“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)
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?”
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
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
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
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.
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

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

### Education, Experience and Examinations

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<tr>
<th></th>
<th>DAWIA Level 3</th>
<th>CSEP</th>
<th>PEM</th>
<th>CTEP</th>
<th>PE</th>
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<td>BS</td>
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<td>5 yrs (AS)</td>
<td>10 yrs</td>
<td>4 (ABET BS)</td>
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<td>Refs: 2</td>
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<td>3 (ABET MS)</td>
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<td></td>
<td>Ref = “Sponsor”</td>
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<td><strong>Exam(s)</strong></td>
<td>In-class</td>
<td>120 Q’s 2 hours 4 hours</td>
<td>200 Q’s 4 hours</td>
<td>200 Q’s 4 hours</td>
<td>FE + PE</td>
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<td></td>
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<td>(Acq. 60 / 1)</td>
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<td></td>
<td>PE (12 yrs)</td>
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<td></td>
<td></td>
<td>No (20 yrs)</td>
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<td><strong>Cost to applicant</strong></td>
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<td>$300 app. (mbr)</td>
<td>$250 app/exam</td>
<td>$200 (mbr)</td>
<td>$275 exam</td>
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<td>$80 exam</td>
<td>($50 recert)</td>
<td>($150 recert)</td>
<td>$50 app</td>
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<tr>
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<td></td>
<td>($100 recert)</td>
<td></td>
<td></td>
<td>(recert ??)</td>
</tr>
</tbody>
</table>

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
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.
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:

- **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?

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

* 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.
#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*

<table>
<thead>
<tr>
<th>Certification</th>
<th>Qualifying Exam</th>
<th>Experience</th>
<th>Education (minimum)</th>
<th>ACQ</th>
<th>SYS</th>
<th>STM</th>
<th>TST</th>
<th>LOG</th>
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<th>CLM</th>
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<tbody>
<tr>
<td>DAWIA SPRDE(SE) / ENG LEVEL I</td>
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<td>DAWIA SPRDE(SE) / ENG LEVEL II</td>
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<td>No</td>
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<td>BS (Tech)</td>
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<td>BS (Tech)</td>
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<td>202</td>
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<td>352A</td>
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</table>

| 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(SEM) / STM LEVEL I | No              | 1 year     | BS (Tech)           | 101 | 101 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| DAWIA SPRDE(SEM) / STM LEVEL II | No              | 2 years    | BS (Tech)           | 201A | 202 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| DAWIA SPRDE(SEM) / STM LEVEL III | No              | 4 years    | BS (Tech)           | 303 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
# Relevant Topic Areas

*DAU Career Fields, Courses and Modules*

| Topic Area                                      | SPRD(SE) | T&E       | PM / STM | ACQ      | SYS | STM | TST | LOG | PMT | CON | SAM | EVM | BCF | IRM |
|------------------------------------------------|----------|-----------|----------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Department of Defense Acquisition              | ALL      | ALL       | ALL      | 101      | 201A| 201B| 101 | 202 | 203 | 302 | 102 | 204 | 303 | 103 |     |
| 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  |          |     |     |     |     |     |     |     |     |     |     |     |
| Program Management (Mgt, Ldrshp, Contracting, Finance, etc.) | NO      | NO        | PM = ALL |          |     |     |     |     |     |     |     |     |     |     |     |

Note: The table represents mapping of career fields to relevant courses and modules for specific topic areas. Each cell indicates the availability of courses or modules for a particular career field.
# DAWIA Experience Requirements

* A closer look... *

<table>
<thead>
<tr>
<th></th>
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<th>2 years</th>
<th>4 years</th>
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<td>SE / ENG T&amp;E PM STM</td>
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</table>

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

- **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

Slide #1 of 2 (Business & Environment)

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

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

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

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

- 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)

Areas expanded on next slide
## Body-of-Knowledge Mapping

### Spreadsheet Zoom-In (top, middle, bottom)

<table>
<thead>
<tr>
<th>Category</th>
<th>Body-of-Knowledge Topic</th>
<th>DAWIA COURSES / MODULES</th>
<th>INCOSE CSEP</th>
<th>ASEM PEM</th>
<th>ITEA CTEP</th>
<th>PE (Industrial Engineering)</th>
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<tr>
<td>* DoD ACQ</td>
<td>PPBE (CLB 009)</td>
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<td>DoD S&amp;T Mgt Intro (CLE 045)</td>
<td>CLE 045</td>
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<td>Acq. = DAG Chp 4 (phase out 2014)</td>
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<tr>
<td>* DoD ACQ</td>
<td>JCIDS Intro (CLB 101)</td>
<td>CLB 101</td>
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</table>

| * DoD ACQ | ODSp level T&E considerations | TST 303                |             |          |           |                           |
| * DoD ACQ | T&E in a Rapid Acquisition context | TST 303                |             |          |           |                           |
| * DoD ACQ | DoD Open Sys. Arch. (CLC012)    | CLE 012                |             | Acq. = DAG Chp 4 (phase out 2014) |           |                           |
| Prob & Stats | Prob & Stats intro (CLE 035) | CLE 035                |             |          |           |                           |
| Risk | Risk Management (CLM 017) | CLM 017                | 5.5: 7.3 |          | Risk Management | 1 J |
| Risk | Risk Management (actions/process) | PMT 3521                | 5.5: 7.3 |          | Risk Management | 1 J |
| Risk | Differences between issues, risks and opportunities (tech transition context) | STM 202 / PMT 352A&B | 5.5: 7.3 |          | Risk Management | 1 J |
| Risk | Function of Risk Management as part of SE | SYS 101 / PMT 352B | 5.5: 7.3 |          | Risk Management | 1 J |

| SE - AoA | Trade Studies (CLE 026) | CLE 026                |             |          |           |                           |
| SE - Architect | Function of Architecture Design process as part of SE | STS 101 | 4.4: 9.2 |          |           |                           |
| SE - Architect | Role(s) played by a systems model (INCOSE HR includes prototyping) | STS 101 | 9.6 App. L (12) | 9.4.2 |          |                           |
| SE - Architect | Functional Analysis & Allocation (hierarchy within a system or SoS) | Appendices E & J | 9.2.2 |          |           |                           |
| SE - Architect | Architecture Synthesis | Appendix K |          |          |           |                           |
| SE - Config | Function of Configuration Management as part of SE | SYS 101 | 8.5 App. G (GB) | 9.2.5 |          |                           |
| SE - ECP | Engineering Change Proposals, Upgrades and Design Revisions | 77 | 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 mgmt & security) |          | |                           |

| TM - Tech | Tech. Readiness Assess. (CLE 021) | CLE 021 |             |          |           |                           |
| TM - Tech | Application of tech management & SE to technology development | STS 202 | 9.1 - 9.3 |          |           |                           |
| TM - Tech | Technology Project (cost, budget, risk, ramps, demo, TTA, data rights, trans.) | STS 303 / PMT 352B |          | | | |
| TM - Tech | Function of Technical Assessment process as part of SE | SYS 101 |          | | | |

| 155 | Total | Number of matches -> | 142 | 72 | 40 | 39 |
| 125 | Without DoD Acquisition | Number of matches -> | 112 | 60 | 39 | 29 |

| Coverage vs. full-spectrum of topics | 92% | 46% | 26% | 25% |
| Coverage vs. npm 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 | Assumes CSEP-Acq | 62% | | |
| Combined coverage vs. full-spectrum of topics | Assumes CSEP-Acq | 68% | | |
| Combined coverage vs. non-DoD Acquisition topics | Assumes CSEP-Acq | 71% | | |

| 0.75483871 | | | | | |

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*Assumes CSEP-Acq* refers to a specific set of criteria or standards provided by INCOSE CSEP. The values shown are percentages representing the coverage and overlap between different sets of topics or assessments.
Continuous Learning Requirements
Activities important to continuous professional growth...

- 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)

<table>
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<th>Professional Development Activities Mapped to Professional Certification Categories</th>
<th>INCOSE</th>
<th>INCOSE</th>
<th>ASEM</th>
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<td>EDUCATION &amp; TRAINING</td>
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<td>Earn a new degree</td>
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<td>Pass a college credit course</td>
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<td>Complete on-line training</td>
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<td>Complete self-directed learning</td>
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<td>Complete employer-in-house training</td>
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<td>Complete commercial (outside provider) training</td>
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<td>Complete initial / refresher training courses</td>
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<td>Attend conference technical session</td>
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<td>Exercises / drills</td>
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<td>Develop a training course</td>
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<td>Deliver an original presentation (e.g., conference paper)</td>
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<td>Originate / publish a technical procedure or method</td>
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<td>Participate in legislative / policy-making activity</td>
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<td>Submit exam item</td>
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<td>Review / quality exam items</td>
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<td>INCOSE Membership</td>
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<td>Attend chapter meeting / educational session</td>
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<td>Review prof dev. offerings (IEE recent comm. letter)</td>
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<td>Volunteer / community service in technical capacity</td>
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<td>Volunteer in Eng / fel (uncompensated)</td>
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<tr>
<td>Volunteer in STEM-specific activity</td>
<td>1 / hr</td>
<td>23</td>
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<tr>
<td>Volunteer in a leadership capacity (pro org / tech society)</td>
<td>1 / hr</td>
<td>24</td>
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<tr>
<td>CERTIFICATION, DESIGNATIONS &amp; LICENSURE</td>
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<tr>
<td>Obtain new state license</td>
<td>15 / license</td>
<td>29</td>
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<tr>
<td>Obtain new certification</td>
<td>15 / cert</td>
<td>30</td>
<td></td>
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<tr>
<td>Other professional accomplishments</td>
<td>TBD</td>
<td>51</td>
<td></td>
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<td></td>
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<tr>
<td>Designation as “Lead Systems Engineer”</td>
<td>15 / cert</td>
<td>16</td>
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</tbody>
</table>
The Professional Engineer Credential
Career Field of Interest: Industrial Engineering
## Maryland NCEES Information for PE

### Education / Experience / Exam requirements

<table>
<thead>
<tr>
<th>Education</th>
<th>Exams</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering (non-accredited)</td>
<td>FE / PE</td>
<td>8 years</td>
</tr>
<tr>
<td>Engineering Technology (non-accredited)</td>
<td>FE / PE</td>
<td>8 years</td>
</tr>
<tr>
<td>EAC / ABET Engineering Masters</td>
<td>FE / PE</td>
<td>3 years</td>
</tr>
<tr>
<td>EAC / ABET Engineering Bachelors</td>
<td>FE / PE</td>
<td>4 years</td>
</tr>
<tr>
<td>PhD in Engineering</td>
<td>FE / PE</td>
<td>3 years</td>
</tr>
<tr>
<td>Related Science</td>
<td>FE / PE</td>
<td>8 years</td>
</tr>
<tr>
<td>TAC / ABET Engineering Technology</td>
<td>PE only</td>
<td>8 years</td>
</tr>
<tr>
<td>High School</td>
<td>PE only</td>
<td>12 years</td>
</tr>
<tr>
<td>Related Science</td>
<td>None</td>
<td>20 years</td>
</tr>
</tbody>
</table>

Exams are administered by NCEES.

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

http://boards.ncees.org/view/index/board-1027-maryland_pe/2/
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)
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)
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)
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

Knowledge Areas: Section IV (slide 1 of 2)

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)

Accessed 21 Jan 2014
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
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
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.)