Analytics in Defense Transportation
An Opportunity for Better Decision Making

October 2017

Bruce A. Busler, SES
Executive Director
SDDC Transportation Engineering Agency (TEA) USTRANSCOM Joint
Distribution Process Analysis Center (JDPAC)
Bruce.a.busler.civ@mail.mil

Together, we deliver.
Agenda

• Blue Ribbon Analytics
• Analytics in Transportation
• JDPAC Capabilities and Enabling Tools
  – Enterprise Data Science
  – Cost Based Decision Support
  – Modeling, Simulation & Optimization
• Changing the Culture to Embrace Analytics

Together, we deliver.
Blue Ribbon Analytics

- A better way to look at the production and consumption of analytic output ... everyone can earn an analytic blue ribbon!

- Implement use of “blue ribbon” approaches by extending analytic methodologies, applications and tools into everyday business activities, processes and decisions

Together, we deliver.
What Makes People Tick, How Do They Think?!

https://hbr.org/2017/03/the-new-science-of-team-chemistry

<table>
<thead>
<tr>
<th>Pioneer</th>
<th>Driver</th>
<th>Guardian</th>
<th>Integrator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collective brainstorming and creative approaches</td>
<td>Quick decisions, direct answers, and logical solutions</td>
<td>Meticulous analysis and tried-and-true approaches</td>
<td>Diplomacy, humility, and collaboration</td>
</tr>
<tr>
<td>A focus on ideas, possibilities, and novelty</td>
<td>A focus on results and growth</td>
<td>A focus on quality, accuracy, dependability, and order</td>
<td>A focus on people, relationships, and consensus</td>
</tr>
<tr>
<td>A fun and energetic atmosphere</td>
<td>A competitive atmosphere and minimal “time wasting”</td>
<td>Respect for rules and processes</td>
<td>Positivity and encouragement</td>
</tr>
</tbody>
</table>

Individuals of this type characterized by:

- Bringing energy, humor, and novel thinking
- Asking “what if” to move beyond the obvious
- Challenging the status quo

Individuals of this type contribute by:

- Pushing for action and keeping a results-oriented mindset
- Promoting directness and efficiency
- Getting things done!

- Grounding solutions in facts, data, and reality
- Understanding the logistics and details necessary to implement
- Reducing chance of rework

Everyone has a preference/bias for how the interact with the world
What is your basic philosophical tendency when faced with important decisions?

Statement 1: Too much analysis can cause you to get “lost in the trees” and miss the more important strategic consequences of decisions

Intuition, gut, emotion...

SYSTEM 1

Statement 2: Thorough, rigorous analysis, with numbers, is essential for making good decisions by helping you avoid the pitfalls of faulty intuition

Rational thinking, analysis...

SYSTEM 2

Thinking Fast and Slow

Together, we deliver.
System 1

Together, we deliver.
System 2

24 x 17

Answer = 408

Together, we deliver.
Together, we deliver.
And the winner is...

SYSTEM 1!!!

(if the situation is sufficiently salient)

But, System 1 thinking subject to all sorts of “biases”

Salient: noticeable, striking, prominent
In summary...

- System 1 RULES!!
- For important decisions (think: risk), System 2 can only be useful IF it can influence System 1, where the final decision will be made
- The language of System 1 is STORIES; the language of System 2 is LOGIC (MATH)

KEY POINT: How does analytics support decision making?!  
(Hint: The trend is moving towards data-driven outcomes)

Together, we deliver.
• **Analysis:** the broad and general process of breaking complex topics into smaller parts to gain a better understanding
  
  – Greek root: *analysis*, “a breaking up”
    
    • *ana*: “up, throughout”
    
    • *lysis*: “a loosening”

Together, we deliver.
• **Analytics:** a multi-dimensional discipline with extensive use of mathematics and statistics and the use of data processing techniques and predictive models to gain valuable knowledge from data and data analysis
  – Discovery and communication of meaningful patterns in data
  – Systematic use of quantitative and statistical decision methods in business processes and decisions
  – Insights from data are used to recommend action or to **guide decision making** rooted in business context
Data Analysis

• **Data Analysis**: Inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision making, a subset of analytics that requires:
  
  - Data collection, storage, prep
  - Algorithms applied to structure data
  - Algorithms applied to information
  - Applications to visualize & interpret
  - Infrastructure to enable analysis

*The Mathematical Corporation*

“Big Data” Data Lake Capabilities Changing the Nature of Data Analysis
## Data vs. Information in Analytics

### Information vs. Insight

<table>
<thead>
<tr>
<th></th>
<th>Past</th>
<th>Present</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information</strong></td>
<td>What happened?</td>
<td>What is happening now?</td>
<td>What will happen?</td>
</tr>
<tr>
<td></td>
<td>(Reporting)</td>
<td>(Alerts)</td>
<td>(Extrapolation)</td>
</tr>
<tr>
<td><strong>Insight</strong></td>
<td>How and why did it happen?</td>
<td>What’s the next best action?</td>
<td>What’s the best/worst/most likely that can happen?</td>
</tr>
<tr>
<td></td>
<td>(Modeling, experimental design)</td>
<td>(Recommendation)</td>
<td>(Prediction, optimization, simulation)</td>
</tr>
</tbody>
</table>

---

**Analytics At Work**

“The goal is to turn data into information, and information into insight” ~ Carly Fiorina

---

**Business Intelligence, Data Analysis**

**Data Analytics**
• Transportation industry is ripe for analytics
  – Volume of data collected
  – Data availability
  – Types of data collected – both structured and unstructured
  – Trends and patterns, causes and effects over time
  – Plethora of use cases to optimize business decisions
Use Cases in Defense Transportation

- Predict the impact to operations of major unplanned events on both sustainment and deployment networks
- Identify inefficient touchpoints in business processes where improvements can be made to save money and time
- Adjust operations practices based on movement data over time determining patterns, trends, and seasonality
- Meet military “can’t fail” effectiveness for certain missions requiring high confidence solutions with a keen understanding of all risk elements
- Create efficiencies across the transportation network with cost and cost-savings as important operational parameters
- Optimize demand and capacity incrementally from cradle-to-grave for transportation planning and execution
- Understand how business lines and functions affect one another

What Topics Can You Imagine? Asking the Right Questions is a Critical Step in Analytics!
• May not be suited to an analytic approach:
  – Decisions where there is no time to generate or collect data
  – Scenarios that have no precedent and data is not extensible
  – When history is misleading based on differing conditions between past and future
  – When the decision maker has considerable experience on subjective topics
  – When the variables can’t be measured due to the nature of the topic

• In these situations, decision makers often rely heavily upon intuition, but an analytic approach, even through “thin analysis” may provide additional insights for decision makers to leverage

KEY POINT: Analytics Almost Always Adds Valuable Insight
USTRANSCOM
Enterprise Data Sciences (EDS)
Purpose

• Quickly expand upon the foundation of *Blue Ribbon Analytics* to establish an enterprise-wide, science-based, decision support capability

• Institutionalize data science practices to *grow the enterprise* beyond simple descriptive analysis, providing forward looking, risk-based decision support to all levels of the organization and it’s components

Scope

• *Establish analytical disciplines* within USTRANSCOM that focus on integrated enterprise analysis using data science practices

• Partner with USTRANSCOM Directorates and its Components to help *transform the way we make decisions using this approach*
• Data Science vs. Enterprise Data Science
  – **Data Science**, also known as data-driven science, is an interdisciplinary field about scientific methods, processes and systems to extract knowledge or insights from data in various forms
    • *Performed by data scientists*
  – **Enterprise Data Science** is the disciplined application of Data Science methods across a Business Enterprise, providing analytical insight into the relationships between business lines
    • *Integration into the decision process at all levels of the enterprise*
Enterprise Data Science – 30,000ft View

**Enterprise Data Science IS:**
- A Command Capability
- A Community
- A Collaborative Environment
- A Cultural Shift
- A Discipline
- Science-based Analysis
- Forward Looking
- Enterprise Focused
- Well Underway

**Enterprise Data Science IS NOT:**
- An Office
- An Organization
- A Service
- A Data Scientist
- Difficult to get to

**CONDUCTS**

**EMPOWERS**
How EDS works—Real World Example

**Data Science Methods**

- Confidence Factors
- Exponential Smoothing
- K-Means Clustering
- Naïve Forecast
- Ensemble Modeling
- Distribution
- LCL/UCL
- Outlier Mitigation

**Predictive Forecast**

- Aggregation of multiple models
- Analysis of Capacity
- Efficiencies to improve Capacity
- Built-in What-If capability

**Complex Decisions**

- Aircraft Allocation
- Commercial Decisions
- Predictive Analytics Group
- OT&E Decisions
- CAAP Working Group
- Modal Management
- ARC Volunteerism
- RDAB Decisions
- Train Fence
- Mobilization
- What-If Scenarios
- ETC...

OT&E – Organize Train & Equip
CAAP – COM-AFOR Apportionment & Allocation Process
ARC – Air Reserve Component
RDAB – Readiness Driven Allocation Board

Together, we deliver.
Building Out EDS Capabilities

Building Blocks for Success

**Raw Data**
- Source Data
- Requisition
- Shipment
- Transportation

**Analytical Data**
- Warehouses
- Data Marts
- Lakes
- Cubes

**Business Intelligence**
- Reporting
- Analysis
- ADHOC
- Dashboards

**Descriptive Analytics**
- Data Aggregation
- Data Mining

**Predictive Analytics**
- Statistical Models
- Forecasting Techniques

**Prescriptive Analytics**
- Optimization
- COAs

**Descriptive Analytics**
- Answers the question “What happened?”

**Predictive Analytics**
- Answers the question “What could happen?”

**Prescriptive Analytics**
- Answers the question “What should be done?”

Current EDS Tool Suite: Cognos Analytics, R+, SPSS, Teradata, IBM Watson, Tableau
The EDS Blueprint: Three Lines of Effort

**OPR: TCJ6**

**Data Management**
- LOE 1: Provide a data structure and data warehouses/lakes that in addition to basic data transactions provide a "live" data environment suitable for analytic purposes; TCJ6 OPR, but responsive to the analytic architecture as an end-state developed by JDPAC
- **Data**
  - Structured Data
  - Relational Databases
  - Enterprise Data Warehouses
  - **Big Data**
  - Unstructured Data
  - Machine Data
  - Web Data
  - Audio/Video
  - Documents and Text

- Develop, construct, test, and maintain architectures (such as databases and large-scale processing systems)
- Ensure architecture will support requirements of the business
- Discover opportunities for data acquisition
- Develop data set processes for data modeling and production
- Employ a variety of methods to marry system data together
- Recommend ways to improve data reliability, efficiency, and quality
- e.g. Hadoop Cluster
- Operational Systems

**OPR: TCAC**

**Enterprise Data Science**
- LOE 2: Provide an analytic architecture, tools and TTPs as a means of assembling and conducting data analysis that reveal information and knowledge about the enterprise to gain value; any application of "machine learning" is fundamentally predicated on these applications; TCAC OPR

- **1. Describe**
  - Process
  - Aggregate
  - Enrich

- **2. Discover**
  - Clustering
  - Regression
  - Hypothesis

- **3. Predict**
  - Classification
  - Regression
  - Recommend

- **4. Advise**
  - Reasoning
  - Optimization
  - Simulation

- Conduct research to answer industry and business questions
- Leverage large volumes of data from internal and external sources to answer business questions
- Employ sophisticated analytics programs, machine learning, statistical methods to prepare the data for use in predictive and prescriptive modeling
- Explore and examine data to find hidden patterns
- Automate work through the use of predictive and prescriptive analytics
- Tell the story to key stakeholders based on scientific facts and subject matter knowledge

**Community of Practice**
- LOE 3: Develop a community of practice for analytic producers and consumers that employ data analysis products or saved queries/dashboards/metrics (i.e. think "Blue Ribbon Analytics") to build towards an analytic-savvy organization(s) writ large; TCAC facilitated with DLA, TCJ3, TCJ4, 618 AOC, AMC/A3, AMC/A4, etc

- Multi-tiered analytic framework supporting decisions at all levels of the command
- Collaborative analytics community using mature analytical practices to support the enterprise
- Provides feedback loop for maturation of the analytical information, processes, and products
- Ensures CoP has reachback into advanced analytical capability (tools, people, and process)
- Enables cross-business view of impact of decisions on the enterprise
- Provides self-service high level and detailed data

**Facilitated by: TCAC**

Together, we deliver.
• **Coming Soon:**
  – Data Driven Metrics
  – Dashboard “Widgets”
  – Advanced Statistical Analysis
  – Prescriptive Analytics

• **Leverage SCO “Data Lake/Machine Intelligence” Initiative**
Deployment and Distribution (D2) 
Cost Based Decision Support (CBDS)

"Bringing Cost into the Decision Cycle"
Cost Based Decision Support (CBDS)

Self-Help Dashboard
- “One-Stop” Cost Shop
- Links to Docs and Tools
- 24/7 SharePoint Access

Seminar Series
- 6 Modules, 2 Days
- 8 Directorates
- >800 Contact Hours

Analytic Cost Experts
- Available in J8, JDPAC, J3
- Personal assistance
- Great Patriots

Together, we deliver.

USTCI 90-22
- Institutionalize Cost Consciousness
- Codified Standardized Methodologies
MAFCAT 1.0

- USCENTCOM Centric
- DLA Cost to Deliver
- July 2012 – 4QTR 2016
- Cost Avoidance: >$400M

APPLICABLE

MAFCAT Definitions

Tankering – Aircraft ferrying ‘lower cost’ fuel for use on follow-on mission leg in lieu of buying ‘higher cost’ enroute fuel

Cost-to-deliver – DLA’s cost to provide fuel support

MAFCAT 2.0

- Global in Nature
- DLA Cost
- PoP: 4QTR FY16
- MAFCAT 2.0 CA >$45M

MAFCAT Rules of Engagement

- Never bump cargo when tankering for cost avoidance
- Do not adversely impact mission accomplishment

MAFCAT – Mobility Air Force Cost Avoidance Tankering
Modeling, Simulation, and Optimization (MS&O)

Together, we deliver.
Analysis of Mobility Platform (AMP)

An integrated suite of modeling and simulation & optimization tools that...

- Provides end-to-end deployment and distribution modeling
- Supports operational planning, deliberate and crisis action planning, and mobility programmatic analysis
- Answers force closure, infrastructure, lift asset, process, and policy analysis questions

Suite of Tools Well Suited for Full Range of Planning/Design Activities

Together, we deliver.
Analysis of Mobility Platform

• Model of record for all major programmatic analyses since 1995
• Used in support of Combatant Command OPLAN Force Flow analysis
• Increased fidelity, incorporated optimization to support execution planning
• Comprehensive representation of end-to-end deployment and distribution

State of the Art Model – DOD “Gold Standard” for Transportation

Key Users
- SDDCTEA/JDPAC
- OSD-CAPE
- JS J4 & J8
- CAA
- AFIT
- AFRL
- AMC A9
- AF A9
AMP provides extensive reports and causal analysis tools, such as:

- Scenario (RLN Results, Error Log, Constraints Table)
- Airlift (Aircraft Mission, Aircraft Utilization, Unused Aircraft)
- Sealift (Ship Berth Time, Ship Cargo Utilization, Sealift Missions)
- Theater (Asset Utilization/Usage, Trip Details)

“Quality of Solve” Metrics For Output Refinement/Acceptance
AMP-PAT Tool Set – Airport/Seaport Analysis

• Quick-look Tools
  – Airport Throughput Tool (ATT) and Seaport Throughput Tool (STT)
    • Provides maximum throughput and LIMFAC identification
  – Airport Rapid Analysis Tool (ARAT) and Seaport Rapid Analysis Tool (SRAT)
    • Examines TPFDD requirements over time as compared to the capabilities of enablers at the port

• Simulation Tools
  – Airport Simulation Tool (AST) and Seaport Simulation Tool (SST)
    • Provides detailed stochastic simulation of the port, including graphical depiction of the process and capabilities for cargo and passenger handling

Comprehensive Suite of Tools for Port Analysis
Rapid COA Analysis Tool (RCAT)

Inputs
- Movement requirement
- Available lift assets
- Strategic route (POE to POD, ILOC)

Outputs
- ROM closure estimate
- ROM cost estimate

Together, we deliver.
Crisis Action -- Operational Decision Support

- Assess end-to-end force flow; provide feasible solution
- Detailed theater feasibility analysis
- Rapidly update TPFDD at execution based on
  - Revised sourcing
  - Current ship availability
  - Current port capacities
- Inform mode and port selections
- Port calls and force closure
  - Unit -> port -> ship assignments
  - Support and enforce unit integrity solutions
- Provide multimodal solutions with transshipment
- Enhance insight into granular deployment and distribution activities
  - Airport and seaport throughput capability analysis
  - Detailed utilization analysis of CONUS assets (rail, highway, etc.)
- Rapidly assess alternatives and conduct “what if” analysis
  - Run -> assess -> modify -> repeat

Planning/Design
At Speed of War
Distribution Network Assessment

Sustainment Distribution (SD) Planning and Management (SDP&M)
A collaborative USTRANSCOM effort to evaluate and design SD transportation networks in support of GCC operational requirements

JDPAC Supports Optimization Modeling
Utilizes Supply Chain Guru for flow modeling to gauge scalability, resiliency, and agility of the sustainment network

JDPAC Analytic Approach
• Flow modeling of As-Is Sustainment Network
• Phase 0 Assessment by Line of Operation
• Tradeoffs
• Recommendations Tasks
• Excursions / Scenarios

82%
Sustainment share of DTS volume
Modeling Tool – Supply Chain Guru

Modeling Inputs

- Transportation cost
  - For each mode

- Nodal capacity
  - Based on port capabilities

- Demand forecast
  - Including cargo priorities

- Travel time
  - Including time at the nodes

- Arc capacity
  - Based on historical use

- Lever settings
  - Priority balancing of lateness, costs, and readiness

Questions to Answer

- Large Movement
  - Do we need extra support for a troop rotation?

- Reduce Risk
  - Can we increase the resiliency of our supply chain?

- Show of Force
  - How do we best sustain troops during a show of force operation?

- Disaster Relief
  - What do we need to respond to a large earthquake in Nepal?

Scenarios to Test

- Military vs. Comm’l
  - What if we used more commercial carriers to move our goods?

- Port Enhancements
  - Can we see a return on investment if we enhance a port?

- Using Intermodal
  - What if we move cargo on a different mode?

- Modify Sourcing
  - Can we improve performance with different sourcing?
USCENTCOM DNA Excursion Summary

Objective
Assess the Capacity of the Trans Arabian Network (TAN)
- Baseline Model – As Is
- Excursion A – Historical demand through TAN
- Excursion B – Historical demand with decreased clearance processing time
- Excursion Ax2 – Increase demand by 100%
- Excursion Ax50 – Increase demand by 50-times

Findings
- Capacity not a constraint to performance with single or double historical flow
- Lateness increased with TAN trucking
  - Shorter Clearance decreases lateness
- 3 Ports reached capacity with 50 times the historical flow for small periods of time

Model Excursion Set-up

Analysis provided USCENTCOM planners with credible results to address host nation customs delay issues

Together, we deliver.
Changing the Culture to Support Analytics
Enterprise Analytics and Organizational Culture

• Enterprise Analytics—Opening the Analytical Aperture

  – Changing our approach to enterprise analysis
    • Break the enterprise down—logically map how the pieces fit together
    • Incorporate analytics at the enterprise level on down... manage, share, reuse, repeat

  – Asking the right questions
    • Critical thinking and forward looking
    • Proactive assessment vs. reactive analysis

  – Bringing the right people/tools together
    • Domain Experts, Mathematicians, Statisticians, ORSA, Data Experts, etc.
    • Flexible, dynamic teams equipped with the right tools for the analytic/EDS job

  – Flattening the hierarchy
    • Autonomy and flexibility to collaborate at all levels is KEY
    • Partnering with the decision makers

Together, we deliver.
Questions / Discussion

Together, we deliver.