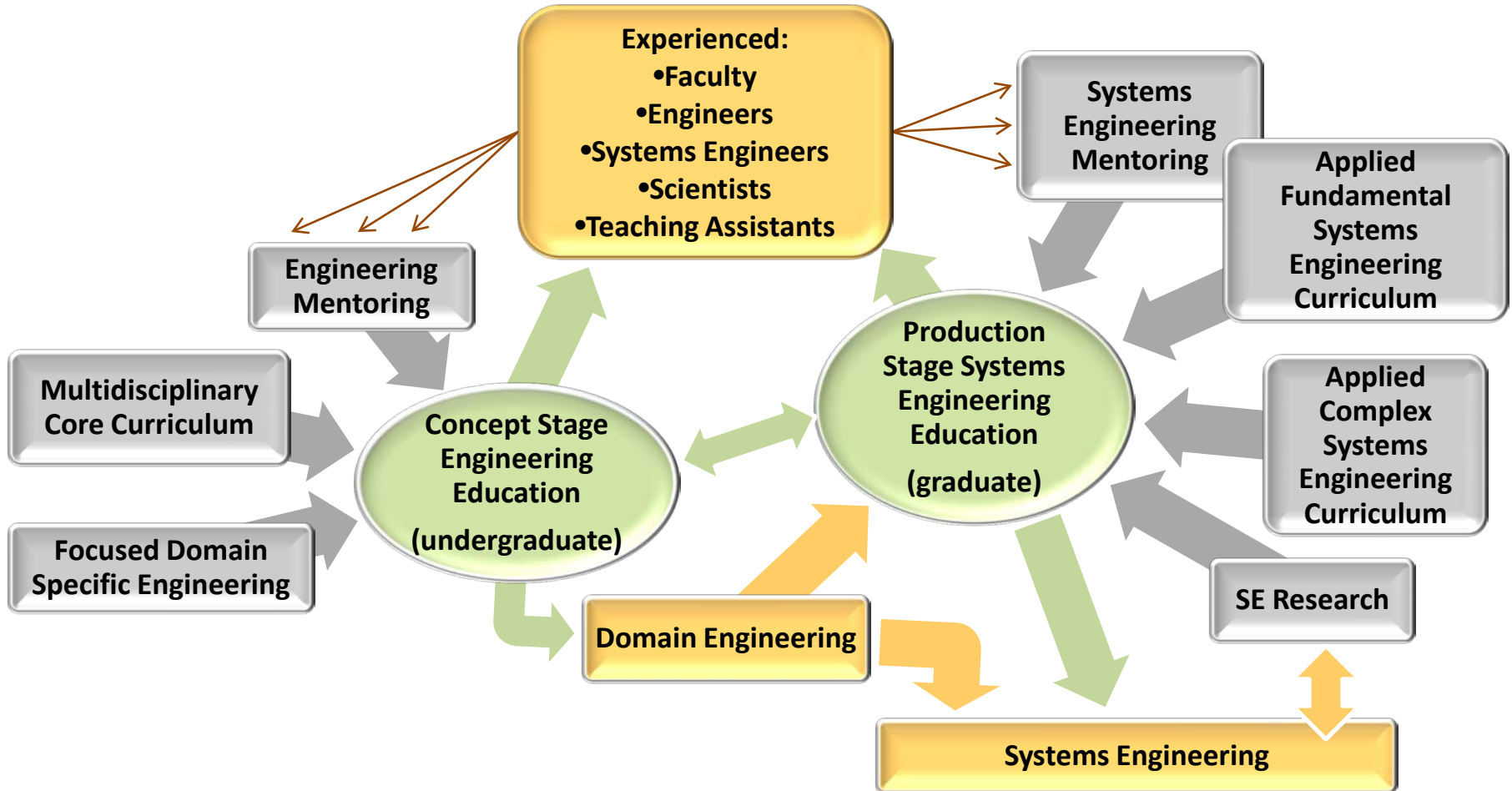
- **Formal Mentoring**
  - Instructors / Faculty / Staff
  - Industry Participants
  - Researchers
- **Informal Mentoring**
  - Teaching Assistants
  - Graduate Research Assistants
  - Students from previous classes
  - Students in current class

Interaction Between Life Cycle Stages

Conclusions and Wrap Up

- The development of an effective systems engineer is…
  - a multifaceted and multi-disciplinary process conducted throughout the entire career of the engineer.
  - accomplished by developing the engineer according a 'systems engineer' lifecycle.
  - developed through distinct stages which result in the completion of major milestones.

- The GT Systems Engineering Initiative addresses the entire life cycle of the Systems Engineer

Questions/Comments

Carlee A. Bishop, PhD

Georgia Tech Research Institute

400 10th St., N.W.

Atlanta, GA 30332-0840

carlee.bishop@gtri.gatech.edu

Tommer R. Ender, PhD

Georgia Tech Research Institute

400 10th St., N.W.

Atlanta, GA 30332-0840

tommer.ender@gtri.gatech.edu