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*USACE Data Strategy Initiative*

## **Insights: An Update of the USACE Data Strategy Initiative**

November 2019 Edition

Cary D. Butler, Martin C. Kittrell, Andrew P. Strelzoff,  
James E. Ross, James M. Bailey, and Ashley N. Abraham

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## Abstract

The Data25 strategy was advanced in FY19 by the U.S. Army Corps of Engineers' Chief Information Officer (USACE CIO) by funding pilots to show the power of data analytics on real USACE operations. This report details pilots that were conducted in three of USACEs Business Lines; Dredging, Hydropower, and Military Construction. The purposes for each of these pilots are listed below.

1. **Enterprise value:** Demonstrates the power of data analytics and its ability to generate business value by improving decision-making across the organization.
2. **Technology value:** Helps the CIO understand how cloud technology could support the overall data strategy.
3. **Business value:** Provides examples of data analytics in action. This view helps the Business Lines, Divisions, and Districts understand what it takes to supplement decision-making with insights generated from data.

The main purpose of the pilots was to provide a glimpse of what could be gained from data analytics. From the initial business questions, the pilot Business Lines are seeking to use data to improve decisions through the automation of business processes, more rapid decision cycles, and the layering of previously siloed data on their own to reveal new insights.

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## Preface

This study was conducted for the USACE Office of the Chief Information Officer under Project USACE Data Analytics, work unit number B72BKG. The technical monitor was Dr. Cary D. Butler.

The work was performed by the Office of Technical Directors, U.S. Army Engineer Research and Development Center, Information Technology Laboratory (ERDC-ITL). At the time of publication, Dr. Jerrell R. Ballard, Jr. was Chief, CSED; Mr. Quincy G. Alexander was Acting Chief, SEID; and Dr. Robert M. Wallace was the Technical Director for Data Analytics. The Deputy Director of ERDC-ITL was Ms. Patti S. Duett and the Director was Dr. David A. Horner

COL Teresa A. Schlosser was the Commander of ERDC, and Dr. David W. Pittman was the Director.

# **1 Introduction**

## **1.1 Background**

The U.S. Army Engineer Research and Development Center (ERDC) has been harnessing the power of data analytics since 2012 by working with military programs across all Services and agencies within the Department of Defense (DoD). ERDC analyzed data from one subsystem of a Black Hawk helicopter that saved millions of dollars for the Army and improved the helicopter's system's performance. Time and again, ERDC data scientists have uncovered insights that are truly revolutionary for the Warfighter.

Transforming data into a strategic asset is crucial for the U.S. Army Corps of Engineers (USACE) Information Technology (IT). To accomplish this mission, the Office of Chief Information Officer (OCIO)/G6 is seeking to create a data-driven environment that consistently and accurately delivers authoritative, timely, and secure data to decision-makers. The digital transformation can be handled by IT, but in order to move all of USACE forward, every employee should change the way data is viewed and managed.

To this point, three pilots were conducted that showed the value of data within the Dredging, Hydropower, and Military Construction lines. Each pilot provided notable insights into the power of data. These pilots demonstrated the enormous potential of data analytics for USACE and how data analytics would provide a more effective, calculated decision-making process for ensuring data integrity across USACE.

## **1.2 Objective**

USACE Commanding General, LTG Todd T. Semonite, created 10 initiatives to improve execution through informed decision making, enabling lower costs, and world-class engineering results. Two of these initiatives are geared towards transitioning USACE to data-informed decision making through the use of data analytics.

Six internal and four external initiatives were prioritized in May 2018 during the Executive Governance Meeting (EGM), which was held at the U.S. Army Engineer Research and Development Center (ERDC).

The first of two initiatives dealing with data seeks to implement a data strategy, including doctrine and governance, through creation of a data management plan. The plan will establish common business rules (e.g. authoritative data sources), thresholds, triggers, and benchmarks. This plan will also implement tools to aggregate data across the organization and improve reporting. Using artificial intelligence (AI) to automate reporting for better and faster decision making will become a priority.

The second data initiative seeks to establish a dedicated USACE Innovations Team that will build and recruit a skilled, which would enable USACE to become a digital business. This team will be tasked with finding qualified individuals in emerging technology fields (e.g., data analytics, AI, machine learning, deep learning) to help speed development to delivery of solutions for evolving mission needs.

The USACE Chief Information Officer (CIO) oversees both of these initiatives.

### **1.3 Approach**

Leaders will need to come together since the objectives and goals overlap in many areas. This will allow for improved decision making across the Corps. To help in this process, a Data-Informed Decisions Project Delivery Team (DIDPDT) was created to become a thought leader in data and decision analytics and the challenges that it will arise when moving data analytics capabilities throughout the organization.

This document is the third update of that PDT. Better understanding for the need of this data-informed decision making is the goal for this PDT.

## 2 Dredging

### 2.1 Maximizing 50 years of data

The Navigation/Dredging Business Line supports coastal restoration as part of the flood risk management mission. Existing dredging data captures over 50 yr of planning, contracting, financial, spatial, operational, environmental, and multiple types of construction metrics in various databases across USACE. Many key operations in the Dredging Business Line can be informed by this existing data. The Data25 pilot for Dredging set out to develop new analytical techniques to demonstrate the value of using comprehensive analytics. Outcomes from this pilot have shown the power of machine learning by improving the automated interpretation of dredging activity during construction. Working in conjunction with data owners and end users, the dredging pilot also looked at cargo movement between key U.S. ports and the effects of open bid crowding in the dredge procurement cycle on contract costs.

Looking forward, the goal is to maximize data analytics on dredging data from across the Corps to drive faster, more informed decision-making at all levels within the Navigation/Dredging Business Line.

### 2.2 Deliverables

#### 2.2.1 Bid-open crowding forecast model

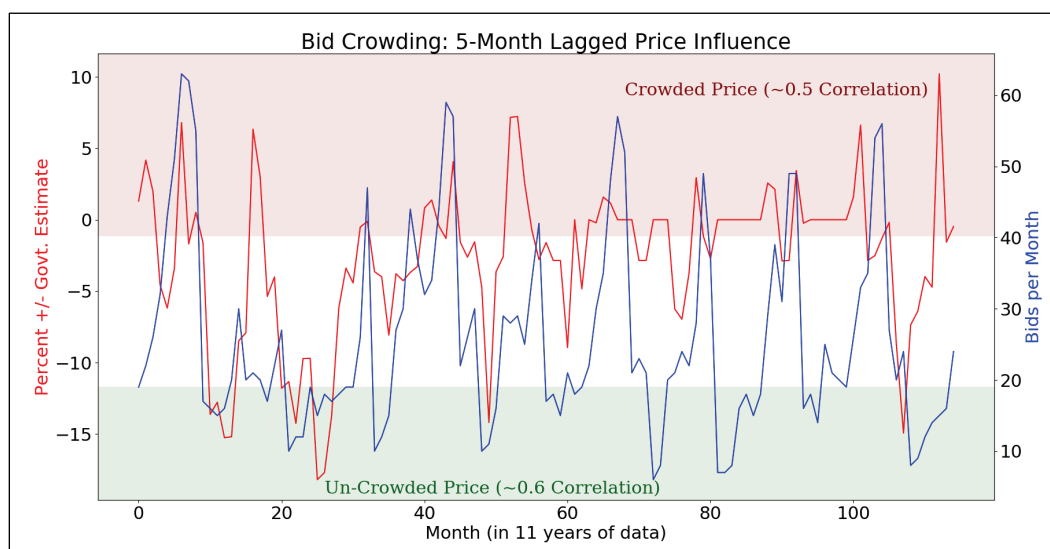
This data analytics effort is helping the Dredging Business Line understand the factors that reduce competition for the Corps dredging contracts, effectively driving up costs and reducing overall programmatic efficiency (Figure 1).

Six questions pertaining to contracts were key for this pilot; these can be seen below.

1. Why do some contracts receive a competitive number of bids (at least 3) with resulting savings to the Government in the final award, while most contracts receive only 1 or 2 bids, and still others result in zero competitive bids?
2. Is pricing worse because too many of the dredging contracts overlap?
3. Can it be determined from the Dredging Information Systems (DIS) archive of dredging contracts the conditions (e.g., number of open

- advertisements for bids, number of dredges already under contract, seasonal trends, etc.) that lead to few and no-bid situations?
4. If so, what strategies can be recommended to the Business Lines for improved situational awareness across the enterprise when it comes to the timing and sequencing of Requests for Proposals (RFPs) across Districts and Major Subordinate Commands (MSCs)?
  5. Is bid-open crowding a regional or national phenomenon?
  6. What are the critical levels of bid-open crowding that cause price spikes?

**Figure 1. Bid-open crowding.**

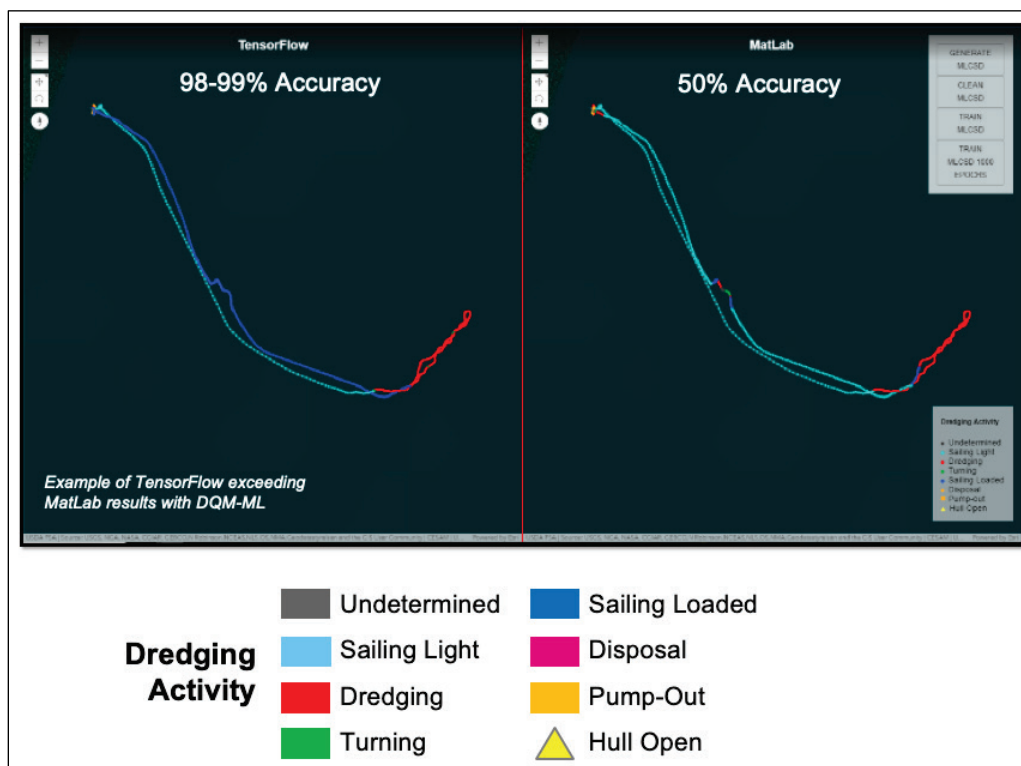


### 2.2.2 Automated dredge activity classification for contract performance

USACE's Dredging Quality Management (DQM) program, which is key to Government oversight, monitors what each dredge is doing in real-time through an array of sensors placed upon each vessel. This live data feed is used to understand where Government-contracted dredges are working, volume of materials dredged, etc. The current process is limited by the ability to manage and analyze large amounts of data captured.

A new machine-learned model (Figure 2) will provide Districts better access to large data and provide live data analytics overseeing the dredging operation. This new model will also allow for retrospective analysis of contracted activity to verify the Government is getting value on each contract. This effort builds upon efforts within the ERDC Dredging Innovations Group (DIG) to extract summary reports and high-level dredging program trends from the DQM archive.

Figure 2. Better labeling of dredge activity allows USACE detailed retroactive analysis of dredging operations to ensure better contract performance.



### 2.2.3 Understanding shoaling rates

Using the Corps Shoaling Analysis Tool (CSAT), which is a licensed, proprietary MatLab-based desktop application, allows the channel shoaling volumes to be calculated using historical channel surveys and shoaling rates are used to predict future dredging volumes. CSAT needs to be connected to other dredging data sources in order to increase its capabilities. This effort focused mainly on transferring CSAT to a cloud computing environment; for this case, the Microsoft Azure cloud environment piloted by the Mobile District. Once the application was converted to an open-source Python, the new code was thoroughly tested and debugged. Once a suitable placement was found within the Azure environment, the application was migrated and configured for automation.

This effort automated much of CSAT's functionality, made it self-service, and did away with licensing fees associated with MatLab open-source Python. This automation will allow for rapid turnaround of data requests, which will increase the use of CSAT for planning for future dredging requirements. The Districts' ability to plan for and executing dredging when and where it is needed would be enhanced. This effort builds upon

efforts within the Coastal Inlets Research Program (CIRP) to streamline the CSAT workflow and increase availability of output for Navigation practitioners.

#### **2.2.4 Channel Portfolio Tool (CPT) data**

In order to explain the positive and critical nature of dredging to stakeholders, the CPT data is being analyzed to document the economic flow of goods through maintained ports and channels. Business questions being addressed here include:

1. How does dredging support energy and agricultural exports, and at which ports is this support is greatest (based on relevant throughput)?
2. How does dredging support port-to-port movements of cargo domestically, and which ports are most important for these domestic movements?
3. What are the natural groupings of projects that emerge from the data, and how (if at all) do these groupings change through time?

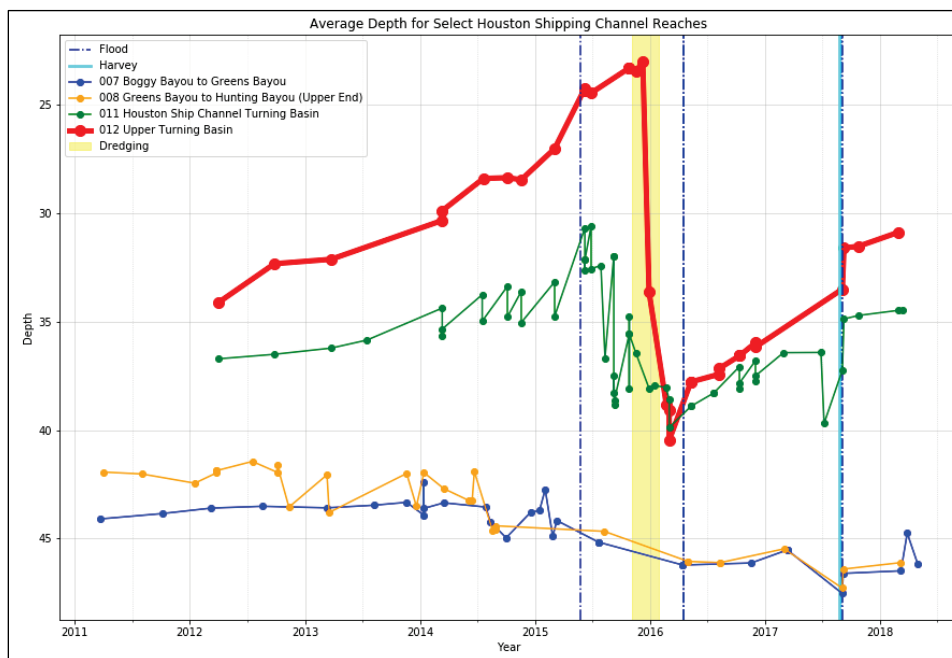
This analytical effort will help USACE communicate how the Dredging program supports various nationwide policy objectives.

#### **2.2.5 Effects of hurricane and flooding events on dredging**

Between 2011 and 2018, average depths for five reaches in the Houston Shipping Channel were targeted and mapped in timelines. Flooding events between 2011 and 2018 and Hurricane Harvey were then overlaid on that timeline to show how the storm events affected sediment deposits. This data could influence the amount of dredging needed following these events.

The added insights gained by consolidating data from other sources into USACE Business Line planning can be seen in Figure 3.

Figure 3. Effects of flooding and hurricane events on Houston Shipping Channel.



### 2.2.6 Dredging data sources

- DQM: Dredging Quality Management
- eHydro: Channel condition surveys and navigation framework channels
- SAGA: Sediment characteristics – core borings
- CPT: Channel Portfolio Tool
- CSAT: Shoaling Rates
- LOMA: Time travel for vessels – uses Coast Guard vessel database
- DIS: Dredging Information System; incorporates economics and dredging history
- RMS (Dredging Component): Construction Database input into contracting and pay contracts
- ODESS: Operations and Dredging Endangered Species System; environmental data
- RSM: Regional Sediment Management
- N/V Jadwin Time and Effort Dredging Time and Effort Hourly Reports (2015-2019)
- Vicksburg District Contract Dredging Time and Effort Reports (2015-2019)
- Red River Historical Contract, Design, and Bathymetry data
- NOAA: National Oceanographic and Atmospheric Administration, weather data
- USGS: United States Geological Survey, river data

### 3 Hydropower

USACE has been generating and collecting data for almost 20 years, but only a small portion of this has been utilized. The enterprise approach to the overall digital transformation is a key objective of the Hydropower Business Line's National Strategic Plan. Three primary challenges have been outlined that prevent utilizing the value data, which are listed below.

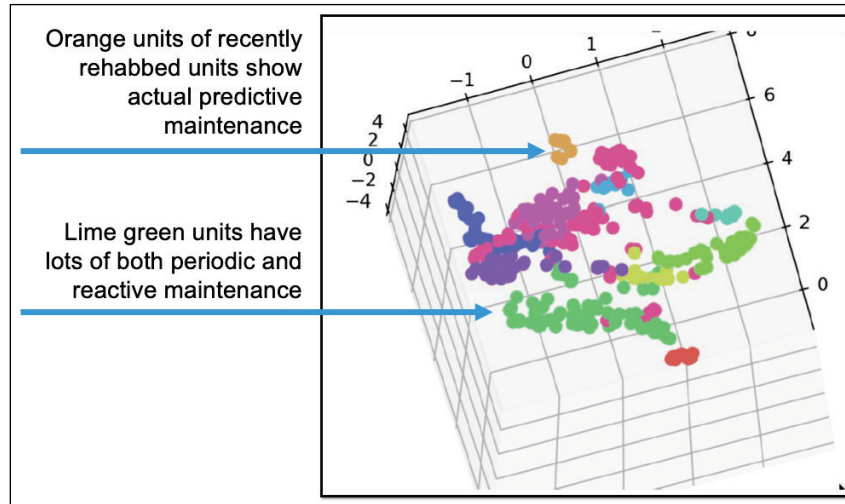
1. Accessing data
2. Developing and using data analytic tools
3. Embracing data-driven decisions

This Hydropower Program recently partnered with other hydropower utility partners to address these challenges. Working with these partners allows USACE to make data accessible to everyone, which will help in the goal of becoming leaders in the hydroelectric industry. The Hydropower Pilot will show the value of data when the correct tools are used, but there are still many hurdles to overcome.

The final challenge that will need to be overcome is embracing this new data-informed approach to managing hydropower assets. This change would allow the move from time-based and reactive maintenance to predictive maintenance founded on sensor data supported by advanced analytics and deep-learning algorithms. By making this change, long and costly outage durations could be avoided.

An initial analysis of the USACE Hydropower outage data reveals that most hydropower plants are doing some time-based and reactive maintenance. Using this analysis, a technique was developed to group units by maintenance patterns; lime green units have both periodic and reactive maintenance and orange units are recently rehabbed units that show actual predictive maintenance (Figure 4).

Figure 4. Identifying maintenance patterns.



Data used in this pilot is complete outage data from 2007 through 2018 for all 75 USACE Hydropower Plants. This Hydropower Pilot answers three interrelated business issues derived from the outage data – details for these issues can be found in *Insights*, November 2019 issue (<https://team.usace.army.mil/sites/HQ-CI/PDT/USACEDA/default.aspx>).

- How much time-based, reactive, and predictive maintenance is done in USACE hydropower plants
- USACE hydropower plants that do better or worse at time-based and predictive maintenance
- Identification of best practices for time-based maintenance

## **4 Military Construction**

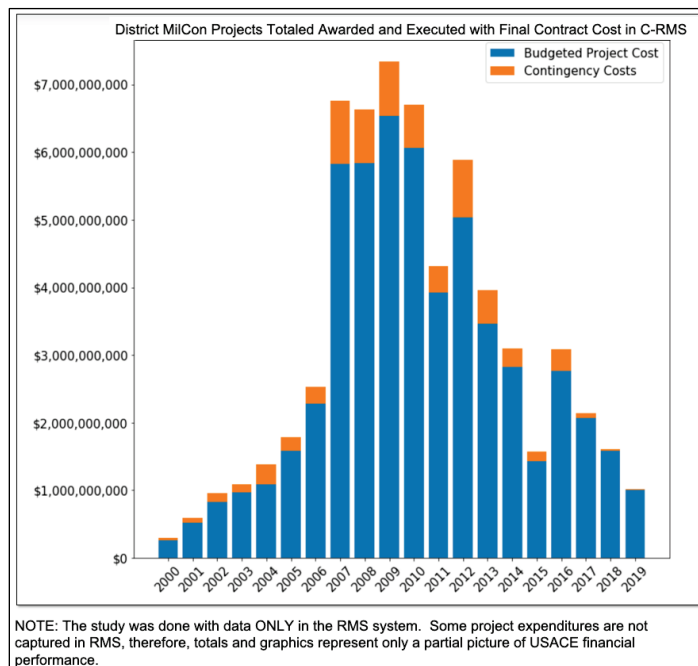
The Data25 pilot will help the Construction Branch identify opportunities to exploit invaluable data. The initial stage of this pilot demonstrated the ability to quickly know and understand the data. Once the initial stage was complete, the team quickly sorted, “cleaned,” and provided valuable analysis.

With the cooperation between ERDC-ITL and HQUSACE Construction, USACE will lead the charge for predictive analytics, which will increase productivity and reduce risk for the field and the enterprise. Within this Military construction pilot, two business issues are being answered; contract financial performance and predictive modeling used to understand contract modification financial and legal exposure.

### **4.1 Contract financial performance**

After two months organizing Military Construction (MilCon) contracts that were located in the Resident Management Systems (RMS) database, algorithms were created to allow RMS leadership to report upward on how USACE is delivering MilCon projects (Figure 5). These algorithms can determine the projects that finished at a zero balance, projects are over budget, and projects under budget. These methodologies and algorithms are being provided to the RMS team to develop an automated system of data discovery for future data calls, which can be extended to all USACE projects.

Figure 5. Contract financial performance.



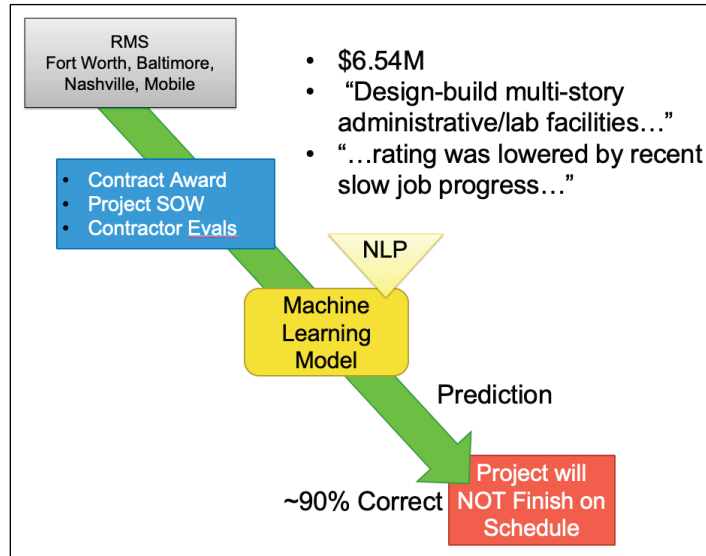
#### 4.1.1 Predictive modeling to understand contract modification financial and legal exposure

The Fort Worth and Baltimore Districts are currently piloting an effort requiring them to use a drop-down menu for recording a category and exposure estimation on each contact modification. According to Dr. Andrew Strelzoff, this would allow the data to be recorded for a proposed length of time and mined for a propensity. Strelzoff also stated that state-of-the-art Natural Language Processing (NLP) is being used to compile RMS contract modifications text descriptions and grouping them into types (HVAC, landscaping, IT, etc.). With this capability, the RMS team can quickly – and without additional data capture – develop a predictive model to understand and anticipate contract modification financial and legal exposure (Figure 6).\*

In addition, he said this would be a model for many other USACE needs where it has extensive but unlabeled data and where hand-labeling or additional data capture would be time consuming or ineffective.

\* Personal communication. November 2019 – interview for *Insights*. Dr. Andrew Strelzoff, Computer scientist, U.S. Army Engineer Research and Development Center – Information Technology Laboratory.

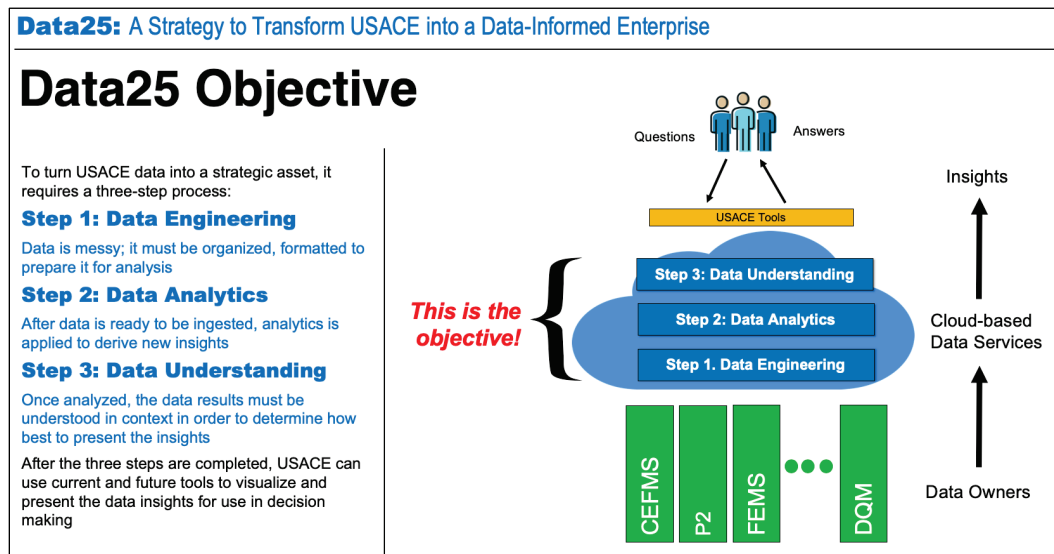
Figure 6. Predicting project time performance from contract text in RMS.



## 5 Data25: Implementing the Strategy

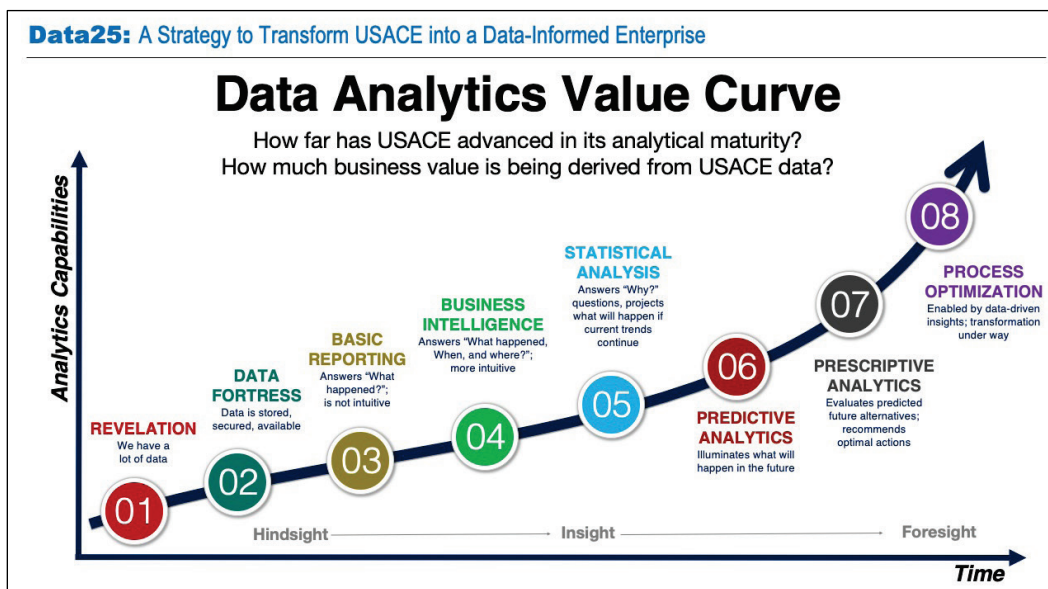
The goal of Data25 is to turn the structured data of USACE into strategic assets that could be used to make informed decisions across all levels of the organization (Figure 7). This plan is hoping to execute the USACE Data Strategy by 2025 (Figure 8). This effort is part of an overall data strategy being developed that will organize all of USACE’s data.

Figure 7. Data objective.



The Data Governance Board (DGB) is in charge of the oversight of the Data25 execution plan. The Chief Information Officer (CIO)/G6, assisted by the Chief Data Officer, is host of the DGB and responsible for developing the data strategy and implementing the strategy. The DGB has identified seven top initiatives and deliverables to increase USACE’s data analytics capabilities.

Figure 8. Data analytics curve.



These seven initiatives are:

- Publish terms of reference
- Develop a USACE data strategy
- Project delivery data analytics demo pilots
- Define and identify USACE authoritative data sources with associated processes
- Establish USACE enterprise data quality standards
- Establish USACE data analytics learning opportunities, data metrics/data analytics
- Establish data analytics center of expertise

USACE seeks to embed data analytics into the decision-making capabilities of the organization, which would require a common approach that could be applied to all 43 Districts and 17 Business Lines within the organization. The approach will be evolved through working with a small number of business lines that are already in the process of using data analytics. The effort will then be expanded to include additional Business Lines as well as Districts.

## 5.1 Guiding principles

The DGB, Deputy Commanding General, and CIO have provided guiding principles for this strategy, which include:

- managing data as a corporate asset,
- simplifying access to quality data,
- building a culture dedicated to the practice of using data to make decisions,
- providing a conducive enterprise platform to integrate and analyze data, and
- implementing the strategy in increments.

## 5.2 Three pillars of Data25

This data strategy rests on three pillars that must be addressed and adequately resourced; remove any of these pillars and the strategy runs the risk of collapse.

### 5.2.1 Data Analytics Center of Expertise (DACX)

The DACX will be used to increase USACE capabilities by providing a communication forum and community of practice for those working in data and decision analytics across USACE. It will work with the Business Lines and Districts to develop and refine how data is captured, stored, managed, and analyzed and also will serve as the common voice through all three phases of executing USACE Data25.

Primarily built to create a knowledge base of expertise in data and data analytics, the DACX will develop the expertise and methodologies required to assist Districts, Divisions, and Business Lines as USACE data is transformed into a strategic asset for the organization. It will focus on making data analytics a repeatable process and support the creation of data analytics capabilities down to the District level, as well as leading a community of practice across the enterprise focused on maturing DA capabilities. More specifically, the DACX will support Business Lines, Divisions, and Districts with:

- developing a workforce with an understanding of data analytics techniques and can apply them to real USACE problems,
- integrating data analytics into business processes, and

- overseeing the creation and sustainment of an enterprise repository for data that is accurate, authoritative, and accessible.

### **5.2.2 Cloud computing**

The second pillar of Data25 is moving USACE to cloud computing that will accelerate IT delivery, efficiency, and innovation. USACE is currently working with industry to determine the way forward in this area.

Cloud computing is defined by industry as storing, managing, processing, and accessing data and programs through an on-demand network of remote servers. Moving to the cloud will allow USACE to improve the management of data, which will improve the ability to analyze. A cloud environment will allow for 24/7 access to data, make collaboration across organizational boundaries easier, and scale easily as the number and size of data files grows. Moving to the cloud is also a sensible financial decision since virtual equipment is used for computing. It also allows information to be moved more quickly and it accelerates computing speed, which would compress the time to stand up new capabilities and get them in the hands of USACE personnel.

### **5.2.3 Data organization**

In order to have an effective data strategy, data that has been stored away must be organized in a way that makes it authoritative, accurate, and accessible.

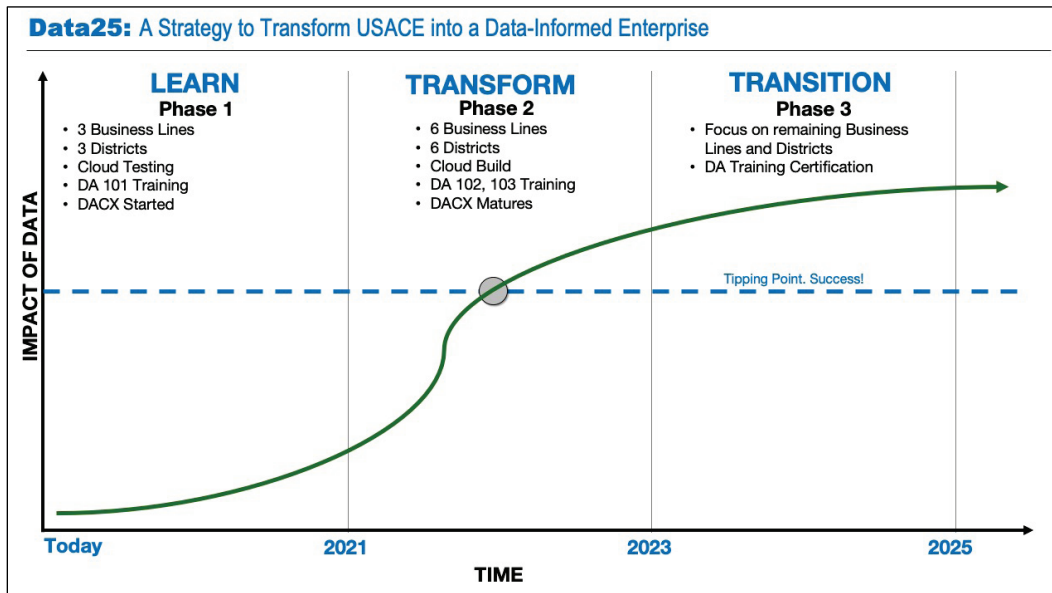
This third pillar defines and establishes the rules for organizing USACE data, including the input, maintenance, and labeling of data. Through this data governance, USACE will increase its efficiency in the use of data by improving data quality, eliminate redundancy and duplicity, reduce errors in reporting and analysis, and help define critical data.

## **5.3 Three phases of implementation**

As seen in Figure 9, Data25 utilizes a three-phase approach; learn, transform, and transition. Lessons learned from first adopters through 2021 will be gathered as the data strategy matures and then used to transform an additional six Business Lines and Districts in Phase 2. At the end of 2023, there should be a Data-Informed District (DID) in each of the nine Divisions of the Corps. From 2023 through 2025, the methodologies

and processes learned and transformed through the first two phases will be applied across the rest of the Corps' Business Lines and Districts. Details for each phase can be found in the *Insights*, November 2019 issue at (<https://team.usace.army.mil/sites/HQ-CI/PDT/USACEDA/default.aspx>).

Figure 9. Data25 timeline.



## **6 Data Access**

Initiating an enterprise data strategy across USACE is a complex journey and a complicated process. The following sections are some lessons learned to help with this journey.

### **6.1 Owner of data**

Some stakeholders have the mindset that having data will allow them to retain the power that this data holds, so they prefer retaining their own data rather than sharing with others within the larger organization. If data from USACE cannot be gathered into shared repositories, the insights needed to transform USACE into a data-driven decision-making organization would not occur.

### **6.2 Established trust**

In order to reach a state of shared data, trust must be established between the data custodians and those accessing their data. Stakeholders must know how their data is being used and by whom, so transparency in the process is key.

### **6.3 What the data reveals**

Analysis of data can reveal issues that many take as criticism of their work, how their employees are performing, how money was spent and budgeted, or how successful projects have been. Knowing the truths that are in the data can only help the organization become better.

### **6.4 Messy data**

Mechanisms to collect data, format it, and validate whether it is authoritative has to be completed before analysis can be performed. Some data sources keep no historical data, rewrite over collected data on a timed basis, or suffer from gaps in the data. All these issues have to be addressed as this initiative moves forward.

### **6.5 Data tools**

One of the biggest battles faced to date is the desire to believe a tool can solve USACE's data problem. Considerable funding has been dedicated to

tools that visualize data, but getting the data organized first would determine how to best to visualize that data.

## **6.6 Data-savvy employees**

Without skilled employees in place, there is no need to have a data strategy. Building a workforce that understands how to corral and analyze data will be the backbone of this strategy.

## **6.7 Changing the culture**

USACE has 17 Business Lines, 9 Divisions, and 43 Districts, which traditionally operate within their own box. Sharing data across organization boundaries would allow USACE to explode with innovation and efficiency.

## 7 Conclusion

Data25 can usher USACE into a new era with the following:

- Moving USACE towards seeing data as a strategic asset.
- Intersecting data between all USACE business lines.
- Managing the powerful data properly and knowing the role data analytics can play in innovation.
- Trained the workforce to use data to derive insights, which would allow performance to increase due to the quality of decisions being made.
- Making sure all teams in USACE contribute to Data25.
- Exploring data USACE already has for the power it contains.
- Improving how USACE manages data will improve every tool that relies on that data.
- Allowing each USACE employee to be a data creator, data owner, and data user.

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<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT</b>  The Data25 strategy was advanced in FY19 by the U.S. Army Corps of Engineers' Chief Information Officer (USACE CIO) by funding pilots to show the power of data analytics on real USACE operations. This report details pilots that were conducted in three of USACEs Business Lines; Dredging, Hydropower, and Military Construction. The purposes for each of these pilots are listed below.  <ol style="list-style-type: none"> <li>1. <b>Enterprise value:</b> Demonstrates the power of data analytics and its ability to generate business value by improving decision-making across the organization.</li> <li>2. <b>Technology value:</b> Helps the CIO understand how cloud technology could support the overall data strategy.</li> <li>3. <b>Business value:</b> Provides examples of data analytics in action. This view helps the Business Lines, Divisions, and Districts understand what it takes to supplement decision-making with insights generated from data.</li> </ol> <p>The main purpose of the pilots was to provide a glimpse of what could be gained from data analytics. From the initial business questions, the pilot Business Lines are seeking to use data to improve decisions through the automation of business processes, more rapid decision cycles, and the layering of previously siloed data on their own to reveal new insights.</p>					
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