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McKernan, Megan; Drezner, Jeffrey; Munson, Ken; Anton, Philip; Newberry, Sydne; Levedahl, Alexis

Monterey, California. Naval Postgraduate School

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Assessing Department of Defense Use of Data Analytics and Enabling Data Management to Improve Acquisition Outcomes

Philip Anton and Megan McKernan, RAND NDRI
Naval Postgraduate School's 17th Annual Acquisition Research Symposium



Congressional Tasking:

The briefing from the Secretary of Defense shall address:

Status Quo

Extent



“The **extent to which data analytics capabilities have been implemented** within the military services, DOD laboratories, test centers, and [FFRDCs] to provide technical support for acquisition program management”

Opportunities

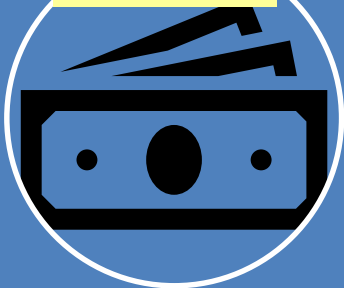
Increase Use



“The **potential to increase the use of analytical capabilities** for acquisition programs and offices to improve acquisition outcomes”

Status Quo

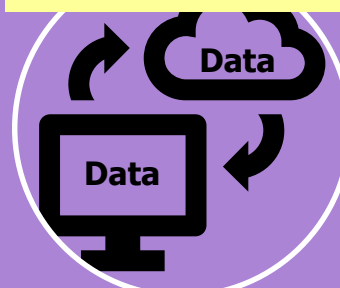
R&D



“The **amount of funding** for intramural and extramural **research and development activities to develop and implement data analytics capabilities** in support of improved acquisition outcomes”

Opportunities

Efficient Data



“Any **potential improvements, based on private-sector best practices, in the efficiency of current data collection and analysis processes that could minimize collection and delivery of data** by, from, and to government organizations”

Status Quo

Expose Data



“**Steps** being taken to appropriately **expose acquisition data** in an anonymized fashion to **researchers and analysts**”

Status Quo

Train



“Whether the **curriculum** at the National Defense University, the Defense Acquisition University, and appropriate private-sector academic institutions includes appropriate **courses on data analytics and other evaluation-related methods** and their application to defense acquisitions”

Research approach addresses the breadth of Congressional topics: data, analysis, and improvement opportunities

- Inputs:
 - Discussions with select stakeholders
 - Existing literature, public budget exhibits, policies, legislation, training course catalogs and curricula; inventories of relative IT systems
 - Experience, knowledge, and judgement of authors, as noted
- Study techniques
 - Functional decomposition and mapping; workforce cost analysis; budget and solicitation analysis; literature review and analysis; analysis of industry best practices; analysis of DoD data management and analytic activities.
- Assumptions
 - Data analytics are a means for improving decisions
 - *We lay out analytics that support specific decisions, but we generally do not directly study cause-and-effect*
 - Advanced business analytics have some DoD applications
 - *Found some application and explorations, but further applications require continued investigation*

Research approach embraces the breadth of congressional interest with some limitations on study scope and depth

- Broad scope driven by inclusive definitions of “acquisition” and “analytics” (see next slide) as well as the broad nature of Congress’s questions
- Did not assess what specific acquisition data or data analytics are needed
- A survey (a “data call”) was proposed to solicit specific examples of data analytics underway in the DoD acquisition community, but it was deemed infeasible within available time and resources
 - In lieu of a survey, primary inputs include discussions with select stakeholders; existing literature; public budget exhibits; policies and legislation; training catalogs and curricula; and inventories of relevant IT information systems
- Experience, knowledge and author judgment was used to synthesize information and fill gaps in primary inputs, published research and other secondary data
 - Where author judgment is applied, it is noted

We used the following broad definitions of *Acquisition* and *Data Analytics* based on DoD's definition and Congressional language

Acquisition

The conceptualization, initiation, design, development, test, contracting, production, deployment, integrated product support (IPS), modification, and disposal of weapons and other systems, supplies, or services (including construction) to satisfy DoD needs, intended for use in, or in support of, military missions.

Defense Acquisition
University (DAU), 2017

Data Analytics

Data analysis, measurement, and other evaluation-related methods (i.e., techniques to assess and analyze data) to inform acquisition decisions, policymaking, program management, evaluation, and learning.

(based on conference
report elements)

Bottom-Line Conclusions (in prose)

Acquisition data analytics is extensive:

- DoD Data and analytics supports acquisition decision-making through a wide range of acquisition functions
 - Those functions include fields used for decades: e.g., engineering, test and evaluation, cost estimating, auditing, and many others
 - The data analytics employed by these applied functions range from simple empirical methods to advanced engineering and estimating approaches
- It is difficult to precisely measure the magnitude of annual investment in data analytics, but rough macro-level, parametric estimates are in the billions of dollars.
- Cases of some major acquisition program decisions that went counter to the extant data and analysis appear to have been made for other strategic reasons or drivers—not for broad lack of data analytics

Still, there is room for improvement:

- Applying advanced commercial business data analytics to DoD acquisition program data is limited and mostly in the exploratory phase
- Barriers to expanded data and analytics include:
 - Some cases of inefficient collection and lack of sharing data due to cultural, security, and investment issues
 - Limited analytic desktop software for general staff
 - Workforce trained on job-specific data analytics rather than broader analytic skills
- Progress has been made to:
 - Apply commercial best practices to efficient data management and sharing
 - Add commercial business intelligence tools (e.g., Tableau, QlikSense) to information systems to facilitate data processing, analysis, and visualization
 - Offer new courses in data analytics at acquisition training institutions
- Continued investments and progress is needed
 - DoD appears to recognize this based on continued (albeit constrained) investments

Q1. To what extent have data analytics capabilities been implemented?

Findings:

- The breadth of data analytics across acquisition functions gives a measure of extent (*see next slide*)
- Spending indicates extent:
 - One estimate: \$11–15 billion/year on analytic-related workforce
 - About \$3 billion/year on IT systems for acquisition (FY 2019 budget exhibits)
 - *Major IT systems supporting acquisition processes and data collection. Some have analytic layers.*
- Data analyses are often available, but final decisions reflect risks and other equities

A breadth of DoD data analytics support acquisition functions and decisions

Data Management (examples)

- Strategy, planning, and budgeting
- Data requirements and use cases
- Authoritative sourcing
- Collection, archiving, curation, and sharing
- Security
- Backup and recovery
- Training and support
- Data definitions and standards
- Assessment, auditing, cleaning, and transformation
- Purging



Analytic Techniques (Examples)

General:

- Quantitative analysis, qualitative analysis, data mining, statistical analysis, machine learning (e.g., classification, clustering, outlier detection, filtering), semantic analysis (e.g., natural language processing, text analytics, sentiment analysis, and visual analysis (e.g., heat maps, time series plots, network graphs, spatial data mapping), etc.

Applied:

- Market research, requirements analysis, mission analysis, technical maturity analysis, risk analysis and framing assumptions, DoD's risk-management framework, affordability analysis, cost estimating, schedule analysis, analysis of alternatives, tradeoff analysis, budget analysis, legal and policy analysis, engineering analysis, T&E, security, quality analysis, supply chain analysis, reliability and life-cycle sustainment analysis, contracting analysis, production analysis, auditing, sustainment analysis, etc.

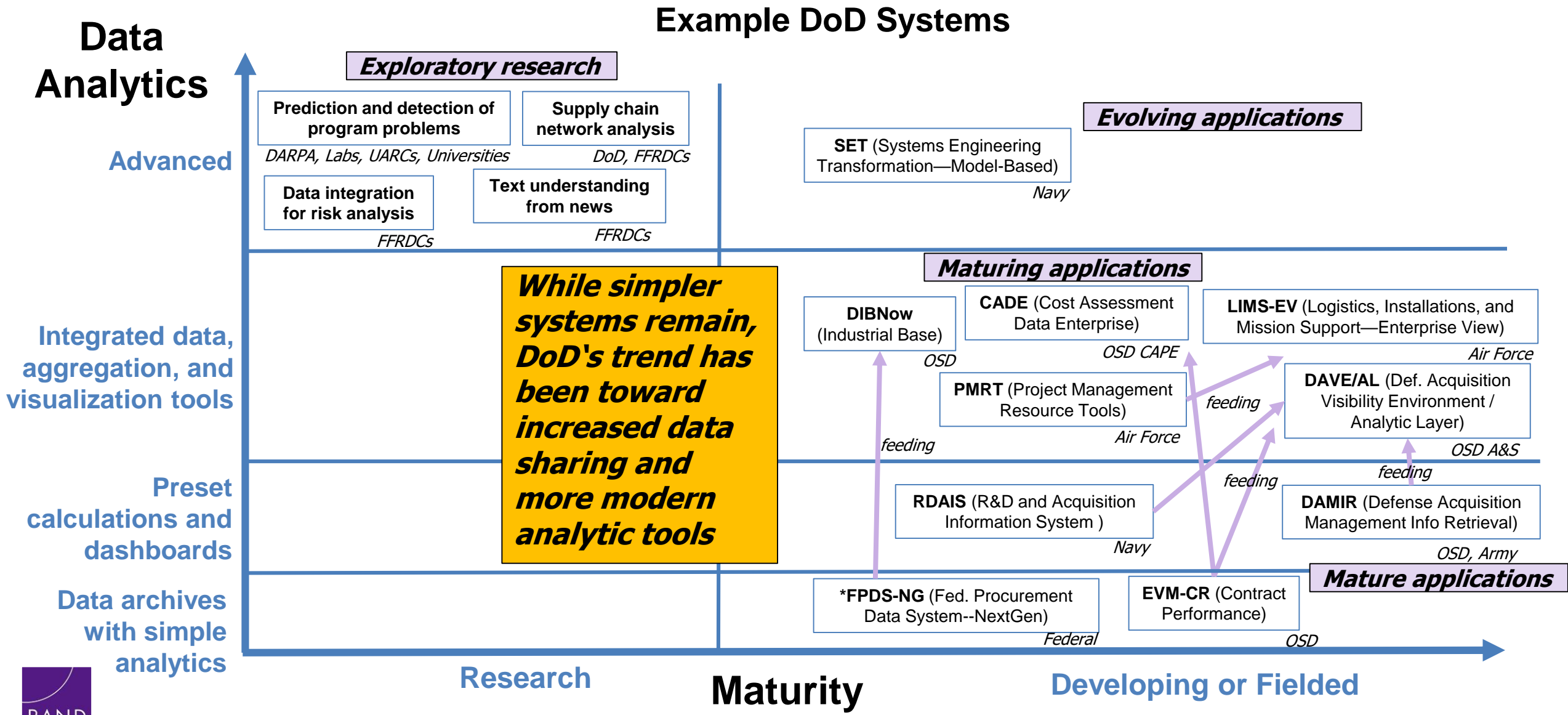


Acquisition Decision-Making

- Congress
- Defense acquisition executive and others at OSD
- Component Acquisition Executive
- Program Executive Officer
- Program Manager

Key Enabler

DoD systems are evolving from isolated data to shared data with analytic layers; More advanced analytics are exploratory



Q2. What is the potential to increase the use of analytic capabilities to improve acquisition outcomes?

Findings: Options include:

- Develop a data-analytics strategy between acquisition domains
- Continue maturing data collection, access, and analytic layers on systems
- Expand analytic tool availability
- Create statutory authorities for external analyst protected access to data
- Establish policy of full data access for analysts

- Improved decision-maker incentives and understanding of data analytics may improve use of available data
- Expand types of analysis

Perspectives:

- Commercial advanced data analytics do not always apply to government
 - Even industry has problems implementing data analytics
- Need more predictive indicators
- Data analytics will not eliminate acquisition risks

Q3. How much R&D funding is there to develop and implement data analytic capabilities?

Findings:

- FY 2019 DoD RDT&E budget request:
 - Estimate: roughly \$200 million (+/- 80%) across 31 program elements (PEs)
 - *Found specific discussion related to data analytics for acquisition*
 - \$520 million/year for IT systems (up from \$313 million in FY 2017)
 - *Provides data and sometimes have analytic layers*
- Some SBIR and STTR topics in January 2019 solicitations for acquisition data analytics
- Found anecdotes of exploratory research on advanced analytics for acquisition

Notes:

- This does not include R&D outside acquisition proper
 - Military operations, budgeting, requirements, or intelligence analysis in support of acquisition
- Again, direct application of advanced commercial data analytics is challenging

Q4. What are private-sector best practices that could minimize collection and delivery of data by, from, and to government organizations?

Findings:

- Private-Sector best practices include:
 - Identify specific questions that leadership needs to answer in order to make informed decisions
 - Plan and prioritize what data are needed using an organization's data strategy
 - Define data and establish common definitions between organizations using that data
 - Designate single authoritative source for each datum or dataset, then share existing authoritative datasets between systems via technical means
 - Emphasize that data are corporate-wide assets, not owned by local units

DoD adoption to date:

- DoD is pursuing most of these practices
 - Common PM tool suites are less common but being pursued
 - Other acquisition IT systems provide data feeds (e.g., contracting, auditing)
 - Open systems and data sharing have reduced duplication and ensured common data
 - Data-element sensitivity meta-labeling
- Data sharing and ownership challenges remain

Opportunities:

- Continue pursuing relevant best practices from the private sector
- Clarify that data are DoD-wide assets and address disincentives to data sharing
 - Clarify oversight extent and roles
 - Continue research on sensitivity upgrades from data-aggregation

Q5. What steps are being taken to expose anonymized data to researchers and analysts?

Findings:

- Generally, DoD is not anonymizing acquisition data for various reasons
 - A counter-example is Personally Identifiable Information (PII)
- DoD is:
 - Identifying available data
 - Improving internal data transparency through technical means
 - Adding researcher and analyst accounts on data systems
 - Removing classified and sensitive data elements before publishing

Perspectives:

- Anonymization has significant limitations
 - Some anonymization can be broken with modern correlation tools
 - Meta-data are required for correlation analysis and cannot be anonymized
 - Data sensitivity is often not stored at the data element level
 - Procedures for categorizing and handling sensitive data are complicated, slow, and not well understood; incentives impede progress
 - Aggregating data can increase data sensitivity and classification

Opportunities:

- Process data in a clean room
 - Limits use of anonymization-breaking tools
- Possible option: blind analysis
 - Algorithms run in a black box, only showing the results
 - Challenges include data cleaning and understanding
 - Research would be needed
- *(See prior slide for other data sharing opportunities)*

Q6. Do training institutions include appropriate courses on data analytics and other methods and their application to defense acquisitions?

Findings:

- Yes, DAU, NPS, NDU, AFIT, and partner universities and institutions* offer:
 - Applied methods and tools courses
 - Applied data analytics courses
 - Generic data analytics courses and electives
 - Advanced analytics courses are predominantly at NPS and partner institutions
- Enrollments at DAU in FY 2018 indicates a reasonable stratification:
 - ~150,000: *Applied methods and tools courses*
 - ~ 60,000: *Applied data analytics courses*
 - ~ 3,300: *Generic data analytics courses*
- These courses should help staff understand how to request analysis and understand the results

* Georgia Tech, American University, George Mason University, Georgetown University, George Washington University, Johns Hopkins University, Stanford, University of Michigan, Google, IBM, and DoD Cyber Crime Center (DC3) Cyber Training Academy

Perspectives:

- Not everyone in acquisition can or should become a data scientist
- On-the-job training is also important
- Analytic layers on information systems are fairly intuitive and come with online help and training sessions
- As in industry, few people understand both data science and the application area
- Did not assess quality of courses

Opportunities:

- Implement rotations in analytic-based offices
- Better inform personnel of available analytics-based courses
- Encourage analytics-based training

Potential opportunities and actions (by stakeholder)

Congress

- Declare in 10 USC 2222(e) that acquisition data are “Common Enterprise Data” and thus must be shared across DoD
- Make permanent the FFRDC access to sensitive data under Sec. 235 of the FY 2017 NDAA

USD(A&S) with CMO, CIO, CDOs, and SAEs

- Address disincentives to data sharing
- Enable DoD-wide access for appropriate analysts to sensitive data
- Facilitate access to analytic tools through virtual computing environments and an embellished list of standard software approved for installation on DoD computers
- Continue R&D on improved data and analytic systems and new applications in acquisition
- Develop a data-analytics strategy across acquisition domains

DoD information managers

- Continue pursuing PM and process suites with data outputs to feed oversight information systems
- Continue maturing data collection, access, and analytic layers on data systems
- Continue compiling and sharing catalog of available data

Defense acquisition training institutions

- Continue offering data science courses and applied data analytics for staff, management, and rising leaders

Steps for Future Research

- **For Congress**

- Identify DoD acquisition leadership structures that streamline acquisition while balancing decision incentives and authorities
- Identify how statutes can be changed to give efficient access to sensitive data for UARCs, contractor labs, and SETA support contractor analysts while providing appropriate data protections

- **USD(A&S) with CMO, CIO, CDOs, SAEs**

- Identify how to address disincentives to data sharing
- Develop policies and processes for analysis on data aggregation and classification upgrades
- Develop policies and approaches for granting DoD-wide access to different DoD information systems for government and contractor analysts
- Identify the minimum data needed at what level and for what purposes given costs and benefits
- Conduct detailed analysis to create a cross-domain DoD data-analytics strategy

- **For DoD acquisition training institutions**

- Conduct an assessment of the quality and practical utility of data-analytics courses

- **New or expanded analyses**

- Explore better ways to objectively separate effects of uncertainties and externalities in sustainment metrics
- Recognize and explore mission-level (versus program-level) analysis
- Examine better ways to utilize framing assumptions and their metrics
- Conduct institutional performance analysis
- Identify core data needed to answer important questions

Many of the options identified are concepts that require further research to develop specific implementation approaches.

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