"Industry" Professional Certifications
(Systems Engineering, Engineering Management, and T&E)

Can (should) they be pursued as surrogates for DAWIA Certification in the DoD Contractor Workforce?

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Researcher Biography

Bryan "Chum" Herdlick, Ph.D.

- *Johns Hopkins University / Applied Physics Laboratory*
  - *Principal Professional Staff, Systems Engineer, and Project Manager*
  - *20 years as a Naval Flight Officer*
    - *F-14 Tomcat Radar Intercept Officer (RIO)*
    - *Test Pilot School → Developmental Test aircrew for F-14A/B/D and F/A-18E/F*
    - *OPNAV T&E Oversight Project Officer (N091 / N912 → now N84)*
    - *AIM-9X Sidewinder Missile Product Manager for PMA-259 at NAVAIR*

- *Professional Certifications:*
  - *INCOSE Certified Systems Engineering Professional (CSEP-Acq.)*
  - *ASEM Professional Engineering Manager (PEM)*
  - *ITEA Certified T&E Professional (CTEP)*
  - *(Previously DAWIA certified Level III in T&E and PM; Level II in SPRDE S&T)*

Researcher Motivation & Bias

- As a member of the U.S. Department of Defense (DoD) acquisition workforce, I found that there was a reasonably clear and stable framework for mapping my professional education, qualifications and career progression.
  - Defense Acquisition Workforce Improvement Act (DAWIA) established certifications in relevant acquisition career fields.
  - Defense Acquisition University (DAU) and discipline-specific "school houses" offered tailored training.
  - Critical Acquisition Billets (positions) required certification within 18 months of assuming responsibilities.

- When I left military service, I found that some prospective employers had no workforce improvement or qualification structure that paralleled the DoD DAWIA framework. So, I attempted to assemble a surrogate framework from the corporate / industry sector.
  - I found that many professional organizations in relevant career fields offer certification programs, but it was difficult to critically compare them to the DAWIA / DAU construct.
  - I pursued the certifications I now hold under the assumption that they were useful surrogates for the DAWIA certifications I held on active duty.
  - As I achieved the certifications, I began to question the degree to which my assumption was valid. I asked myself questions such as…

Loss of DAWIA certification on retirement from the military led me to seek equivalent credentials in the civilian sector.

Questions addressed by this research

- "Are industry credentials a one-for-one replacement for the DAWIA certifications I previously held?"

- "Do these industry credentials offer an employee or an organization some reasonable return-on-investment?"

- "Would I recommend that others pursue these certifications?"

- "Would I recommend that organizations offering contract support to DoD consider incorporating industry certifications as a part of workforce development strategies?"

Answers to those questions:
No, Yes, Yes and Yes

Recommendations:

- *Encourage employees to favorably consider industry certifications*
  - Benefits:
    - Demonstrate competency in relevant disciplines
    - Establish common workforce lexicon in relevant disciplines
    - Establish a minimum requirement for workforce understanding of best practices in relevant disciplines

- *Leverage professional development requirements for these credentials as a preferred framework for workforce training development*
  - Identify DAU courses and modules as preferred / required training
  - Consider common professional development activities as annual objectives

- *Incorporate a list of combined "Competency Categories" into activity reports and documentation of employee contributions and achievement.*
  - Establish a common vision and lexicon for "what you do" as a company / branch / division / group
  - Position employees well to construct application packages for certifications and/or recertification

Scope & Depth

- This research *was intended to...*
  - Highlight differences across the certifications
  - Offer insights relative to a DAWIA benchmark
  - Establish potential returns-on-investment
  - Generate discussion

- This research *was not intended as...*
  - An *exhaustive* review of course content or bodies-of-knowledge associated with the certifications considered
  - A comprehensive review of *all* available certifications in a career field or discipline

Industry Certifications
A prospective surrogate for DAWIA certification?   Why?

- DAWIA certifications are not available to contractors*, but industry certifications can offer…
    - …a means of establishing professional credibility akin to that required of government employees filling DoD critical acquisition billets (e.g., DAWIA certification)
        - If DoD cares enough to certify its workforce, then perhaps supporting contractors and their organizations should consider the merits of supporting and/or requiring certification in relevant career fields
    - …annual objectives that are…
        - "tangible" (i.e., measurable / documented),
        - recognized by relevant industry sectors and organizations,
        - a common metric for distinguishing employee dedication to professional achievement in one or more disciplines associated with their work
    - …a framework that can guide future professional development, training and achievement
        - Recertification necessitates accumulation of Professional Development Units

* DAWIA certification is only available / applicable to U.S. government civilians and active-duty military personnel

Why should YOU (the employee) care?
Formal certification processes meets employee "needs"

- McClelland's motivational categories
  - *Those who need to achieve*
  - *Those who need to affiliate*

- Maslow's Hierarchy
  - *Self Actualization*
  - *Public Esteem / Self Esteem*
  - *Membership*

- Herzberg's Motivators
  - *Recognition*
  - *Achievement*
  - *Advancement*
  - *Possibility of Growth*

Formal certification processes can offer a framework of achievement and recognition, addressing the motivational needs of the professional workforce.

Why should the organization care?
What is the prospective return on investment?

- **Strategic:** *Improved Corporate Image / Enhanced Credibility*
  - Demonstrate dedication to workforce competency at an organizational level, beyond formal education and on-the-job training / experience.
    - Align with DoD methods / practice / vision
    - Distinguish employees within professional organizations that influence industry

- **Tactical:** *Efficiency and Consistency in Workforce Management*
  - Establish a common baseline for workforce training
  - Establish a common framework for assessing achievement
    - Mastery of baseline body-of knowledge and terms of reference
    - Accumulation of relevant experience

- **Operational:** *Professional Growth of Technical Staff*
  - Offer guidance and manage assignments to position employees for broad experience, responsibility and certification at earliest opportunities

- **Functional:** *Improved Effectiveness of Teams and Tasks*
  - Establish a common foundation for communication and collaboration across the technical workforce
  - Establish a common understanding of "best practices" to preclude deviations that increase technical and programmatic risk

Organization of this Brief
Presentation Flow

- Research
  - Identify previous comparisons between certifications
  - Identify relevant workforce certifications in career fields such as…
    - Systems Engineering
    - Test & Evaluation
    - Management (Project / Program / Science & Technology)

- Certification Solution Space
  - DoD as benchmark
    - Defense Acquisition Workforce Improvement Act (DAWIA)
  - Industry Options
    - Offered through recognized professional organizations in each career field

- Comparative Analysis
  - Industry Options vs. "The DAWIA Benchmark"

- Findings & Recommendations

Literature Review
Have industry certifications been compared before?

▸ Project Management Certifications Compared
  ◦ Paul D. Giammalvo (2012-2013) – see notes for URL / web-links

▸ Take-aways:
  ◦ *Gladwell's 10,000 hour competency threshold (time applied in study and gaining experience)*
    • *~ 16K hours: "Professional Engineer" (PE) license*
      • Add 3K hours for non-ABET undergrad
    • **~15K hours:** *INCOSE ESEP, CSEP and ASEM PEM*
    • < 10K hours *(i.e., do not reflect "competency" per Gladwell)*
      • INCOSE ASEP (entry level certification)
      • PMI sponsored certifications (including PMP)

Based on this study, CSEP compares favorably with the PE credential, and the PEM certification from ASEM is superior to a PMP from PMI

Depth: Single reference / Not peer-reviewed / CTEP and DAWIA not reflected. Further research & analysis is prudent...

Department of Defense Certifications
Research Methodology: Internet Based

- Developed, managed and recognized by our customer

- Awarded based on satisfaction of *experience* and *education* in clearly identified *competency areas*.

- Relevant Career Fields
  ◦ Systems Engineering
  ◦ Test & Evaluation
  ◦ Management
    • Science & Technology / Program

- *Sources*
  ◦ *Defense Acquisition University (www.dau.mil)*
  ◦ *USD AT&L Workforce Competency Studies of 2011*

DAWIA Certifications
The DoD precedent…(remember: the customer is always right)

- DoD emphasis on baseline competency is demonstrated in their certification program for civilian and military employees in the Acquisition Workforce
  - PROBLEM: DoD acquisition workforce undertrained and inexperienced
    - 1986 – Packard Commission:
  - SOLUTION: Establish DoD acquisition as a profession with career fields and certification criteria
    - Defense Acquisition Workforce Improvement Act (1990 – 10 U.S.C. 1701)
    - *Career-field certification required for critical acquisition billets within 18-months of assuming position*
    - *3 certification levels based on relevant experience and completion of requisite academics*
      - *Level I = Entry-Level (1 year or less, depending on career field)*
      - *Level II = 2 years (min)*
      - *Level III = 4 years (min)*
    - *Defense Acquisition University (DAU) established to manage training*
      - Courses: On-line and face-to-face
      - Additional Training: Continuous Learning modules (on-line / self-paced)
      - Embedded exams and role-playing / problem-solving workshops

The National Contract Management Association has developed their certification extension for DoD on DAU materials & DAWIA requirements, and ITEA is responding to a DoD challenge to achieve similar alignment with DAWIA / DAU certification criteria.

Industry Certifications
Research Methodology: Internet Based

▸ Sponsored by *professional organizations* in career fields similar to those identified by DAWIA
- Systems Engineering (INCOSE)
- Test & Evaluation (ITEA)
- Engineering Management (ASEM)

▸ Applicable Industry Certifications
- Selected based on…
  - "Replacement value" for the aforementioned DAWIA certifications
  - Role(s) of contractors on DoD programs, projects and analysis efforts
- *Finding: Information is inconsistent across the candidates*
  - *Not all have well-documented competencies*
  - *Not all have a useful body-of-knowledge guidebook*
- Details and source information on subsequent slides…

Industry Certification Options
What's available outside DoD that is relevant…?

▸ Certified Systems Engineering Professional (CSEP)
  ◦ *3 levels*: ASEP, CSEP and ESEP
  ◦ International Council on Systems Engineering (INCOSE)
    • *www.incose.org*

▸ Professional Engineering Manager (PEM)
  ◦ *2 levels*: AEM and PEM
  ◦ American Society of Engineering Management (ASEM)
    • *www.asem.org*

▸ Certified T&E Professional (CTEP)
  ◦ *1 level*
  ◦ International Test & Evaluation Association (ITEA)
    • *www.itea.org*

Industry Certification Options
Continued...

- Project Management Professional (PMP)
  - 3 Levels
    - Associate in Project Management (APM)
    - Project Management Professional (PMP)
    - Program Management Professional (PgMP)
  - Program Management Institute (PMI)
    - *www.pmi.org*

PMI
Project Management Institute

Scope: Due to the preferred, engineering focus of the ASEM PEM certification and the findings of previous research, certifications from PMI were not considered as candidates for comparison.

Industry Certification Options
Continued...

▸ The "Professional Engineer" credential
  ◦ *Often referred to as "the gold standard"*
  ◦ FE & PE exams concentrate on application of basic engineering concepts and equations across a broad spectrum of engineering topics (FE) or problem solving skills and tools in a specific discipline (PE)
  ◦ Granted by the state
  ◦ Managed / administered by NCEES *(www.ncees.org)*
    · National Council of Examiners for Engineering and Surveying

While a PE credential may be regarded as more "prestigious", the other industry certifications may offer an alternative that is more broadly accessible to the workforce.

Of the available PE credentials, "Industrial Engineering" was found to be the discipline most closely aligned with the topic areas and competencies considered for this investigation.

Analysis Methodology
Compare & Contrast: DAWIA vs. Industry Certs.

- Comparison of Certification Portfolios
  - Critical knowledge
    - Documented "*Body of Knowledge*" → CSEP, PEM
    - Course Learning Objectives → DAWIA
    - Exam Topic Categories → CTEP, PE (Industrial)

  - Experience
    - Time in a relevant position / role / activity (?)
      - Documented substantiation by supervisor / other (?)
    - Identified by activities in specified "*Competency Categories*"
      - Tailored to certification → DAWIA, CSEP
      - Referenced in BoK → PEM
      - List of "Applicable Activities" → CTEP, PE

  - Continuous Learning & Participation (Career Field / Community)
    - Recertification Criteria: Professional Development Activities

Analysis Methodology
Compare & Contrast

Core Competencies   **Body of Knowledge**   **Professional Development**

Scope: This investigation focused on the Body-of-Knowledge, Competencies, Experience and Professional Development requirements associated with each certification.

Findings
Education, Experience and Examinations

	DAWIA Level 3	CSEP	PEM	CTEP	PE
Education (minimum)	BS (except PM)	BS (Technical)	BS	BS	BS
Experience (years)	4 years	5 yrs Refs: 3	5 yrs (BS) 3 yrs (MS) Refs: none	3 yrs (BS) 5 yrs (AS) 10 yrs Refs: 2	8 (BS) 4 (ABET BS) 3 (ABET MS) Ref = "Sponsor"
Exam(s)	In-class	120 Q's 2 hours (-Acq. 60 / 1)	200 Q's 4 hours	200 Q's 4 hours	FE + PE PE (12 yrs) No (20 yrs)
Cost to applicant	None	$300 app. (mbr) $80 exam ($100 recert)	$250 app/exam ($50 recert)	$200 (mbr) ($150 recert)	$275 exam $50 app (recert ??)

DoD and Industry are comparable in requisite experience & education
Requisite knowledge is verified through examinations
Experience substantiated through supervisors during application

Findings
Core Competencies

- **Combined DAWIA & Industry Total: 65**
  - DAWIA Portfolio covers 77% of combined total
  - Industry Portfolio covers 75% of combined total

- **Industry fails to cover 15 competencies identified by DAWIA**
  - INCOSE CSEP covers 60% of DAWIA SE / ENG competencies
  - ASEM PEM covers 67% of DAWIA STM competencies
  - ITEA CTEP covers 60% of DAWIA T&E competencies

- **DAWIA fails to cover 13 competencies identified by industry**

DoD and Industry offer comparable emphasis and coverage of desired workforce competency areas…

Findings
Coverage of Composite Body-of-Knowledge

- Against the combined DAWIA / Industry body-of-knowledge, which contains 155 topic areas…

  - **DAWIA Portfolio (PM, STM, SE, T&E) achieves…**
    - *92% coverage of combined DoD / Industry topics*
    - 90% coverage when DoD Acquisition-Specific topics are removed

  - **Industry Portfolio (CSEP + PEM + CTEP) achieves…**
    - *68% of combined DoD / Industry topics*
    - 71% of topics when DoD Acquisition-Specific topics are removed

Findings
Coverage of Composite Body-of-Knowledge

- Against the combined DAWIA / Industry body-of-knowledge, which contains 155 topic areas...

    - *An "Augmented" Industry Portfolio achieves 75% of combined DoD / Industry topics*

        - Portfolio: CSEP + PEM + CTEP *+ DAWIA CLM's from related career fields*
            - *Adds 11 topic areas not covered by industry certs alone*
            - *Adds DoD context absent with the retirement of CSEP-Acq in 2014*

An "Augmented" Industry Portfolio of Certifications offers respectable (75%) coverage of the combined (DoD / Industry) Body-of-Knowledge

Augmenting Industry Certifications
DAWIA Education Opportunities

- Given: DAWIA certifications are not offered to DoD contractors
  - Only government civilians and active-duty military are granted DAWIA certification

- Given: Industry certifications do not cover DoD Acquisition topics in great detail (if at all) – especially with the planned retirement of the CSEP-Acq. extension in 2014.

- Given: Equipping the workforce with a working knowledge of DoD acquisition and the conduct of systems engineering, test & evaluation, and program / project management in that context is critical to the success of DoD activities, and the continued credibility and success of organizations offering contract support to DoD.

- *Recommend: Incorporate DAU courses and continuous learning modules into workforce training*
  - *Simultaneously guides professional development and contributes to satisfaction of re-certification requirements*

DAU Continuous Learning Modules

Continuous Learning Modules (Topic Areas)	DAWIA CAREER FIELD		
	SPRDE	T&E	PM / STM
Value Engineering (CLE 001)	Req'd		
Lean Enterprise Intro (CLE 004)	Req'd		
Risk Management (CLM 017)	Req'd		
Technical Reviews (CLE 003)	Req'd	Req'd	
DoD Open Sys. Arch. (CLE012)	Req'd		
IP & Data Rights (CLE 068)	Req'd		STM Only
Design 4 Support (CLL 008)	Req'd		
M&S for T&E (CLE 023)		Req'd	
Info Assur. (CLE 025)		Req'd	
Prob & Stats Intro (CLE 035)		Req'd	
Joint T&E (CLE 029)		Req'd	
R&M (CLE 301)		Req'd	
JCIDS Intro (CLR 101)		Req'd	
PPBE (CLB 009)		Req'd	
Business Case Analysis (CLL 015)		Req'd	
IPT Mgt & Ldrshp (CLM 014)		Req'd	
Improved SoW (CLM 031)		Req'd	
Cost Analysis (CLB 007)			PM Only
Earned Value Mgt (CLV 016)			PM Only
DoD S&T Mgt Intro (CLE 045)			STM Only
Tech. Readiness Assess. (CLE 021)			STM Only
Trade Studies (CLE 026)			STM Only
Perf. Measurement Baseline (CLV 017)			STM Only
EV & Financial Reports (CLV 018)			STM Only
Baseline Maintenance (CLV 020)			STM Only

- DAWIA / DAU augments primary classes for each career field with continuous learning modules that offer relevant insight into critical topics from related career fields
  - *These modules are available to anyone, and available on-line.*

The modules reflected in this table are only a _subset_ of the extensive library of materials available on the DAU website.

25

Re-certification
Guides and emphasizes continuous growth

- DoD / DAWIA – Annual requirement
  - *Annual* professional education / activity requirement
    - Continuous Learning Units (CLUs)
- Industry
  - *3 year* documentation & reapplication cycle
    - Professional Development Units (PDUs)
      - INCOSE CSEP and ASEM PEM
    - Certification Maintenance Points (CMPs)
      - ITEA CTEP
- *Commonly recognized "PDU activities" include achievements that most organizations already recognize as noteworthy…*
  - *Patent awards*
  - *Authoring a book, journal article, or conference paper*
  - *Formal education (both as student or teacher)*
  - *Formal presentation to a technical / professional forum*
  - *Volunteering (STEM, Mentoring, Professional Organization)*

Recommendations

Recommendations:

- *Encourage employees to pursue industry certifications .*
  - Benefits:
    - Demonstrate competency in relevant disciplines
    - Establish common workforce lexicon in relevant disciplines
    - Establish a minimum requirement for workforce understanding of best practices in relevant disciplines
  - Relevant disciplines and certifications include (but are not limited to):
    - Systems Engineering (INCOSE CSEP)
    - Engineering Management (ASEM PEM)
    - Test & Evaluation (ITEA CTEP)

- *Leverage professional development requirements for these credentials as a preferred framework for workforce training development*
  - Identify DAU courses and modules as preferred / required training
  - Consider common professional development activities as annual objectives

- *Incorporate a list of combined "Competency Categories" into activity reports and documentation of employee contributions and achievement.*
  - Establish a common vision and lexicon for "what you do" as a company / branch / division / group
  - Position employees well to construct application packages for certifications and/or recertification

    See next slide for a "composite competency framework"

Systems Engineering Competencies
(Derived from the INCOSE CSEP application)

- **Capability / System Development**
  - Concept Development
    - CONOPS / CONEMPS
    - MOEs & MOPs
    - Military Utility
  - Requirements Development
    - Trade-space Analysis (AoA / CBA)
    - Documentation
  - Design Development
    - Architecture
    - Integration / Interoperability
    - Human Factors

- **Performance Characterization**
  - Test & Evaluation
  - Verification / Validation
  - Demonstration
  - Inspection

- **Research**
  - Analysis, Innovation → Publication

- **Technical Management**
  - Opportunity:
    - Identify / Characterize / Secure
  - Risk:
    - Identify / Avoid / Mitigate
  - Baseline / Configuration Control
  - Assessment, Planning & Execution
    - Contract → SoW / Schedule / Budget
    - Workforce → Skills / Time / Security / Training
    - Facility → Spaces / Equipment / Tools / Security
  - Process Definition / Improvement

- **Related activities & competencies**
  - Modeling & Simulation
  - Manufacturing & Production
  - Logistics
    - Supply / Sustainment / Support
    - Reliability / Maintainability / Availability
    - Packaging / Handling / Shipping / Transportation
  - Security
  - Safety

Implementation
Challenges, Obstacles and Decisions…

- ### *No clear demand signal…(yet)*
  - Historically, DoD Requests for Proposals (RFPs) have not specified these industry certifications as criteria. Workforce credentials-of-interest are often listed as:
    - PE – number of employees
    - Ph.D / MS – % of workforce
    - *"Other certifications"*

  - Precedent(s) for DoD interest in professional certification & alignment with DAWIA?
    - NCMA
    - ITEA (?)

- ### *Cost…*
  - Who bears the cost?
    - Employee?
    - Training budget?
  - Which certs are relevant?
    - Priority / precedence?
  - Goal & justification?
    - Example: 50% of workforce by (date)
      - Why 50% – what is a 'good' target figure (or is there one)?

- ### *No immediate, tangible ($) return on investment…*
  - These certs will probably not immediately translate into new business opportunities, pay raises, or advancement…

How to prioritize or choose?
…popularity, age, organization, other?

Certification		Sponsor Organization Database*	Employee Recipients (resume search or HR)
INCOSE	ASEP	~ 350	
INCOSE	CSEP	~ 1500	
INCOSE	ESEP	~ 200	
ASEM	PEM	*Not available on-line*	
ITEA	CTEP	~ 75	
PMI	PMP	500,000+	
NCEES (Industrial)	PE	*Not available on-line*	

* As determined from lists posted on organizational websites, 25 Jan 2014.
(PMI figures extracted from their 2012 Annual Report)

Implementation
Recommended Priority of Certifications

- #1: Certified Systems Engineering Professional (CSEP)
  - Well structured, with extensive coverage of topics & competencies
  - INCOSE's Handbook is a well organized, concise and comprehensive compendium of SE fundamentals
  - Certifications are suitable for SE professionals at different career stages
    - ASEP, CSEP and ESEP

- #2: Professional Engineering Manager (PEM)
  - Well structured, with extensive coverage of topics & competencies
  - ASEM's "Guide to the Engineering Management Body of Knowledge" is an excellent resource for even the experienced project or program manager!
    - Offers numerous examples, introduces the reader to recognized best practices, and lists extensive references
  - Certifications are suitable for both junior and senior professionals, and useful for those in both management and purely technical roles.

Implementation
Recommended Priority of Certifications

- #3: Certified T&E Professional (CTEP)
  - Relatively new (2013), and not as well structured as CSEP and PEM
    - *Improvements are underway to achieve comparable standards to DAWIA Level III* (ref: Comments by ITEA President in the March 2014 ITEA Journal)
  - No "Handbook" or "Guide to (BoK)"
  - List of applicable references is somewhat helpful, but does not efficiently or effectively focus the candidate CTEP on topics reflected in the exam
  - Single level of certification does not recognize professional experience, growth and advancement in the career field.

Action item (complete): Share this comparative analysis with ITEA, ASEM and INCOSE to offer a unique perspective on areas where they might improve and/or align their certification criteria, process and credibility.

Questions, Comments & Discussion

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Back-up Slides

Spreadsheet Review (greater detail)

Professional Engineer Credential (details)

Abstract

▸ The U.S. Department of Defense (DoD) has established a reasonably clear and stable framework for the education, qualification and career progression of its professional acquisition workforce through a certification process established under the Defense Acquisition Workforce Improvement Act (DAWIA). Although DAWIA certifications are only granted to its military and civilian employees, DoD is also interested in substantiating similar competency within its supporting contractor workforce – as evidenced in a recent challenge by the Deputy Assistant Secretary of Defense (DASD) Developmental Test and Evaluation (DT&E) to the International Test & Evaluation Association (ITEA) to align their professional certification requirements with those established for T&E under DAWIA. This presentation details findings from an initial comparison of industry certifications in systems engineering, test & evaluation, and engineering management to their DAWIA counterparts. A case is made for incorporating industry certifications into the professional development programs at organizations supporting DoD. The brief concludes with a recommendation for aligning the documentation of individual employee achievements with the core competencies associated with relevant certifications to facilitate the application process, and for the use of professional development requirements as annual employee objectives.

Spreadsheet Introduction

Snapshots from the analytical product of this study…

DAWIA Certification Requirements
With DAU courses & modules

CERTIFICATION	Qualifying Exam	Experience	Education (minimum)	ACQ	SYS	STM	TST	LOG	PMT	CON	SAM	EVM	BCF	IRM	CLB	CLE	CLL	CLM	CLR	CLV
DAWIA SPRDE(SE) / ENG LEVEL I	No	1 year	BS (Tech)	101	101											001 004		017		
DAWIA SPRDE(SE) / ENG LEVEL II	No	2 years	BS (Tech)	201A 201B	202 203			103								003				
DAWIA SPRDE(SE) / ENG LEVEL III	No	4 years	BS (Tech)		302											012 068	008			
CERTIFICATION	Qualifying Exam	Experience	Education (minimum)	ACQ	SYS	STM	TST	LOG	PMT	CON	SAM	EVM	BCF	IRM	CLB	CLE	CLL	CLM	CLR	CLV
DAWIA T&E LEVEL I	No	none specified	BS (Tech)	101	101		102									023 025 035				
DAWIA T&E LEVEL II	No	1 year	BS (Tech)	201A 201B	202		204									003 029 301			101	
DAWIA T&E LEVEL III	No	4 years	BS (Tech)				303								009		015	014 031		
CERTIFICATION	Qualifying Exam	Experience	Education (minimum)	ACQ	SYS	STM	TST	LOG	PMT	CON	SAM	EVM	BCF	IRM	CLB	CLE	CLL	CLM	CLR	CLV
DAWIA PM LEVEL I	No	1 year	none	101	101										007					016
DAWIA PM LEVEL II	No	2 years	none	201A 201B					251 257	121 124 127	101	101		101						
DAWIA PM LEVEL III	No	4 years	none		202			103	352A 352B			201 (?)	103							
CERTIFICATION	Qualifying Exam	Experience	Education (minimum)	ACQ	SYS	STM	TST	LOG	PMT	CON	SAM	EVM	BCF	IRM	CLB	CLE	CLL	CLM	CLR	CLV
DAWIA SPRDE(STM) / STM LEVEL I	No	1 year	BS (Tech)	101	101											045 068				
DAWIA SPRDE(STM) / STM LEVEL II	No	2 years	BS (Tech)	201A		202										021				
DAWIA SPRDE(STM) / STM LEVEL III	No	4 years	BS (Tech)			303			251 257 352A							026		014		017 018 020

Relevant Topic Areas
DAU Career Fields, Courses and Modules

DAWIA Formal Courses: Career Field Mapping				ACQ	SYS	STM	TST	LOG	PMT	CON	SAM	EVM	BCF	IRM
Topic Area	SPRDE(SE)	T&E	PM / STM											
Department of Defense Acquisition	ALL	ALL	ALL	101 201A 201B										
Systems Engineering	ALL	101 & 202	101		101 202 203 302									
Science & Technology Management	NO	NO	STM Only			202 303								
Test & Evaluation	NO	ALL	NO				102 204 303							
Logistics	YES	NO	PM Only					103						
Program Management (Mgt, Ldrshp, Contracting, Finance, etc.)	NO	NO	PM = ALL STM = PMT						251 257 352A 352B	121 124 127	101	101	103	101

DAWIA Experience Requirements
A closer look…

	< 1 year	1 year	2 years	4 years
Level 1	T&E	SE / ENG PM STM		
Level 2		T&E	SE / ENG PM STM	
Level 3				SE / ENG T&E PM STM

Relevance and duration of experience is documented and substantiated as part of the application process

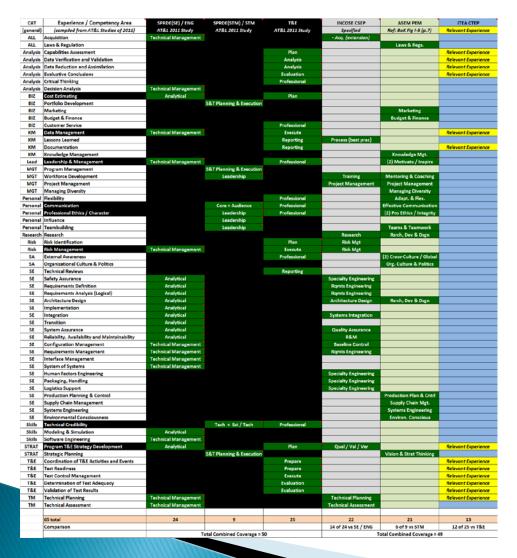**Exams are administered as part of courses and modules to verify comprehension and retention**

Experience Competencies
Spreadsheet Snapshot & Excerpt

CAT	Experience / Competency Area	SPRDE(SE) / ENG	SPRDE(STM) / STM	T&E	INCOSE CSEP	ASEM PEM	ITEA CTEP
(general)	(compiled from AT&L Studies of 2011)	AT&L 2011 Study	AT&L 2011 Study	AT&L 2011 Study	Specified	Ref: BoK Fig I-5 (p.7)	Relevant Experience
ALL	Acquisition	Technical Management			- Acq. (extension)		
ALL	Laws & Regulation					Laws & Regs.	
Analysis	Capabilities Assessment			Plan			Relevant Experience
Analysis	Data Verification and Validation			Analysis			Relevant Experience
Analysis	Data Reduction and Assimilation			Analysis			Relevant Experience
Analysis	Evaluative Conclusions			Evaluation			Relevant Experience
Analysis	Critical Thinking			Professional			
Analysis	Decision Analysis	Technical Management					
BIZ	Cost Estimating	Analytical		Plan			
BIZ	Portfolio Development		S&T Planning & Execution				
BIZ	Marketing					Marketing	
BIZ	Budget & Finance					Budget & Finance	
BIZ	Customer Service			Professional			
KM	Data Management	Technical Management		Execute			Relevant Experience
KM	Lessons Learned			Reporting	Process (best prac)		
KM	Documentation			Reporting			Relevant Experience
KM	Knowledge Management					Knowledge Mgt.	
Lead	Leadership & Management	Technical Management		Professional		(2) Motivate / Inspire	
MGT	Program Management		S&T Planning & Execution				
MGT	Workforce Development		Leadership		Training	Mentoring & Coaching	
MGT	Project Management				Project Management	Project Management	
MGT	Managing Diversity					Managing Diversity	
Personal	Flexibility			Professional		Adapt. & Flex.	
Personal	Communication		Core + Audience	Professional		Effective Communication	
Personal	Professional Ethics / Character		Leadership	Professional		(2) Pro Ethics / Integrity	
Personal	Influence		Leadership				
Personal	Teambuilding		Leadership			Teams & Teamwork	
Research	Research				Research	Rsrch, Dev & Dsgn	
Risk	Risk Identification			Plan	Risk Mgt		
Risk	Risk Management	Technical Management		Execute	Risk Mgt		
SA	External Awareness			Professional		(2) Cross-Culture / Global	
SA	Organizational Culture & Politics					Org. Culture & Politics	
SE	Technical Reviews			Reporting			
SE	Safety Assurance	Analytical			Specialty Engineering		
SE	Requirements Definition	Analytical			Rqmts Engineering		
SE	Requirements Analysis (Logical)	Analytical			Rqmts Engineering		
SE	Architecture Design	Analytical			Architecture Design	Rsrch, Dev & Dsgn	
SE	Implementation	Analytical					
SE	Integration	Analytical			Systems Integration		
SE	Transition	Analytical					
SE	System Assurance	Analytical			Quality Assurance		
SE	Reliability, Availability and Maintainability	Analytical			R&M		
SE	Configuration Management	Technical Management			Baseline Control		
SE	Requirements Management	Technical Management			Rqmts Engineering		
SE	Interface Management	Technical Management					
SE	System of Systems	Technical Management					
SE	Human Factors Engineering				Specialty Engineering		
SE	Packaging, Handling				Specialty Engineering		
SE	Logistics Support				Specialty Engineering		
SE	Production Planning & Control					Production Plan & Cntrl	
SE	Supply Chain Management					Supply Chain Mgt.	
SE	Systems Engineering					Systems Engineering	
SE	Environmental Consciousness					Environ. Conscious	
Skills	Technical Credibility		Tech + Sci / Tech	Professional			
Skills	Modeling & Simulation	Analytical					
Skills	Software Engineering	Technical Management					
STRAT	Program T&E Strategy Development	Analytical		Plan	Qual / Val / Ver		Relevant Experience
STRAT	Strategic Planning		S&T Planning & Execution			Vision & Strat Thinking	
T&E	Coordination of T&E Activities and Events			Prepare			Relevant Experience
T&E	Test Readiness			Prepare			Relevant Experience
T&E	Test Control Management			Execute			Relevant Experience
T&E	Determination of Test Adequacy			Evaluation			Relevant Experience
T&E	Validation of Test Results			Evaluation			Relevant Experience
TM	Technical Planning	Technical Management			Technical Planning		Relevant Experience
TM	Technical Assessment	Technical Management			Technical Assessment		
	65 total	24	9	25	22	21	13
	Comparison				14 of 24 vs SE / ENG	6 of 9 vs STM	12 of 25 vs T&E
			Total Combined Coverage = 50			Total Combined Coverage = 49	

- Column 1: Categories
  - Analysis, Business, Knowledge Management, Management, Personal Traits, Systems Engineering, T&E, etc.
- Column 2: Specific Topics
  - As listed from each source
  - Composite total: 65
- Columns 3–8: Certifications
  - DAWIA *(USD AT&L Studies)*
    - Engineering, Tech Mgt, T&E
  - INCOSE (CSEP)
  - ASEM (PEM)
  - ITEA (CTEP)

Competencies: INCOSE CSEP

See notes view for details

- Requirements Engineering
- Risk & Opportunity Mgt.
- Baseline Control
- Technical Planning
- Technical Effort Assessment
- Architecture / Design Development
- Qualification, Verification, Validation
- Process Definition
- Tool Support
- Training

- Systems Integration
- Quality Assurance
- Specialty Engineering
  ◦ RM&A
  ◦ Logistics
  ◦ Security
  ◦ Safety
  ◦ Human Factors
  ◦ PHS&T
  ◦ Environmental
  ◦ Electromagnetic (EMC / EMV)
- Project Management
- Research

Competencies: ASEM PEM

- Business (Product)
  - R&D + Design
  - Production Planning / Cntrl.
  - Supply Chain Management
  - Project Management

- Business (Organization)
  - Markets & Marketing
  - Systems Engineering
  - Knowledge Management
  - Budget & Finance

- Environment (Professional)
  - Ethics
  - Environ. Consciousness
  - Org. Culture & Politics
  - Laws & Regulations

- Environment (Global)
  - Adaptation / Flexibility
  - Cross-Culture Sensitivity
  - Awareness of Issues
  - Managing Diversity

Competencies: ASEM PEM

▶ People (Interpersonal)
- ◦ Motivating Self & Others
- ◦ Effective Communication
- ◦ Negotiation & Conflict Resolution
- ◦ Teams & Teamwork

▶ People (Leadership)
- ◦ Truthfulness & Integrity
- ◦ Vision & Strategic Thinking
- ◦ Mentoring & Coaching
- ◦ Enthusiasm & Inspiration

ITEA CTEP
"Relevant Experience" List

- Reviewing program and/or system design specifications and/or requirements.
- Reviewing, analyzing, and providing input to acquisition strategies (i.e. acquisition plans, system engineering plans).
- Developing and determining data collection and instrumentation requirements (e.g. types, quantity, trails, confidence level).
- Ensuring that T&E plans comply with applicable policies and procedures.
- Evaluating and selecting data collection tools, technologies, techniques, and methods, and levy accreditation/certification requirements as applicable.
- Coordinating and conducting pretest briefings and post-test debriefs.
- Planning and preparing for product/system testing.
- Sampling and analysis test objects.
- Preparing, reviewing, maintaining, and archiving test documents, reports, and/or charts as required.
- Test and Evaluation program or project management

ITEA does NOT list "competencies" for the CTEP credential

Body-of-Knowledge Mapping
Spreadsheet Snapshot (Excerpts Highlighted)

Areas expanded on next slide

- Column 1: Broad topic area

- Column 2: Specific Topics
  - As listed from each source
  - Composite total: 155

- Columns 3-7: Certifications
  - DAWIA (portfolio)
  - INCOSE (CSEP)
  - ASEM (PEM)
  - ITEA (CTEP)
  - NCEES (PE – *industrial*)

Body-of-Knowledge Mapping
Spreadsheet Zoom-In (top, middle, bottom)

Category	Body-of-Knowledge Topic	DAWIA COURSE(S) / MODULES — Learning Objectives List	INCOSE CSEP — SE Handbook (3.1)	ASEM PEM — EMBoK (3rd Ed.)	ITEA CTEP — List of References	PE (Industrial Engineering) — Exam Knowledge Categories
* DoD ACQ	PPBE (CLB 009)	CLB 009	-Acq. = DAG Chp 4 (phase out 2014)			
* DoD ACQ	DoD S&T Mgt Intro (CLE 045)	CLE 045				
* DoD ACQ	JCIDS Intro (CLR 101)	CLR 101				
* DoD ACQ	OSD-level T&E considerations	TST 303			DAU T&E Mgt. Guide	
* DoD ACQ	T&E in a Rapid Acquisition context	TST 303				
* DoD ACQ	DoD Open Sys. Arch. (CLE012)	CLE 012	-Acq. = DAG Chp 4 (phase out 2014)			
Prob & Stats	Prob & Stats Intro (CLE 035)	CLE 035			Statistics	
Risk	Risk Management (CLM 017)	CLM 017	5.5; 7.3		Risk Management	1 J
Risk	Risk Management (actions / process)	PMT 251	5.5; 7.3	5.3.8	Risk Management	1 J
Risk	Differences between issues, risks and opportunities (tech transition context)	STM 202 / PMT 352A&B	5.5; 7.3			1 J
Risk	Function of Risk Management as part of SE	SYS 101 / PMT 352B	5.5; 7.3			1 J
SE - AoA	Trade Studies (CLE 026)	CLE 026		9.2.5		
SE - Architect	Function of Architecture Design process as part of SE	SYS 101	4.4; 8.2			
SE - Architect	Role(s) played by a systems model (INCOSE HB includes prototyping)	SYS 101	9.6 App. L (L2)	9.4.2		
SE - Architect	Functional Analysis & Allocation (hierarchy within a system or SoS)		Appendices E & J	9.2.3		
SE - Architect	Architecture Synthesis		Appendix K			
SE - Config	Function of Configuration Management as part of SE	SYS 101	8.3; App. G (G4)	9.2.5		
SE - ECP	Engineering Change Proposals, Upgrades and Design Revisions	??	??	8.3.8		
SE - Environ	Environmental issues throughout the lifecycle	PMT 352A	4.12; 9.3; 9.7	10.2		
SE - Human	Human-System Integration		9.4 App. M	9.3 (Human Factors Planning)	Identified Knowledge Area	
SE - IA	Info Assur. (CLE 025)	CLE 025	5.8 (info mgt & security)			
TM - Tech	Tech. Readiness Assess. (CLE 021)	CLE 021				
TM - Tech	Application of tech management & SE to technology development	STM 202		8.1 - 8.3		
TM - Tech	Technology Project (cost, budget, risk, rqmts, demo, TTA, data rights, trans.)	STM 303 / PMT 352B				
TM - Tech	Function of Technical Assessment process as part of SE	SYS 101				

		DAWIA	INCOSE CSEP	ASEM PEM	ITEA CTEP	
155	<-- Total vs Number of matches -->	142	72	40	39	
125	<-- Without DoD Acquisition vs Number of matches -->	112	60	39	29	
	Coverage vs. full-spectrum of topics	92%	46%	26%	25%	
	Coverage vs. npn-DoD Acquisition topics	90%	48%	31%	23%	
	Combined coverage vs. full-spectrum of topics	Assumes CSEP-Acq	59%			
	Combined coverage vs. non-DoD Acquisition topics		62%			
	Combined coverage vs. full-spectrum of topics	Assumes CSEP-Acq		68%		
	Combined coverage vs. non-DoD Acquisition topics			71%		
				0.75483871		

Continuous Learning Requirements
Activities important to continuous professional growth…

PROFESSIONAL DEVELOPMENT ACTIVITIES MAPPED TO PROFESSIONAL CERTIFICATION CATEGORIES						
COMPOSITE ACTIVITY LIST	INCOSE (Recert: 300)	INCOSE CSEP-Acq.	ASEM (Recert: 45)	ASEM PEM	ITEA (Recert: 120)	ITEA CTEP
	(PDUs)	(Category)	(PDUs)	(Category)	(CMPs)	(Category)
EDUCATION & TRAINING						
Earn a new degree					50	1
Pass a college credit course	2/hr (grad)	9			5 / hr	2
Attend a seminar or workshop					1 / hr	4
Complete on-line training					1 / hr	6
Complete self-directed learning			1 / hr	5		
Complete employer in-house training					1 / hr	7
Complete commercial (outside provider) training	1 / hr	14	1 / hr	6	1 / hr	8
Complete initial / refresher training courses					1 / hr	9
Attend conference technical session	1 / hr	3	1 / hr	2	1 / hr	10
Complete a cert-specific training course			1 / hr	1		
Exercises / drills					1 / hr	11
TEACHING / INSTRUCTION						
Teaching a college credit course in a related field / topic	1 / hr	10	3 per 5hrs	4	8 / hr	3
Develop a training course	2 / hr	11			TBD	5
Deliver an original presentation (e.g., conference paper)	2 / hr (prep)	3	10 / brief	4	5 / brief	12
Serve as a part-time instructor					3 / hr	13
INTELLECTUAL PROPERTY & PUBLICATION						
Publish a book	30 author 10 co-auth.	13			75 / book	14
Contribute a book chapter					7 / chp	15
Publish a journal article (not conference paper)	5 / article	12	20 / article	4	10 / article	16
Publish a technical manual					15 / doc	17
Originate / publish a technical procedure or method					10 / ea	18
Register a patent	10 / ea	15			50 / ea	19
PROFESSIONAL SERVICE & SOCIETY PARTICIPATION						
Serve on a standards committee (pro org / ind / gov)					10 / ea / yr	20
Serve on a working group (pro org / tech society)	1 / hr	4				
Serve on an advisory committee (pro org / ind / gov)					10 / ea / yr	21
Participate in legislative / rule-making activity					TBD	22
Exam writing workshop					TBD	25
Submit exam item					1 / item	26
Review / qualify exam items					1 / item ?	27
INCOSE Membership	5 / yr	1				
Formally advocating for certification @ employer org.	5	17				
Attend chapter meeting / educational session	1 / event	2	1 / hr	3		
Review prof. dev. offerings (ITEA recert comm. Mbr)					1 / item ?	28
VOLUNTEER ACTIVITIES						
Volunteer / community service in technical capacity	1 / hr	7				
Volunteer in Eng / Sci (uncompensated)	1 / hr	18	1 / hr			
Volunteer in STEM-specific activity	1/hr	6	(5 / yr)	7	TBD	23
Volunteer in a leadership capacity (pro org / tech society)	1 / hr	5			1 / hr ?	24
CERTIFICATION, DESIGNATION & LICENSURE						
Obtain new state license					15 / license	29
Obtain new certification	5 / cert	8			15 / cert	30
Other professional accomplishments					TBD	31
Designation as "Lead Systems Engineer"	15	16				

- Areas common to all three industry certifications highlighted in red font
- Commonly recognized activities include…
  - Patent awards
  - Authoring a book, journal article, or conference paper
  - Formal education (both as student or teacher)
  - Formal presentation to a technical / professional forum
  - Volunteering (STEM, Mentoring, Professional Organization)

The *Professional Engineer* Credential
Career Field of Interest: Industrial Engineering

Maryland NCEES Information for PE
Education / Experience / Exam requirements

Education	Exams	Experience
Engineering (non-accredited)	FE / PE	8 years
Engineering Technology (non-accredited)	FE / PE	8 years
EAC / ABET Engineering Masters	FE / PE	3 years
EAC / ABET Engineering Bachelors	FE / PE	4 years
PhD in Engineering	FE / PE	3 years
Related Science	FE / PE	8 years
TAC / ABET Engineering Technology	PE only	8 years
High School	*PE only*	*12 years*
Related Science	*None*	*20 years*

Maryland NCEES Information
PE Exam

- Cost:
  - $50 application fee (one time)
  - $275 exam fee

- Attempts: 3
  - Pass rates of around 70%
  - 2 year wait after 3rd try

- Renewal Cycle: 2 yrs

- PDU (hours) / yr: 12

- Industrial Engineering
  - Most alignment with broad spectrum of SE activities

  - 8 hours, open-book
  - 40 multiple choice in AM
  - 40 multiple choice in PM

- Authorized Calculators
  - Casio: All FX-115 models
  - HP 33s and HP 35s
  - TI-30X or TI-36X

Industrial Engineering PE Exam
Knowledge Areas: Section I

Systems Definition, Analysis, and Design 20%

A. System analysis and design tools (e.g., flowcharts, Pareto charts, affinity diagrams, nominal group technique, input/output analysis)

B. Requirements analysis (e.g., value stream mapping)

C. Performance measures and applications (e.g., leading, lagging, structure)

D. Modeling techniques (e.g., simulations, queuing, linear programming, Markov chains)

E. Process types (e.g., discrete versus continuous, manufacturing, service)

F. Model interpretation (e.g., sensitivity analysis)

G. Model verification

H. Model validation

I. Bottleneck analysis (e.g., theory of constraints)

J. Value analysis and engineering (e.g., risk analysis)

K. Project management and planning (e.g., PERT/CPM; balancing risk, cost, scope, and time; Gantt charts)

Industrial Engineering PE Exam

Knowledge Areas: Section II

Facilities Engineering and Planning 20%

A. Process flow

B. Network optimization

C. Layout design techniques (e.g., systematic layout planning [SLP], affinity diagram, relationship diagrams, center of gravity rule)

D. Space analysis (e.g., equipment needs, demand, location, footprint of the equipment/WIP sizing)

E. Capacity analysis (e.g., calculation of personnel requirements, calculation of machine requirements)

F. Cost-benefit analysis

G. Site selection factors

H. Site selection methods (e.g., prioritization, factor weighting)

I. Unit load analysis

J. Life cycle cost analysis (e.g., acquisition, implementation, sustainment, retirement)

- ▸ K. Material handling techniques and equipment (e.g., conveyors, industrial trucks, manual, overhead crane)

Industrial Engineering PE Exam

Knowledge Areas: Section III

Supply Chain and Logistics 20%

A. Forecasting methods (e.g., exponential smoothing, moving averages, seasonal)

B. Production planning methods (e.g., aggregate, MRP, MRPII, ERP, JIT, Kanban, lean manufacturing)

C. Engineering economics (e.g., break-even analysis, technical capability assessment, ROI)

D. Costing systems (e.g., activity-based costing including cost drivers, guidelines for overhead)

E. Production scheduling methods (e.g., shortest processing time first, due date order)

F. Inventory management and control

G. Distribution methods (e.g., transshipment, routing)

H. Storage and warehousing methods

I. Transportation modes (e.g., truckload [TL], less than truckload [LTL], air, rail, ship, special requirements)

Industrial Engineering PE Exam

Work Design 20%

A. Motion economy rules

B. Line balancing

C. Work measurement systems techniques (e.g., stopwatch, predetermined time systems, proprietary process determined time system)

D. Time-study techniques (e.g., motion study, man-machine charts, predetermined time systems)

E. Time-standard tools (e.g., learning curve, training program)

F. Sample size calculations

G. Observation frequency methods

H. Work sampling analysis

I. Safety codes, standards, and voluntary guidelines (e.g., ANSI, OSHA, MIL STD, NIOSH)

Industrial Engineering PE Exam

Work Design 20%

J. Methods for quantifying risk factors (e.g., NIOSH lifting equation, OSHA limits for noise)

K. Coefficient of friction (slip resistance)

L. Rapid upper limb assessment (RULA)

M. Limits of human capacity

N. Lifting aids (e.g., gait belts, cranes)

O. Link analysis and associated criteria (e.g., importance, frequency of use)

P. Workplace design/human-computer interaction (e.g., use of anthropometric data)

Q. Days Away, Restricted, and Transferred (DART) rate calculations (e.g., injury/illness incident rate and/or the management of the information required to calculate this rate)

Industrial Engineering PE Exam

Knowledge Areas: Section V

Quality Engineering 20%

A. Statistical process control (e.g., control chart construction and interpretation)

B. Process capability analysis (e.g., Cpk, Cp)

C. Acceptance sampling (e.g., single sampling, double sampling, MIL STD 105E, Dodge Romig, OC-curves)

D. Continuous improvement methods (e.g., Deming, Kaizen, TQM, Six Sigma)

E. Techniques for process improvement (e.g., design of experiments [DOE], Taguchi, FMEA)

F. Reliability analysis

G. Maintenance procedures (e.g., reactive, preventive, predictive)

H. Quality management system (e.g., ISO9000, benchmarking)

I. Root cause analysis

Industrial Engineering PE Exam
Study & Reference Materials

▸ Not provided by NCEES for Industrial Engineering

▸ NCEES website refers candidates to:
◦ Institute of Industrial Engineers (www.iienet2.org/bookstore)
  - Review for the Professional Engineers Examination in Industrial Engineering, 4th Ed. (paperback)
    - Product Code: REVIEW
    - List: $100   Member: $90
  - Sample P.E. Exam in Industrial Engineering (paperback)
    - Product Code: PEEXAM
    - List: $78   Member: $73
  - Handbook of Industrial Engineering, 3rd Ed. (hardcover)
    - Product Code: IEBOOK3
    - List: $299   Member: $239

PE License
Return on Investment ?

- A recent article by David Butcher identified several real and/or perceived benefits of becoming a licensed PE, which include:
  - Sense of achievement
  - Evidence of competence
  - Method of distinguishing one's self from competition
  - Stature and respect
  - Responsibility and authority
  - Higher earning potential
  - Career advancement opportunities
    - Independent consultant
    - Government engineer
    - Educator

  www.thomasnet.com/journals/career/is-a-professional-engineer-license-worth-it/

- The National Society of Professional Engineers (www.nspe.org) is also a good resource for additional information on PE licensure (e.g., documenting experience, benefits of licensure, etc.)