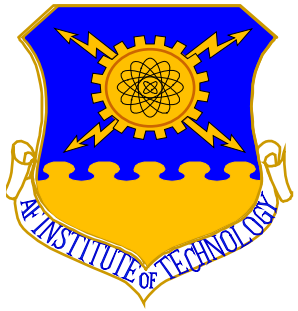

school of
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A Brief Study of Software Engineering Professional Continuing Education in DoD Acquisition

Maj Mark Reith, Ph.D.

Software Professional Development Program

Air Force Institute of Technology

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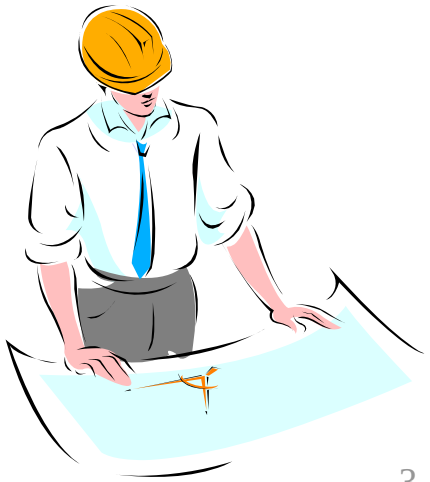
Overview

- AF Software Engineering Survey 2010
  - Current State of the Field
  - Perceived Challenges
  - Education Needs
- Software Professional Development Program (SPDP) 4.0

Software Engineering Survey

- **AF Software Engineering Survey 2010**
  - **Initiated by AFIT/LS, sponsored by AFMC/EN**
  - **39 Question, Web-based Delivery**
  - **Data Collection: 8 – 28 Mar 10**
- **Purpose:**
  - **What is the state of software engineering in the AF?**
  - **What can we do as educators to help? (Requirements Anyone?)**

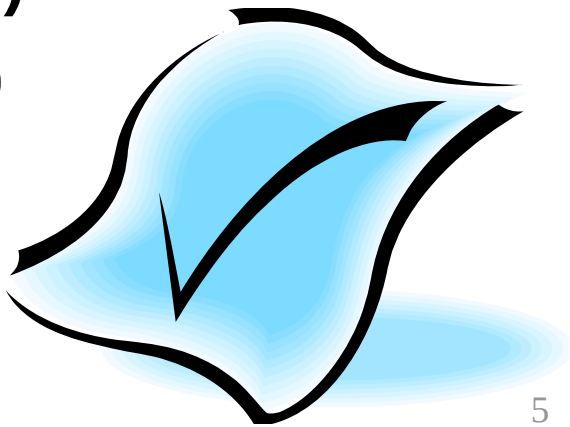


Background

- **Found:**
  - **Lists of software engineering challenges**
  - **AF policies and guidelines**
  - **Industry best practices and education**
- **Challenging to identify:**
  - **State of the software engineering field within AF**
  - **Characteristics of those practitioners**
  - **Cause of symptoms (challenges)**
  - **Effectiveness of current education system**

Survey Parameters

- Invited ~24K active duty & civilian employees to take a voluntary survey
- Invitees were limited to:
  - 6 AF Specialty Codes (AFSC's)
  - 13 Civilian Job Series Codes (CJSC's)
- Breadth of the survey was limited to:
  - Air Force Material Command (AFMC)
  - Air Force Space Command (AFSPC)



Software Career Fields?

Military

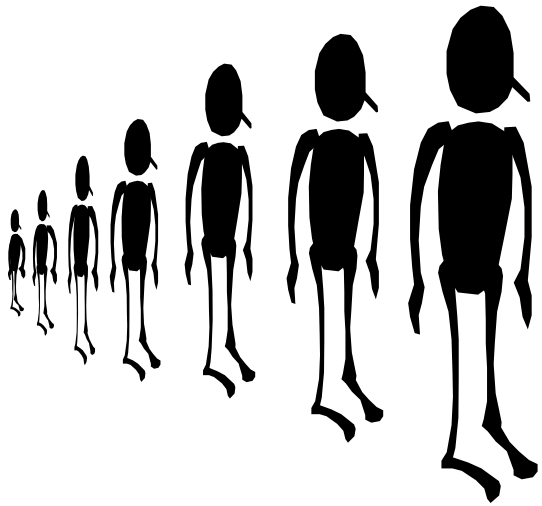
- 33S - Communications Officer
- 61S - Scientist
- 62E - Developmental Engineer
- 63A - Acquisition Manager
- 3D0X2 - Cyber System Ops
- 3D0X4 - Computer System Programming

Civilian

- 0334 - COMPUTER SPECIALIST
- 0340 - PROGRAM MANAGEMENT
- 0343 - MANAGEMENT & PROGRAM ANALYSIS
- 0346 – LOGISTICS MANAGEMENT
- 0801 – GENERAL ENGINEERING
- 0850 - ELECTRICAL ENGINEERING
- 0854 - COMPUTER ENGINEERING
- 0855 - ELECTRONICS ENGINEERING
- 0861 - AEROSPACE ENGINEERING
- 1101 - GENERAL BUSINESS & INDUSTRY
- 1515 - OPERATIONS RESEARCH
- 1550 - COMPUTER SCIENCE
- 2210 - INFORMATION TECHNOLOGY MANAGEMENT

Population Size

- Difficult to determine how many employees are involved in:
  - Software development
  - The management of software development
- Assumption: population size of software engineering practitioners is much smaller than invitee list
- Number of respondents: 858



Screening Criteria

- **Asked invitee to fill out survey under any of the following conditions:**

1. Have any experience developing software for the Air Force, or

2. Have any experience managing a project involving the development of software for the Air Force, or

3. Have any experience serving as a significant stakeholder in a project involving the development of software for the Air Force

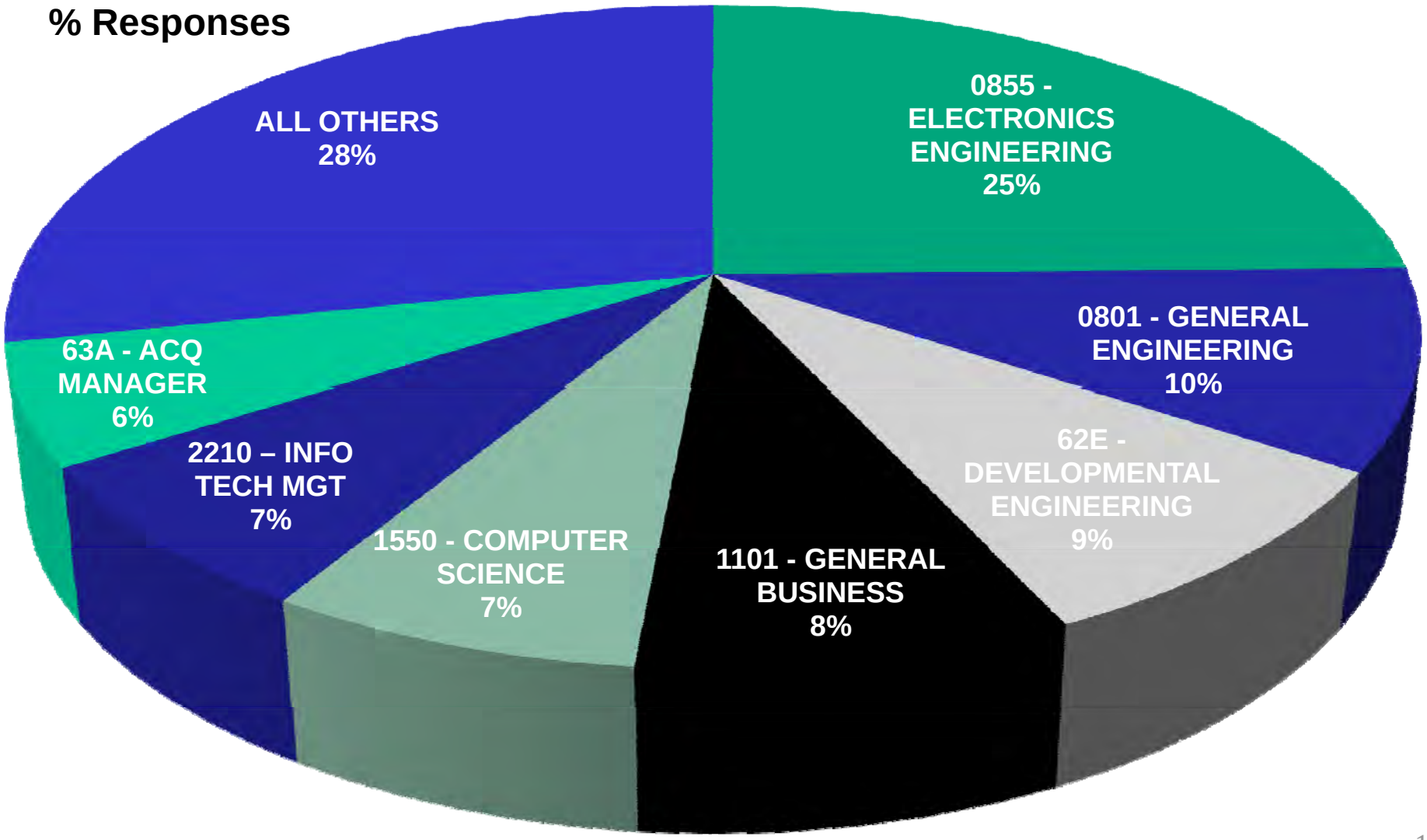
Sample Size by Career Field

Number of Respondents by Career Field

Career Field	#
0855 - ELECTRONICS ENGINEERING	212
0801 - GENERAL ENGINEERING	83
62E - DEVELOPMENTAL ENGINEER	75
1101 - GENERAL BUSINESS & INDUSTRY	72
1550 - COMPUTER SCIENCE	62
2210 - INFORMATION TECHNOLOGY MANAGEMENT	62
63A - ACQUISITION MANAGER	50
0346 - LOGISTICS MANAGEMENT	47
33S - COMMUNICATIONS OFFICER	39
0343 - MANAGEMENT & PROGRAM ANALYSIS	31

Career Field	#
0854 - COMPUTER ENGINEERING	29
0861 - AEROSPACE ENGINEERING	26
3D0X4 - COMPUTER SYSTEM PROGRAMMING	18
0850 - ELECTRICAL ENGINEERING	12
1515 - OPERATIONS RESEARCH	10
3D0X2 - CYBER SYSTEM OPS	10
OTHER	8
0340 - PROGRAM MANAGEMENT	7
61S - SCIENTIST	4
0334 - COMPUTER SPECIALIST	1

Sample Size by Career Field



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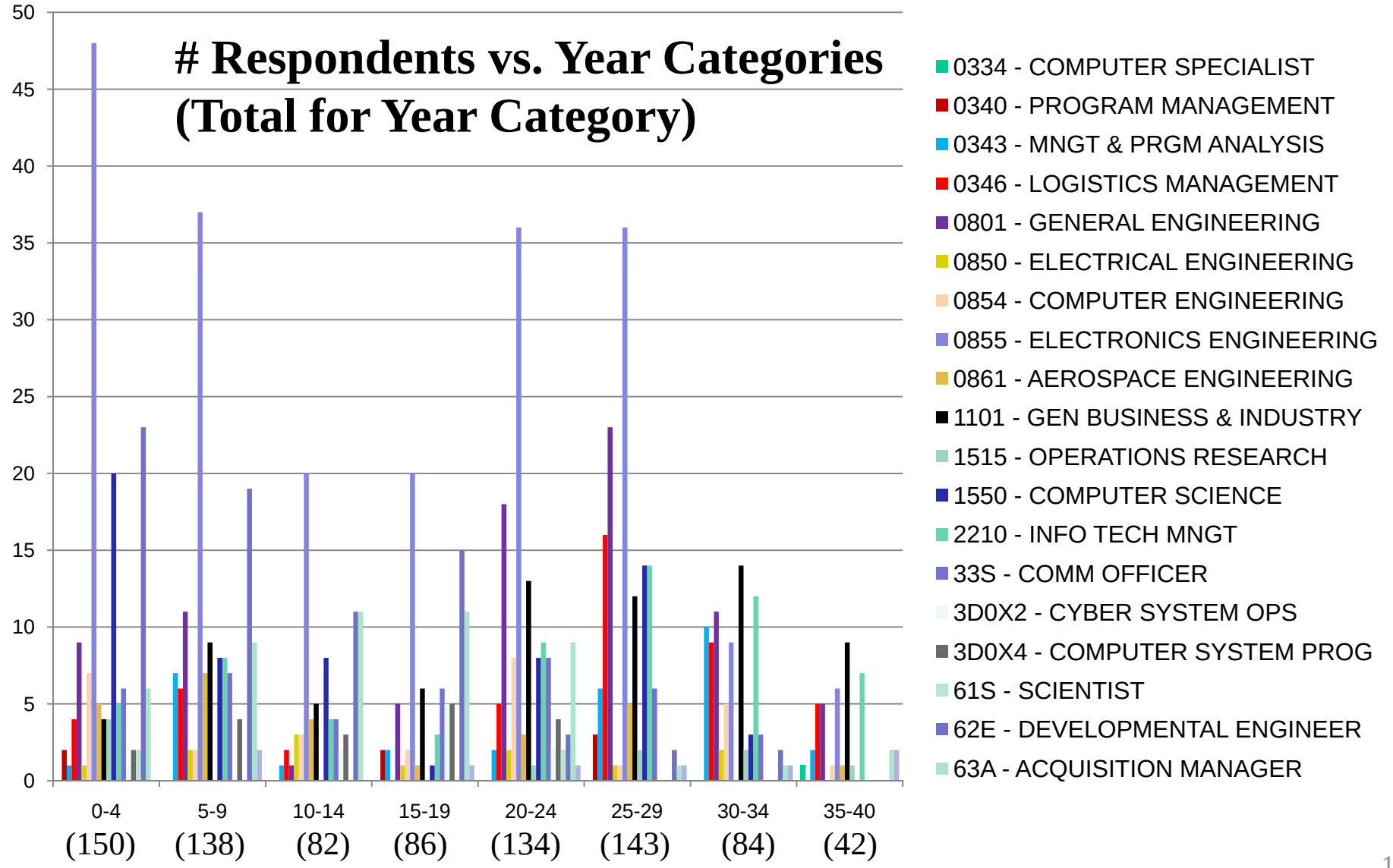
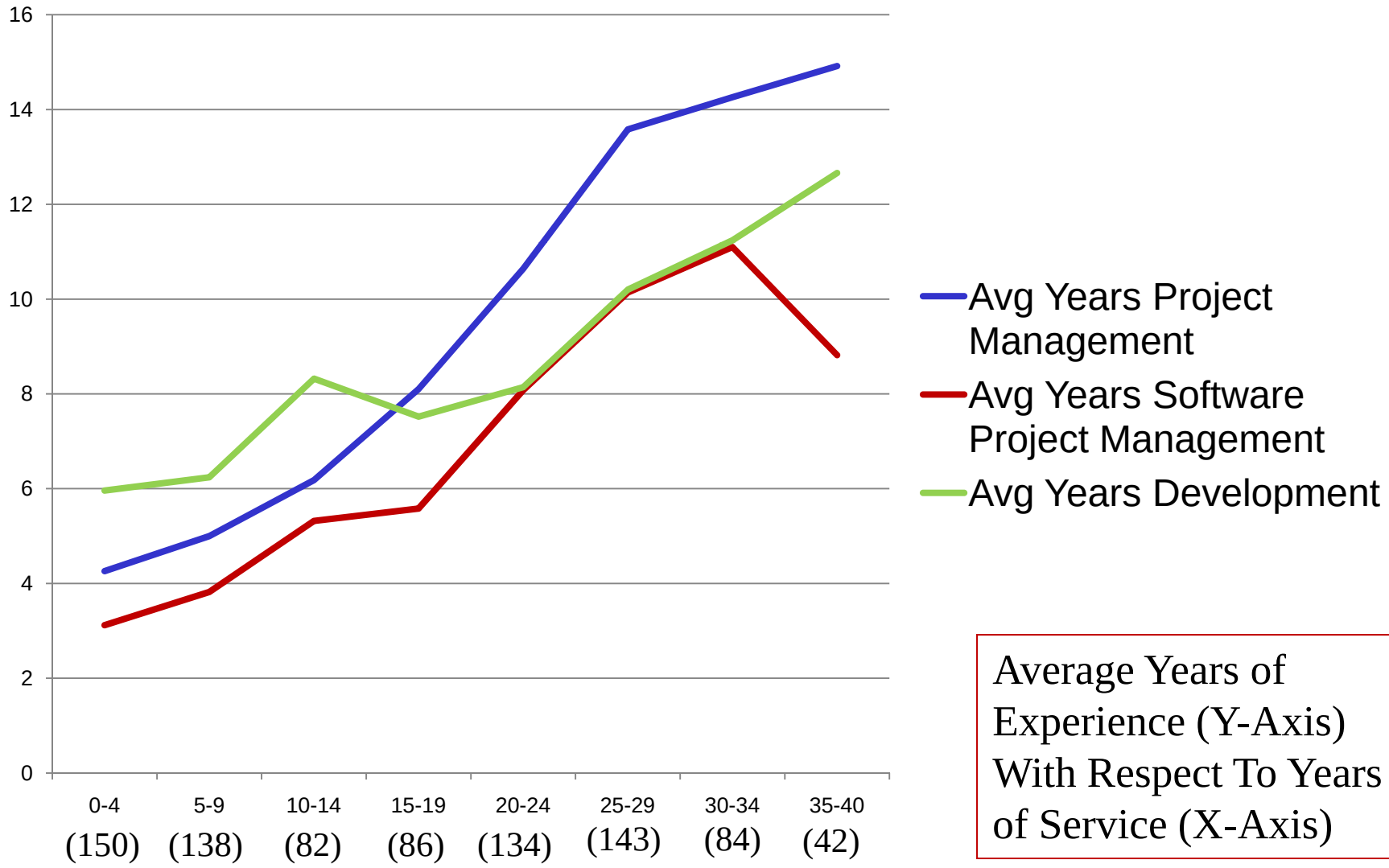


Major Survey Themes

- **Assess the Current State of:**
  - **Experience**
  - **Education & Certifications**
  - **Software Development/Acquisition Challenges**
- **Identify Education Needs:**
  - **Who needs it?**
  - **What do they need?**

Years Experience



Average Years of Experience (Y-Axis) With Respect To Years of Service (X-Axis)

Experience

Career Field	# Resp	% Mgt Exp	% Mgt Qual	% Dev Exp	% Dev Qual
0855 - ELECTRONICS ENGINEERING	212	59%	67%	80%	71%
0801 - GENERAL ENGINEERING	83	70%	70%	53%	35%
62E - DEVELOPMENTAL ENGINEER	75	56%	55%	47%	31%
1101 - GENERAL BUSINESS AND INDUSTRY	72	78%	83%	43%	28%
1550 - COMPUTER SCIENCE	62	66%	79%	90%	81%
2210 - INFORMATION TECHNOLOGY MANAGEMENT	62	68%	79%	82%	68%
63A - ACQUISITION MANAGER	50	76%	68%	24%	18%

Percentage of Respondents Indicating a Mid-to-High Level of Experience or Qualification

Compares:

1. Management to Development Experience/Qualification Level
2. Experience to Qualification Level

Distinct # Software Projects

Served As Program Manager

Career Field	# Resp	Mean	Std Dev
0340 - PROGRAM MANAGEMENT	7	8.1	6.4
0854 - COMPUTER ENGINEERING	29	7.4	10.4
1101 - GENERAL BUSINESS AND INDUSTRY	72	5.5	6.3
1550 - COMPUTER SCIENCE	62	4.7	6.8
0343 - MANAGEMENT & PROGRAM ANALYSIS	31	4.2	6.3
Across All Sampled Career Fields	858	3.6	5.6

Served As Developer/ Engineer

Career Field	# Resp	Mean	Std Dev
0854 - COMPUTER ENGINEERING	29	11.5	12.9
1550 - COMPUTER SCIENCE	62	9.6	12.8
0850 - ELECTRICAL ENGINEERING	12	7.3	8.6
2210 - INFO TECH MANAGEMENT	62	7.1	10.6
3D0X4 - COMPUTER SYSTEM PROGRAMMING	18	6.1	8.9
Across All Sampled Career Fields	858	4.4	7.4

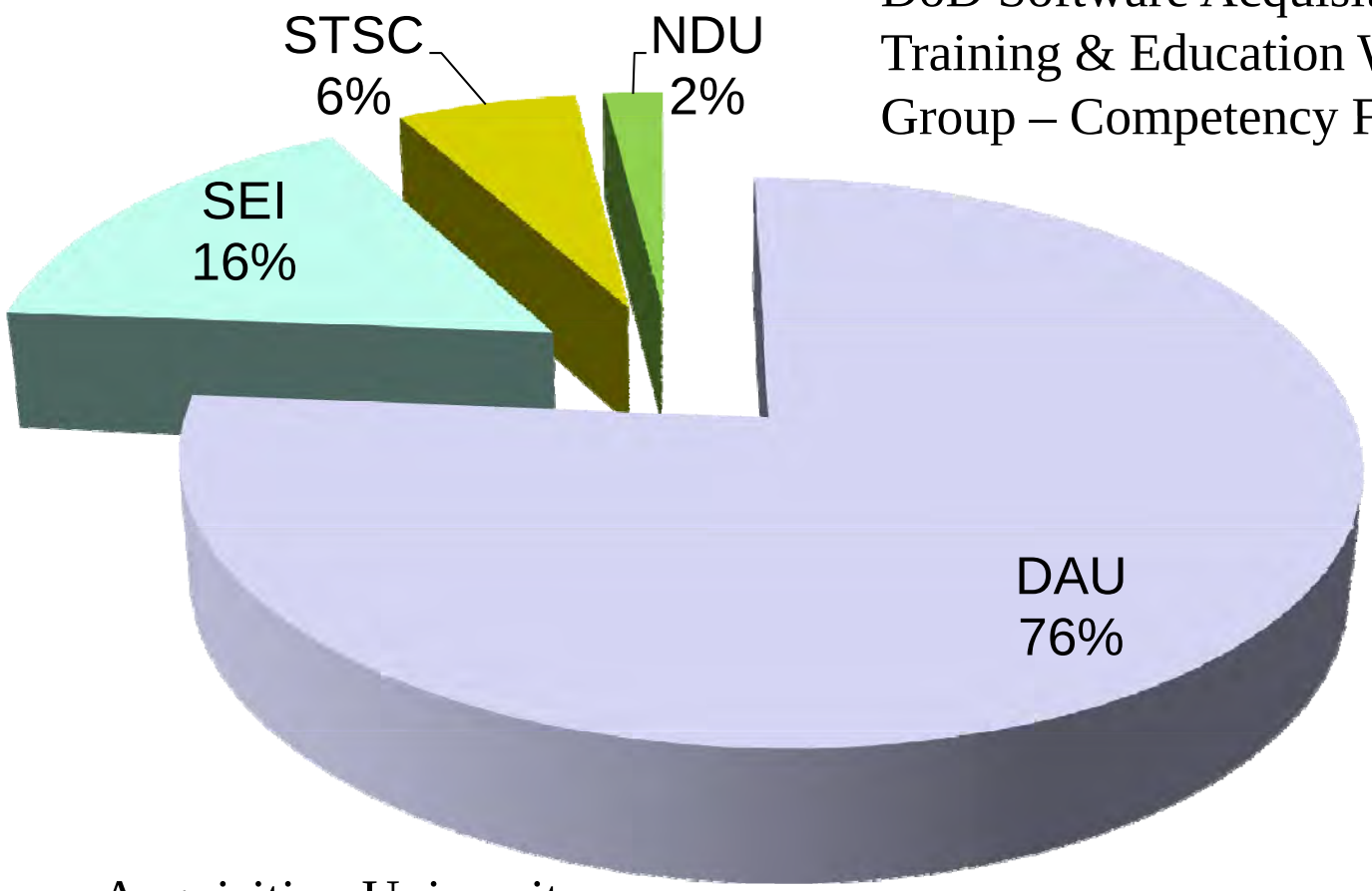
Level Experience Per Phase

Level	Requirements	Arch/Design	Construction	Testing	Sustainment
None	5%	10%	14%	5%	9%
Slightly	15%	24%	23%	14%	17%
Moderately	30%	30%	26%	30%	26%
Experienced	35%	26%	27%	34%	31%
Extremely	15%	10%	10%	17%	18%
Total Responses	853	849	847	852	851

Percentage of Sample Size at Various Experience Levels Per Software Lifecycle Phase

Education Sources

DoD Software Acquisition Training & Education Working Group – Competency Framework



DAU – Defense Acquisition University
SEI – Software Engineering Institute
STSC – Software Technology Support Center
NDU – National Defense University

SPDP Education

Taken SPDP Courses	Not Taken SPDP Courses	Didn't Answer
116 (14%)	724 (84%)	19 (2%)

Yourself	# Indicated
Lack of time	205
Inappropriate curriculum for current project	89
Lack of interest	40
Not previously aware	34
Little perceived value	34
Courses not available on my schedule	34
Courses on desired topics not offered	26
Distance learning not appropriate for me	16

Supervisor	# Indicated
Other priorities for your time	313
Inappropriate curriculum for current project	221
Not aware of SPDP	71
Little perceived value	52
Fully supports	32

External Certification

Certification	# Certified (All Career Fields)
Project Management Professional (PMP)	38
IEEE Certified Software Development Professional (CSDP)	6
IEEE Certified Software Development Associate (CSDA)	4
Engineering License w/ Software Engineering Specialization	10
ASQ Certified Software Quality Engineer	4
INCOSE Certified Systems Engineering Professional	5

At Best, Only 67 (7.8%) of Respondents Indicate Having External Certifications

Organizational Attributes

Organizational Attribute (# Respondents)	Not Exhibited / Poorly	Satisfactorily / Exemplary
Establishing accurate performance, cost, and schedule baselines (821)	63%	37%
Understanding policy and guidance for software acquisition and development (810)	38%	62%
Identifying the appropriate composition of team members (814)	37%	63%
Establishing and adhering to a defined architecture (814)	37%	63%
Adequately addressing system integrity/security (811)	35%	65%
Project leadership has appropriate understanding of how software impacts overall program (811)	39%	61%

Organizational Attributes

Organizational Attribute (# Respondents)	Not Exhibited / Poorly	Satisfactorily / Exemplary
Choosing appropriate software lifecycle model (811)	39%	61%
Choosing appropriate software methodology (808)	32%	68%
Choosing appropriate implementation language (810)	31%	69%
Educating stakeholders as to their role in software acquisition/development (811)	60%	40%
Capturing lessons learned (811)	56%	44%
Disseminate lessons learned to external organizations (810)	74%	26%

Observations

- **"#1 Reason" why AF software projects fail to meet cost, schedule, or performance (741 "free responses")**
- **Simple Word Search**
  - **Requirements: 490**
  - **Management: 132**
  - **User: 49**
  - **Experience/expertise: 45**
  - **Design: 39**
  - **Integration: 24**
  - **Architect: 11**

Observations (cont.)

- **Requirements: change, creep, underfunded, under-analyzed, poor quality, inaccurate**
- **Management: unrealistic expectations, poor quality, unclear direction, failing to listen to engineers, lack of understanding software complexity, inappropriately handled of issues, wrong focus, lack of oversight, micromanagement, lack of technical background, over-promises**
- **User: not involved, indecisive, unrealistic expectations, doesn't understand own requirements**

Education

- How education may address the aforementioned challenges… (679 responses)
- Simple Word Search
  - Management/Managers/Leadership: 217
  - Engineer: 91
  - Experience: 54
  - Class: 32
  - Practice: 26
  - Learn: 32
  - Example: 17

Education (cont.)

- **Management/Managers/Leadership: education on software project management, technical concepts, software estimation, expectation management, team composition**
- **Engineers: education on requirements gathering/analysis, interpersonal skills, software "engineering" rather than programming education, testing**
- **Practice/Learn/Example/Experience: best practices, lessons learned, examples**

Most Desired Topics

Response	Personally	σ	Boss	σ	Coworker	σ
Team Management	205	-1	401	2	159	-1
Testing	261	1	126	-1	315	2
Stakeholder Expectation	205	-1	334	2	171	-1
Architecture/Design	358	2	170	-1	360	2
Requirements Engineering	401	3	331	2	419	3

σ = standard deviation

Respondents Were Asked to Choose Up to 5 Topics

Policy - Guidance - Resources

AF Specific (# Respondents)	Unaware	Know/Apply It	N/A
USAF Weapon Systems Software Management Guidebook (813)	59%	36%	5%
Guidelines for Successful Acquisition and Management of Software-Intensive Systems (GSAM) (807)	68%	29%	2%
AFI 63-1201 Life Cycle Systems Engineering, Attachment 8 Software Engineering (804)	39%	59%	1%
AFI 63-101 Acquisition & Sustainment Life Cycle Management, Section 3.84 Software Engineering (797)	36%	63%	2%
Space & Missile System Center Software Acquisition Handbook (800)	72%	22%	6%
AF System Engineering Assessment Model (AFSEAM) (804)	50%	48%	2%

Policy - Guidance - Resources

Industry / Academia (# Respondents)	Unaware	Know/Apply It	N/A
Software Lifecycle Processes (IEEE 12207) (810)	37%	61%	2%
Guide to the Software Engineering Body of Knowledge (SWEBOK) (804)	67%	31%	2%
Software Engineering-Software Measurement Process (ISO/IEC 15939) (797)	55%	44%	2%
Capability Maturity Model Integration (806)	17%	81%	2%
Six Sigma Process Improvement (804)	7%	91%	1%
ISO 9000 Quality Management Systems (803)	10%	89%	1%

Conclusions

- Significant problem areas
  - Requirements
  - Management
- Very little sharing among software development organizations
- Practitioners are sensitive to time for PCE
- Unaware of resources out there
  - Missing the AF-specific piece on policy & best practices
  - Very little external certification

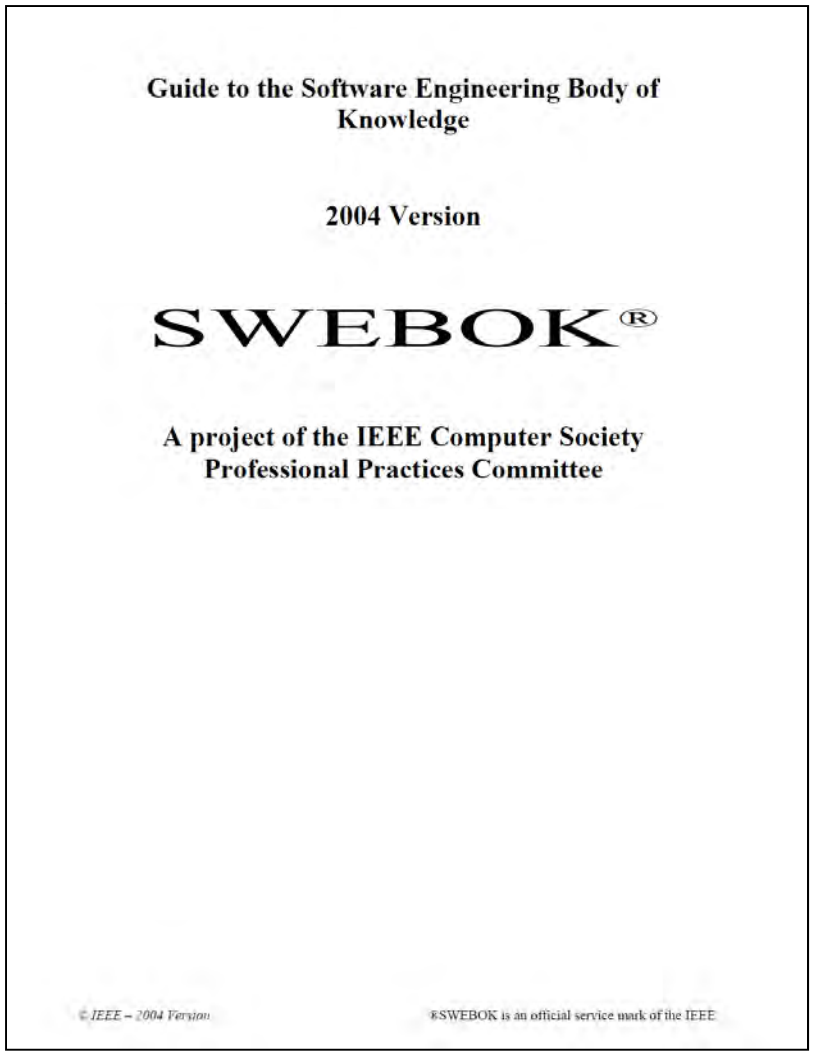
SPDP 4.0

- Partition management and engineering concerns across 2 tracks
- Shorter courses over distance learning
  - 4 weeks → 3 weeks w/ 18-24 hrs of coursework per course
  - 2-8 hour courses for special topics
- Industry Standards → AF Implementation of Industry Standards; Best Practices

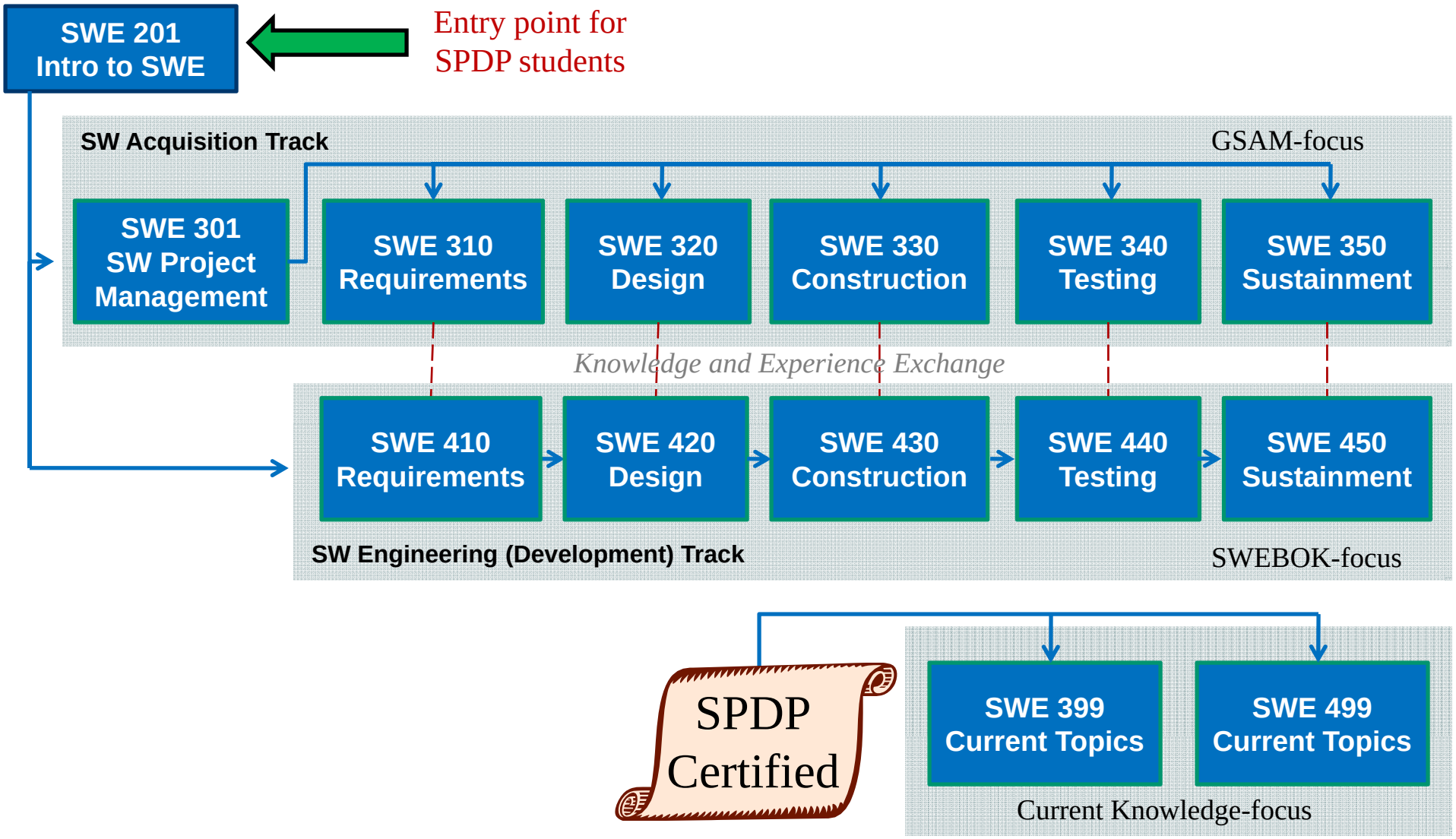
SPDP 4.0 (cont.)

- New learning objectives
  - Knowledge-focused → Assessment-focused
- Working towards AF qualification for software engineering personnel
  - AF Software Project Manager Certificate
  - AF Software Engineer Certificate

Backbone Guidance



Program Overview



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- Mr. Dominick Tuccillo, AFMC/EN
- Mr. Ernesto Gonzalez, SAF/AQRE

Summary

- **AF Software Engineering Survey 2010**
- **SPDP 4.0**

For more information:

mark.reith@afit.edu
SPDP@afit.edu

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