Developing the US Department of Defense Engineering Workforce

Aileen Sedmak

**Office of the Deputy Assistant Secretary of Defense
for Systems Engineering**

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DASD, Systems Engineering Mission

Systems Engineering focuses on engineering excellence – the creative application of scientific principles:

- To design, develop, construct and operate complex systems
- To forecast their behavior under specific operating conditions
- To deliver their intended function while addressing economic efficiency, environmental stewardship and safety of life and property

DASD(SE) Mission: Develop and grow the Systems Engineering capability of the Department of Defense – through engineering policy, continuous engagement with component Systems Engineering organizations and through substantive technical engagement throughout the acquisition life cycle with major and selected acquisition programs.

A Robust Systems Engineering Capability Across the Department Requires Attention to Policy, People and Practice

- *US Department of Defense is the World's Largest Engineering Organization*

- *Over 108,000 Uniformed and Civilian Engineers*

- *Over 39,000 in the Engineering (ENG) Acquisition Workforce*

DASD, Systems Engineering

DASD, Systems Engineering
Stephen Welby
Principal Deputy Kristen Baldwin

Systems Analysis
Kristen Baldwin (Acting)

Addressing Emerging Challenges on the Frontiers of Systems Engineering

Analysis of Complex Systems/Systems of Systems

Program Protection/Acquisition Cyber Security

University, FFRDC and Industry Engineering and Research

Modeling and Simulation

Major Program Support
James Thompson

Supporting USD(AT&L) Decisions with Independent Engineering Expertise

Engineering Assessment / Mentoring of Major Defense Programs

Program Support Reviews

OIPT / DAB / ITAB Support

Systems Engineering Plans

Systemic Root Cause Analysis

Mission Assurance
Robert Gold

Leading Systems Engineering Practice in DoD and Industry

Systems Engineering Policy & Guidance

Development Planning/Early SE

Specialty Engineering (System Safety, Reliability and Maintainability Engineering, Quality, Manufacturing, Producibility, Human Systems Integration)

Counterfeit Prevention

Technical Workforce Development

Standardization

Providing technical support and systems engineering leadership and oversight to USD(AT&L) in support of planned and ongoing acquisition programs

Why Engineering is Important to the DoD Mission

- **Department of Defense develops and delivers to our soldiers, sailors, marines, and airmen incredibly effective but increasingly complex weapon systems, and as the complexity of our systems has increased, so has the need for effective systems engineering throughout the life cycle.**

- **Engineers play a vital role in fielding high-quality, affordable, supportable, and effective defense systems**
  - Evolving and verifying an integrated, total life cycle balanced set of systems, people, and process solutions that satisfy the customer's needs and meet department affordability goals
  - Requires technical competency, critical and strategic thinking, knowledge of various product domains, and knowledge of other engineering disciplines

- **DoD Engineers**
  - Help program managers identify and mitigate risks
  - Shape DoD technical planning and management
  - Support knowledge-based decision making
  - Provide technical depth of acquisition policy and processes
  - Provide a balanced solution for affordable and capable systems

Mission Focus of Engineering Workforce

- **DoD Laboratory Enterprise is largest in Federal Government**
  - Ensure U.S. technological superiority, prepare for an uncertain future, and accelerate delivery of technical capabilities to the warfighter
  - Advance basic sciences with horizon potential, develop militarily relevant technology which transition to industry, and provide quick response and prototyping capability for emerging threats to enable warfighters in any contingency

- **Service Commands (SYSCOMs/MAJCOMs/ASCCs)**
  - Develop, procure, and sustain materiel to meet warfighting capabilities

- **Depots**
  - Focus on total sustainment, including design, manufacture, repair and overhaul, of hundreds of systems
  - Support warfighter readiness through superior design, manufacture, fielding, maintenance receipt, storage, issue, demilitarization and renovation of equipment

Better Buying Power 3.0 (Draft)

Achieving Dominant Capabilities Through Technical Excellence and Innovation

Achieve Affordable Programs
- Continue to set and enforce affordability caps

Achieve Dominant Capabilities While Controlling Lifecycle Costs
- Strengthen and expand "should cost" based cost management
- Build stronger partnerships between the acquisition, requirements, and intelligence communities
- Anticipate and plan for responsive and emerging threats
- Institutionalize stronger DoD level Long Range R&D Planning

Incentivize Productivity in Industry and Government
- Align profitability more tightly with Department goals
- Employ appropriate contract types, but increase the use of incentive type contracts
- Expand the superior supplier incentive program across DoD
- Increase effective use of Performance-Based Logistics
- Remove barriers to commercial technology utilization
- Improve the return on investment in DoD laboratories
- Increase the productivity of IR&D and CR&D

Incentivize Innovation in Industry and Government
- Increase the use of prototyping and experimentation
- Emphasize technology insertion and refresh in program planning
- Use Modular Open Systems Architecture to stimulate innovation
- Increase the return on Small Business Innovation Research (SBIR)
- Provide draft technical requirements to industry early and engage industry in funded concept definition to support requirements definition
- Provide clear "best value" definitions so industry can propose and DoD can choose wisely

Eliminate Unproductive Processes and Bureaucracy
- Emphasize Acquisition Executive, Program Executive Office and Program Manager responsibility, authority, and accountability
- Reduce cycle times while ensuring sound investments
- Streamline documentation requirements and staff reviews

Promote Effective Competition
- Create and maintain competitive environments
- Improve technology search and outreach in global markets

Improve Tradecraft in Acquisition of Services
- Increase small business participation, including more effective use of market research
- Strengthen contract management outside the normal acquisition chain
- Improve requirements definition
- Improve the effectiveness and productivity of contracted engineering and technical services

Improve the Professionalism of the Total Acquisition Workforce
- Establish higher standards for key leadership positions
- Establish stronger professional qualification requirements for all acquisition specialties
- Strengthen organic engineering capabilities
- Ensure the DoD leadership for development programs is technically qualified to manage R&D activities
- Improve our leaders' ability to understand and mitigate technical risk
- Increase DoD support for Science, Technology, Engineering and Mathematics (STEM) education
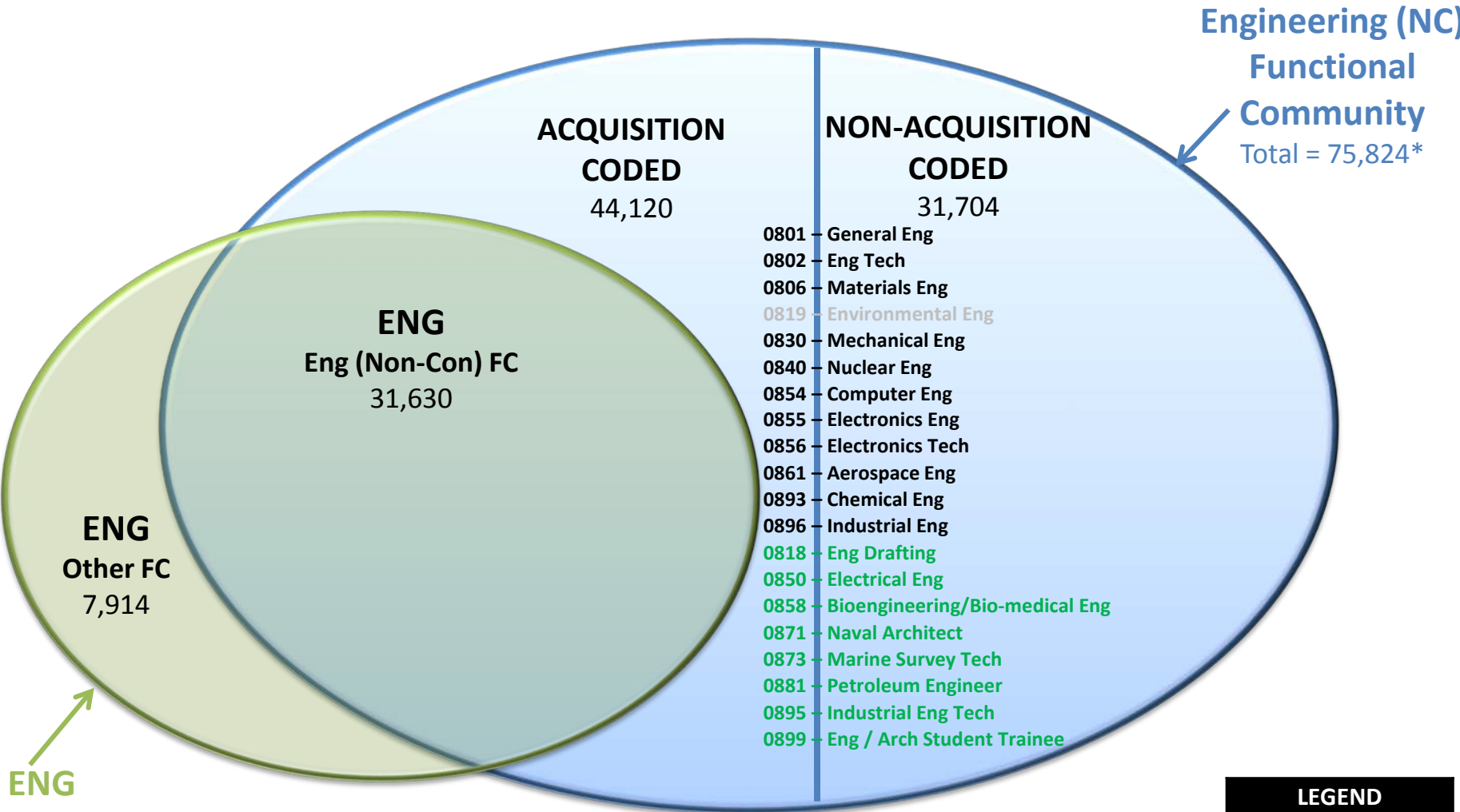
Continue Strengthening Our Culture of Cost Consciousness, Professionalism, and Technical Excellence

Current State of the DoD Engineering Workforce

Future State: Engineering (Non-Construction) Functional Community and the Acquisition Engineering (ENG) Workforce

Engineering (NC) Functional Community
Total = 75,824*

ACQUISITION CODED
44,120

NON-ACQUISITION CODED
31,704

0801 – General Eng
0802 – Eng Tech
0806 – Materials Eng
0819 – Environmental Eng
0830 – Mechanical Eng
0840 – Nuclear Eng
0854 – Computer Eng
0855 – Electronics Eng
0856 – Electronics Tech
0861 – Aerospace Eng
0893 – Chemical Eng
0896 – Industrial Eng
0818 – Eng Drafting
0850 – Electrical Eng
0858 – Bioengineering/Bio-medical Eng
0871 – Naval Architect
0873 – Marine Survey Tech
0881 – Petroleum Engineer
0895 – Industrial Eng Tech
0899 – Eng / Arch Student Trainee

ENG
Eng (Non-Con) FC
31,630

ENG
Other FC
7,914

ENG
Total = 39,544

Sources:
*DCPDS, 30 September 2013
AT&L Defense Acquisition Workforce Data Mart, 30 September 2013

LEGEND	
Grey	Outgoing
Green	Incoming

Geographic Distribution of DoD Engineering Workforce

Map of the United States showing DoD engineering workforce values by state:

- WA: 3,733
- OR: 375
- CA: 10,368
- NV: 144
- ID: 85
- MT: 53
- WY: 45
- UT: 1,849
- CO: 666
- AZ: 760
- NM: 1,440
- ND: 101
- SD: 61
- NE: 425
- KS: 174
- OK: 2,273
- TX: 2,240
- MN: 168
- IA: 40
- MO: 671
- AR: 308
- LA: 659
- WI: 86
- IL: 1,035
- MI: 1,421
- IN: 1,892
- OH: 3,285
- KY: 466
- TN: 536
- MS: 1,051
- AL: 4,718
- GA: 2,915
- FL: 4,615
- SC: 1,165
- NC: 1,163
- VA: 9,317
- WV: 207
- PA: 2,385
- NY: 986
- ME: 1,526
- NH: 82
- VT: 6
- MA: 745
- RI: 1,694
- CT: 250
- NJ: 3,509
- DE: 42
- MD: 9,618
- DC: 2,834
- HI: 2,126
- AK: 297

Other OCONUS:

Foreign Countries	1,472
U.S. Territories	237
Unspecified	22

Color	Population
	5000+
	1000-5000
	500-1000
	100-500
	0-100

Data Source: FedScope, 30 September 2013

Acquisition 08XX Engineers

- ## Over 67% of Acquisition Engineers are in the Engineering Career Field

| 08XX Engineers by Acquisition Career Field	
Acquisition Career Field	**08XX Total**
Engineering	31,965
Test & Evaluation	5,127
Facilities Engineering	4,848
Science & Technology Manager	1,976
Production, Quality, & Manufacturing	1,194
Program Management	1,013
Contracting	772
Business	224
Life Cycle Logistics	173
Information Technology	110
Industrial/Contract Property Mgmt	2
Unknown	1
Grand Total	**47,405**

Acquisition Engineering Career Field 08XX by Series		
Civilian Occupational Series	**Total**	**% of ENG**
0855 - Eng., Electronics	10,580	26.8%
0801 - Eng., General	7,249	18.3%
0830 - Eng., Mechanical	5,573	14.1%
0861 - Eng., Aerospace	2,728	6.9%
0854 - Eng., Computers	2,452	6.2%
0850 - Eng., Electrical	1,288	3.3%
0893 - Eng., Chemical	486	1.2%
0896 - Eng., Industrial	439	1.1%
0871 - Architect, Naval	367	0.9%
0806 - Eng., Materials	327	0.8%
0803 - Eng., Safety	136	0.3%
0819 - Eng., Environmental	118	0.3%
0802 - Eng. Technician	84	0.2%
0810 - Eng., Civil	77	0.2%
0856 - Eng. Technician, Electronics	36	0.1%
0858 - Eng., Biomedical	12	0.0%
0899 - Eng./Arch. Student Trainee	4	0.0%
0804 - Eng., Fire Prevention	4	0.0%
0840 - Eng., Nuclear	3	0.0%
0873 - Ship Surveyor	2	0.0%
Grand Total	**31,965**	**80.8%**

Data Source: AT&L DAW Data Mart, 30 September 2013

Acquisition Engineering Workforce Age Demographics
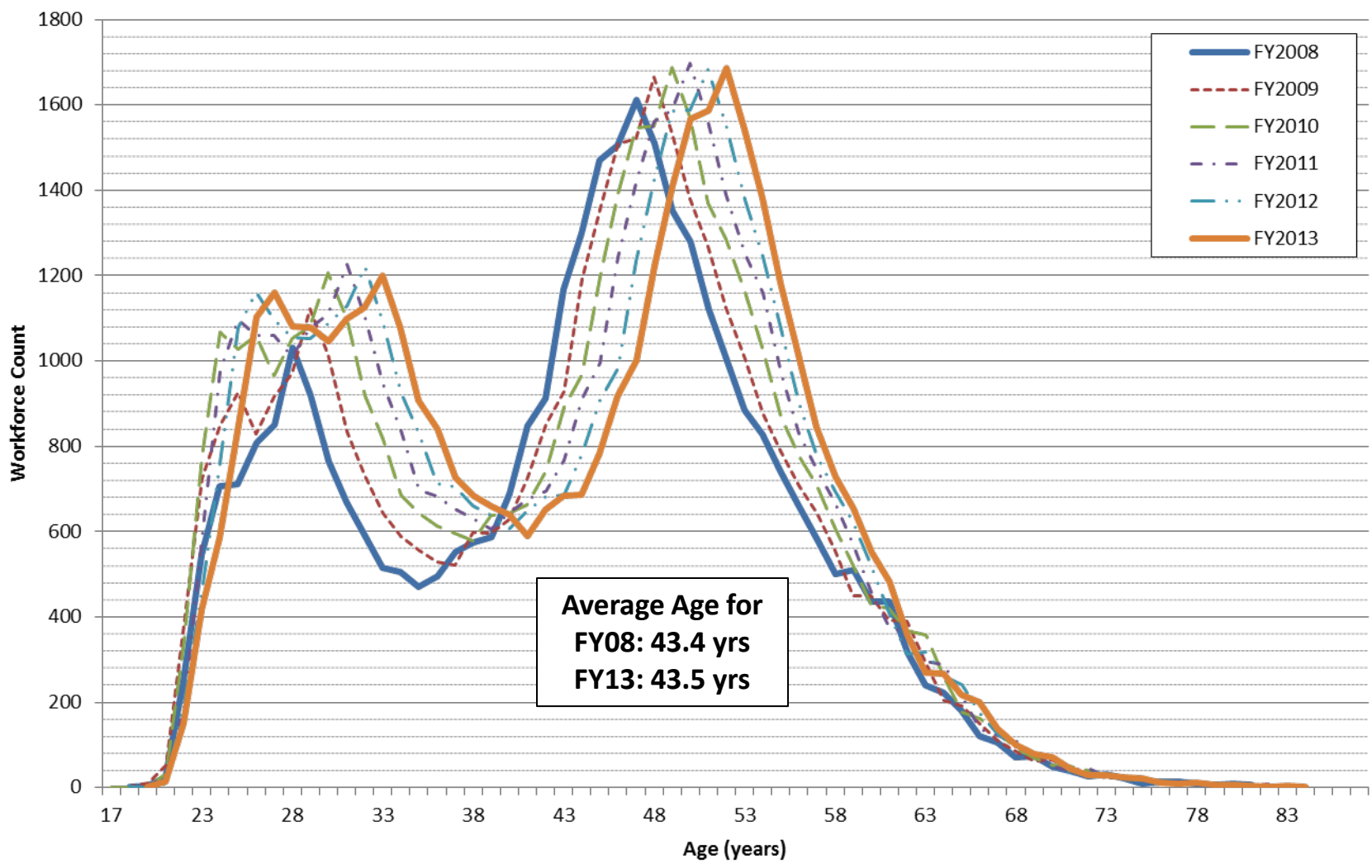
Average Age for
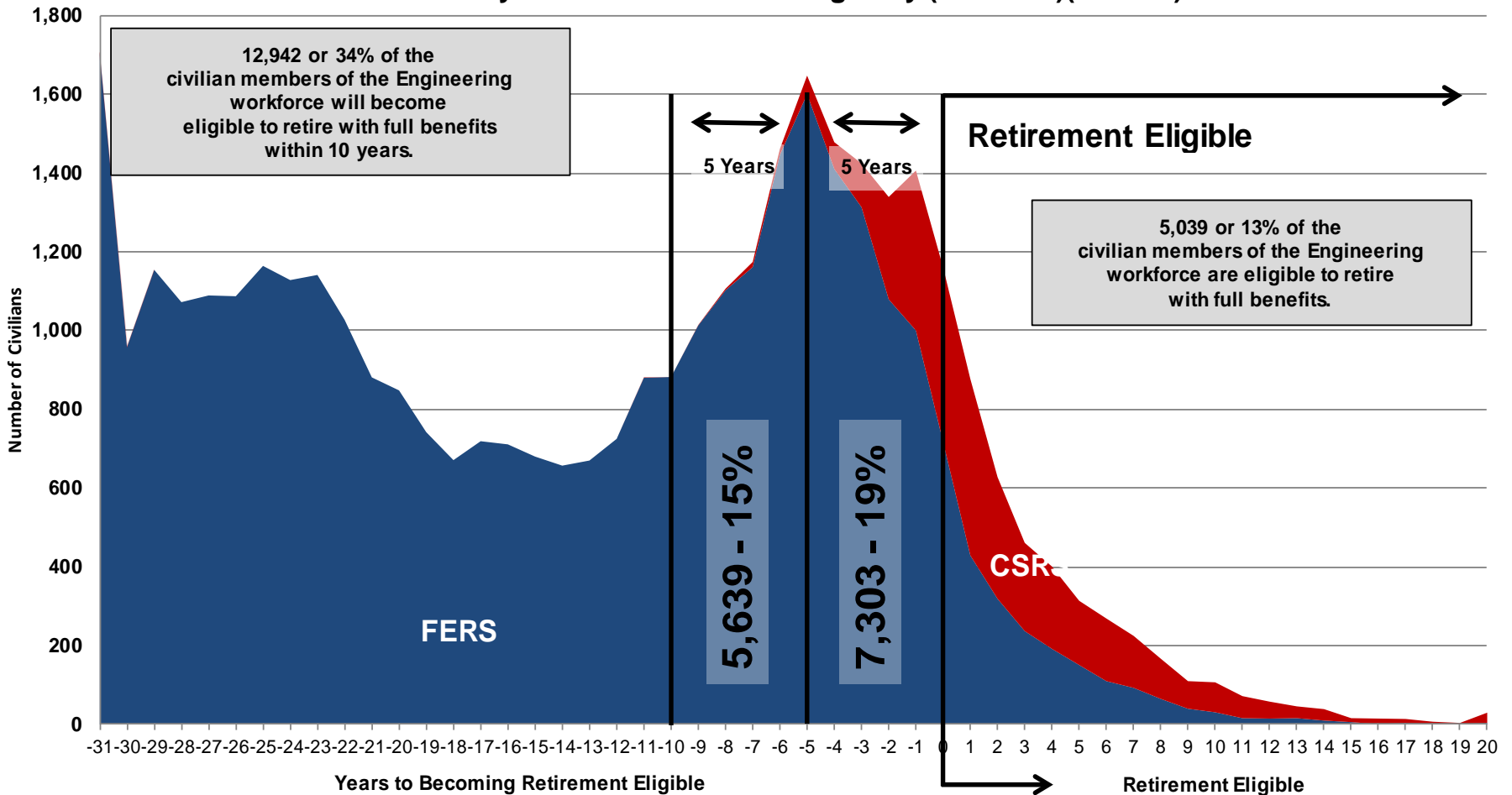FY08: 43.4 yrs
FY13: 43.5 yrs

Data Source: AT&L DAW Data Mart, 30 September 2013

FY 2013 Engineering Workforce Distribution by Years to Retirement Eligibility

Defense Acquisition Workforce - Engineering

### Distribution by Years to Retirement Eligibility (Civilians)(FY2013)

12,942 or 34% of the civilian members of the Engineering workforce will become eligible to retire with full benefits within 10 years.

5 Years   **5 Years**

Retirement Eligible

5,039 or 13% of the civilian members of the Engineering workforce are eligible to retire with full benefits.

5,639 – 15%

7,303 – 19%

FERS

CSRS

Number of Civilians

1,800 1,600 1,400 1,200 1,000 800 600 400 200 0

-31 -30 -29 -28 -27 -26 -25 -24 -23 -22 -21 -20 -19 -18 -17 -16 -15 -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Years to Becoming Retirement Eligible

Retirement Eligible

Acquisition Engineering Career Field

ENG Career Field by Component
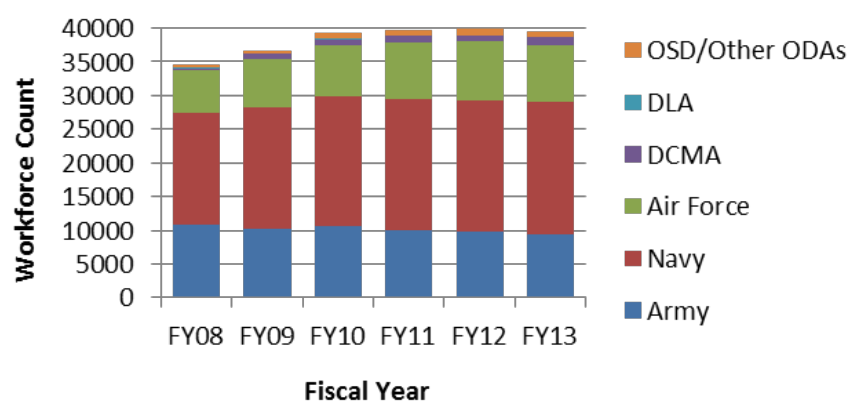
Component Rollup	FY 2013 Count	%
Army	9,419	23.8%
Navy	19,588	49.5%
Air Force	8,521	21.5%
DCMA	1,134	2.9%
DLA	12	0.0%
OSD/Other ODAs	870	2.2%
Grand Total	**39,544**	

ENG Career Field Military vs. Civilian
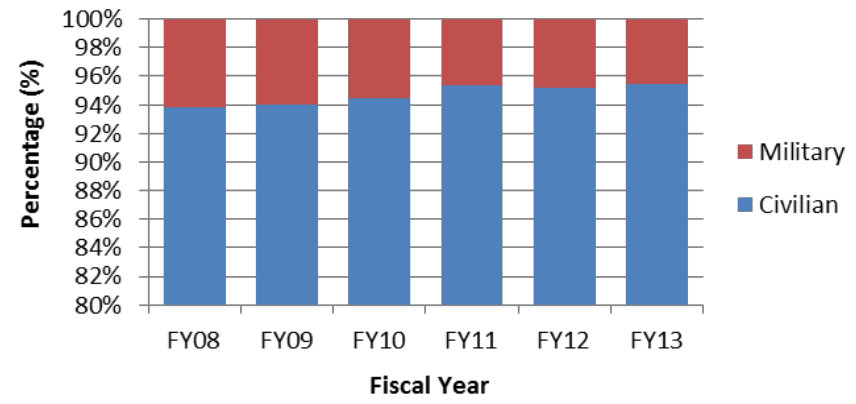
Top ENG Occupational Series	FY 2013 Count	%
0855-Engineer, Electronics	10,580	26.8%
0801-Engineer, General	7,249	18.3%
0830-Engineer, Mechanical	5,573	14.1%
1550-Computer Scientist	3,039	7.7%
0861-Engineer, Aerospace	2,728	6.9%
0854-Engineer, Computers	2,452	6.2%
Military	1,795	4.5%
0850-Engineer, Electrical	1,288	3.3%
Other	4,840	12.2%
Career Field Total	**39,544**	

Data Source: AT&L DAW Data Mart, 30 September 2013

Engineering Workforce Concerns

Ability to Recruit and Retain in an Improving Economic State

Quarter-to-Quarter Growth in Real GDP
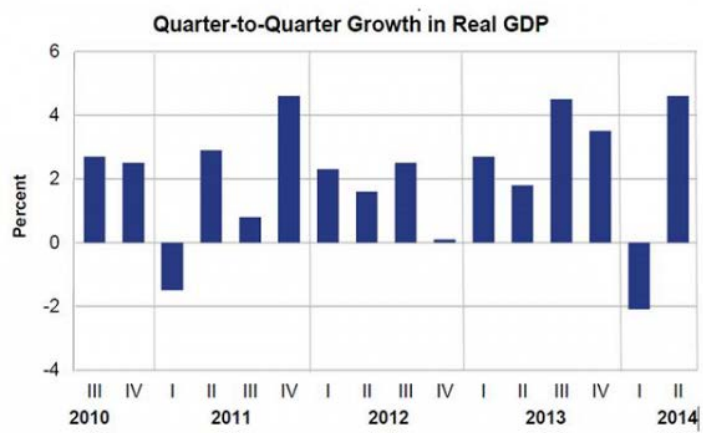
Real GDP growth is measured at seasonally adjusted annual rates.

Source: *GDP Turns up in Second Quarter*, published on *Economics and Statistics Administration*, September 26, 2014. Retrieved from http://www.esa.doc.gov/print/Blog/2014/09/26/gdp-turns-second-quarter

Industrial Production Index
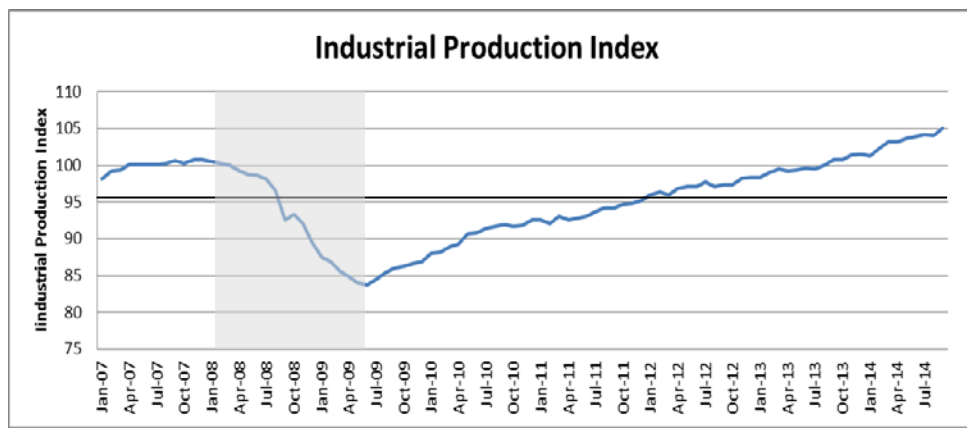
Data Source: Federal Reserve – Industrial Production and Capacity Utilization Historical Data
Note: The shaded areas are periods of business recession as defined by the National Bureau of Economic Research (NBER).

- **Private sector expansions create greater talent competition for the Department**

- **How do our technical workforce requirements/needs compare with industry needs?**

How does DoD retain engineers in this economy?

Our Ability to Compete for Talent

- **2013 Universum survey of 9,770 Undergrad Engineering Majors from US based schools determined the top 10 Ideal employers for engineers:**

1.	NASA*	6.	Lockheed Martin
2.	Google	7.	GE
3.	Boeing	8.	Disney
4.	Apple	9.	US Department of Energy*
5.	Microsoft	10.	Exxon Mobile

NASA (received 19.4 % of votes) is known among US engineering schools as employer of prestige, innovation and recruiting the best students (most common answers to why they chose NASA)

How do we effectively recruit leveraging best practices used by other employers?

Recruitment and Retention Concerns

- **U.S. engineering workforce reaching a critical state**
  - Current trends indicate that the demand for a technical workforce will increase
  - U.S. ability to produce STEM graduates is insufficient to fill the target engineering workforce demands

- **Nearly 50% of the acquisition Engineering workforce will be eligible to retire by 2023**
  - Market for the best engineering talent will remain highly competitive
  - Need to grow our engineers to maintain capability, capacity, and competence
  - Current and potential future budget constraints will inhibit the Department's ability to maintain or grow its workforce size

How do we maintain and expand on the capability and capacity of the Engineering Workforce?

Engineering Demographic Concern

Percent of Students with US Citizenship or Permanent Residency
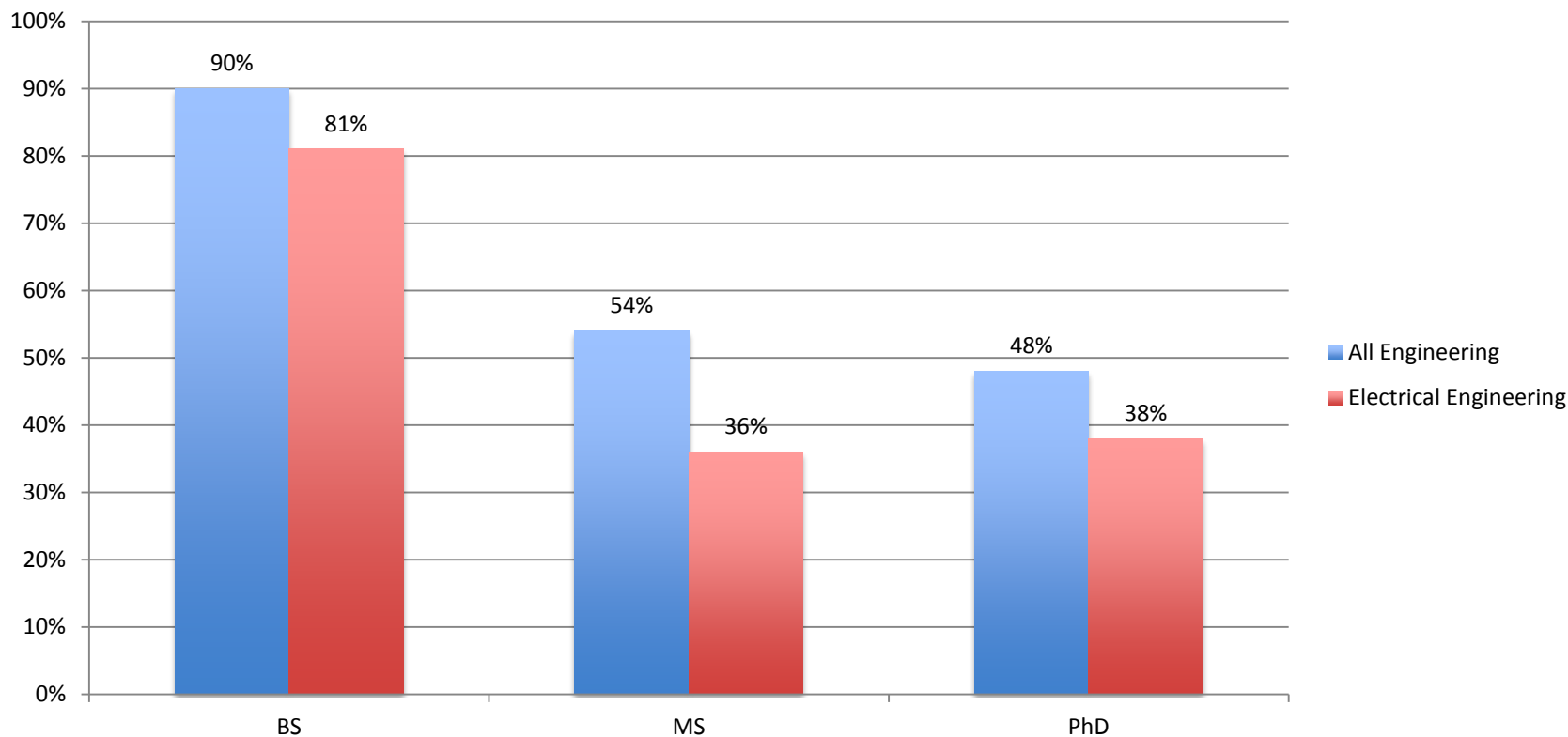
Source: Navid Yazdani, Lincoln Laboratory, MIT

Less than 60% of advanced degrees in engineering from top 25 US universities are awarded to US citizens

Growing Great Engineers

- ## Depth
  - Extensive expertise and experiences in one or more engineering disciplines and in one or more product domains

- ## Breadth
  - Awareness of and appreciation for other functional areas
  - Understanding of system lifecycle and processes
  - Knowledge of other engineering disciplines and how they integrate into a system solution
  - Knowledge of product domains

- ## Leadership
  - Ability to motivate and inspire individuals and teams
  - Comfort in dealing with complexity
  - Focus on underpinning decisions with data
  - Capability to make tough technical decisions

Growing capability, capacity and competence

On-going / Current Engineering Workforce Initiatives

Engineering Workforce Initiatives

- **Better Buying Power: Improve Professionalism of the Total Acquisition Workforce**
  - Establish higher standards for key leadership positions (i.e., Key Leadership Position Qualification Board) [BBP 2.0/BBP 3.0 (DRAFT)]
  - Strengthen organic engineering capabilities [BBP 3.0 (DRAFT)
  - Improve our leaders' ability to understand and mitigate technical risk [BBP 3.0 (DRAFT)]

- **Systems Engineering Research Center: Human Capital Development Research Portfolio**

- **Science, Technology, Engineering and Mathematics (STEM)**

Chief Engineering/Lead Systems Engineering Key Leadership Position (KLP) Qualification Board (Q-Board)

Sec 1706 of Title 10 requires "properly qualified" members in cited positions on MDAPs/MAIS
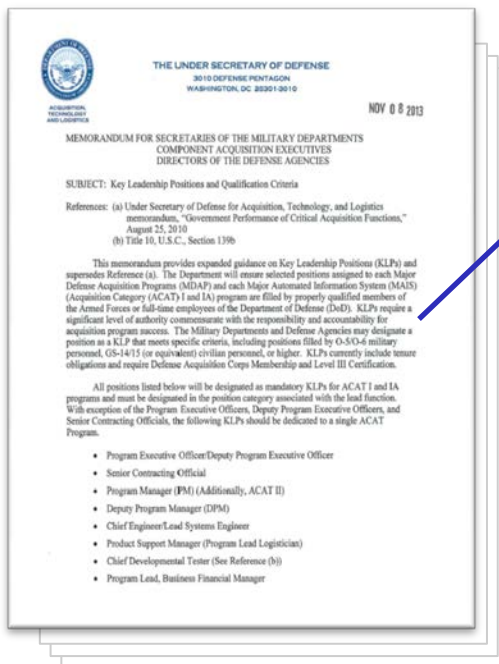
Nov 8 2013 USD (AT&L) Memo on KLP and Qualification Criteria

- "…will <u>establish</u> a Joint <u>KLP Qualification Board</u>, to be stood up in CY 2014, will prescreen Defense Acquisition Workforce personnel <u>to qualify a pool of candidates</u> to these important positions."

- "They will <u>simply identify individuals as prepared</u> to fill mandatory KLPs based on their training, education, and experience."

- "To aid in evaluating and selecting the <u>best qualified</u> KLP candidates, <u>five factors</u> have been identified as requirements essential for selection …"

- "KLP candidates are <u>expected to meet all five requirements prior to assignment</u>."

- "… prequalify people to fill mandatory KLPs in a <u>consistent and standardized manner across the DoD</u>."

- KLP Q-board will: "Be <u>comprised</u> of the <u>acquisition functional leads</u> from all Services, appropriate Agencies, …."

Strengthen Organic Engineering Capabilities

- **Focus on strengthening the Department's organic military and government civilian technical expertise by broadening implementation of programs <u>conducting</u> an appropriate level of <u>early product design and development using</u> technical <u>in-house capabilities</u>**

- **Ensure <u>DoD</u> is a <u>more informed buyer</u>, allowing for better acquisition strategy and RFP development and contract control**

- **<u>Benefit Industry</u> by <u>receiving better requirements definition and information</u> to improve their ability to plan and execute design and development activities**

Improve our Leaders' Ability to Understand and Mitigate Technical Risk

- **Focus on ensuring that the <u>enterprise</u> has the <u>knowledge</u> to make <u>informed decisions</u> based on <u>well-characterized technical estimates</u> of likely outcomes differentiating excellent acquisition organizations from merely adequate ones**

- **Institute the appropriate <u>tools, processes, and governance</u> needed to <u>build</u> technical <u>risk management credibility</u> in and across the Department**

- **Improve <u>government-industry alignment</u> of approaches to <u>risk</u> definition and monitoring**

Current SERC Human Capital Development Initiatives

Utilizing Systems Engineering Research Center (SERC) to conduct research to develop and improve the Department's human capital

- **Helix**
  - Understanding SE workforce to best leverage engineering talent

- **Experience Accelerator**
  - Developing SE skills more rapidly

- **SE Capstone Marketplace**
  - Developing next generation of SE talent through multidisciplinary projects

- **SYS 350 A/B/C**
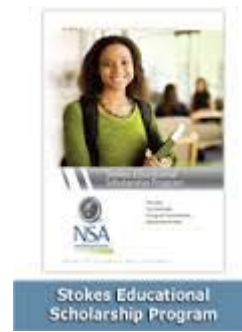 - Developing SE Technical Leadership

OSD Sponsored STEM Programs

- **Outreach supporting Federal STEM Initiatives**
  - DoD STARBASE Program

- **DoD STEM Mission Focused**
  - National Defense Education Program (NDEP) Science, Mathematics, and Research for Transformation (SMART)
  - Stokes Educational Scholarship Program

Service STEM Programs

- **Outreach supporting Federal STEM Initiatives**
  - Army Educational Outreach Program (AEOP)
  - Navy STEM2STERN

- **DoD Mission-Focused STEM**

  Air Force
  - University Nanosatellite Program
  - Awards to Stimulate and Support Undergraduate Research Experiences (ASSURE)
  - National Defense Science and Engineering Graduate Fellowship Program (NDSEG)

  Navy
  - Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) Research and Education Partnership

Conclusion

- **Engineering is vital to the Department's mission**

- **Future workforce concerns are tied to recruiting, developing, and retaining a diverse set employees in a competitive environment**

- **Current/on-going efforts work towards addressing these concerns**

For Additional Information

Aileen Sedmak

ODASD, Systems Engineering
703-695-6364 | aileen.g.sedmak.civ@mail.mil

Systems Engineering: Critical to Defense Acquisition

Defense Innovation Marketplace
http://www.defenseinnovationmarketplace.mil

DASD, Systems Engineering
http://www.acq.osd.mil/se