



INSTITUTE FOR DEFENSE ANALYSES

Improving Munition Readiness in DOD

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MORS Executive Summary

Title: Improving Munition Readiness in DOD

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Executive Summary:

The Institute for Defense Analyses (IDA) has developed a risk-based analytical framework to provide decision makers with information about the risk associated with munition stockpiles and potential mitigation strategies. Using a linear optimization-based modeling and simulation tool, and with appropriate input data, IDA has been able to identify readiness gaps (the current inventory of munitions compared to munitions required to achieve the mission), determine the time to health (under steady-state and conflict conditions), and find key points of congestion (constrained production) in the supply chain. The newly developed tool takes a holistic look at the defense industrial base, accounting for constraints at the prime level and the subtier supplier level. This briefing describes the approach taken, the key outputs of the model, and future plans for the model's use.

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Improving Munition Readiness in DOD

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Colorado Springs, CO

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Munitions Preparedness and Risk Mitigation

- Using a risk-based approach to inform decisions associated with munitions stockpiles, IDA has developed an analytical framework and suite of tools to present enterprise-wide-level snapshots of munitions readiness
 - What is the munitions purchase plan that replenishes munitions used in the steady state (counter-terrorism activities, test and training)?
 - What is the optimal production schedule for munitions, many of which share production lines?
 - When are the infrastructure investments needed to either enhance existing facilities or build new plants to increase capacity?
 - How are simultaneous munitions surges that result from mobilization or unexpected conflict best accommodated?
- A fairly straightforward risk concept is employed
 - Risk is measured as the gap, or shortfall, between munitions requirements and munitions inventories ("readiness shortfall")
 - Munitions requirements are informed by Munitions Requirements Process (MRP) data, including Global Floor (GF) data, and operational plan (OPLAN) data
- Risk is examined over time. Assessments show how risk can be reduced/minimized at various levels of investment
- Model capabilities have been demonstrated on a small number of munitions with a limited set of industrial base supplier data

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IDA | IDA Support to DOD

- Within IDA's Strategy and Risk Program, munitions readiness support has been provided to a variety of DOD sponsors
 - A cross-cutting study for the Joint Staff (JS J8 and JS J4) and the Office of the Secretary of Defense (OSD/Industrial Policy) focused on developing options for mitigating operational risk brought on by precision-guided munition (PGM) shortfalls for a critical set of munitions
 - A study for DASD Industrial Policy in support of Executive Order 13806 (*Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States*) focused on assessing surge possibilities within the manufacturing and the defense industrial base (DIB) in the United States for peacetime and conflict cases to increase munitions preparedness
- Analyses of munitions are conducted at a micro-scale (e.g., firm level) to assess health, identify risks and fragility, and suggest options for mitigating risk using optimization modeling techniques
 - Initial outputs accommodated prime level supply data. Recent modeling improvements allow IDA to incorporate detailed sub-tier production and capacity data below the prime, when that data is available, so sub-tier capacity bottlenecks can be identified. DoD had only limited sub-tier supplier data for a few munitions at the time of the study, and this data was incorporated

IDA | Key Outputs Provided to DOD Sponsors

- Various types of risk assessments are generated
 - Readiness gaps – What is the current inventory of munitions, and how does that inventory compare to the required number of munitions needed to achieve the mission?
 - “Time to health” – Under steady-state and conflict conditions, how long does it take to build up munitions inventories to the desired level?
 - Operational deficits – Given a set of conflict demands, do we have the requisite number of munitions to achieve the mission? If not, how large are the deficits?
 - Bottleneck identification – What are key points of congestion (constrained production) in the network preventing the prime producers from surging? How might these production bottlenecks be alleviated?
- A linear optimization model with steady-state and conflict demands produces an optimal plan for purchasing munitions and investing in infrastructure over a user-specified time interval
 - Both prime and sub-tier supply capabilities are considered given the availability of data
 - Optimization could be tuned to allow for trade studies, including prioritization of different PGMs and budget assessments

IDA | Assessing Risk with MunOpt (1 of 2)

- MunOpt = “Munitions Optimization”
 - Optimization – The mathematically driven “optimal” set of procurement and investment strategies to minimize risk given the preferences of the user in the objective
 - Simulation – Evolution of inventory levels over time given ongoing steady-state demand, conflict-specific demands, and planned procurement
- MunOpt has the potential capability of capturing many important aspects of the DIB problem with the requisite data
 - Complex demand profiles and varying operational plan expenditures
 - Supply chain interdependencies
 - Investments in infrastructure, capital equipment, labor, and so forth
 - Production lead times
 - Shared production lines

MunOpt draws upon a database of classified and proprietary data inputs, including quantitative data on end-items and hundreds of associated subcomponents, at various supply chain tiers

IDA | Assessing Risk with MunOpt (2 of 2)

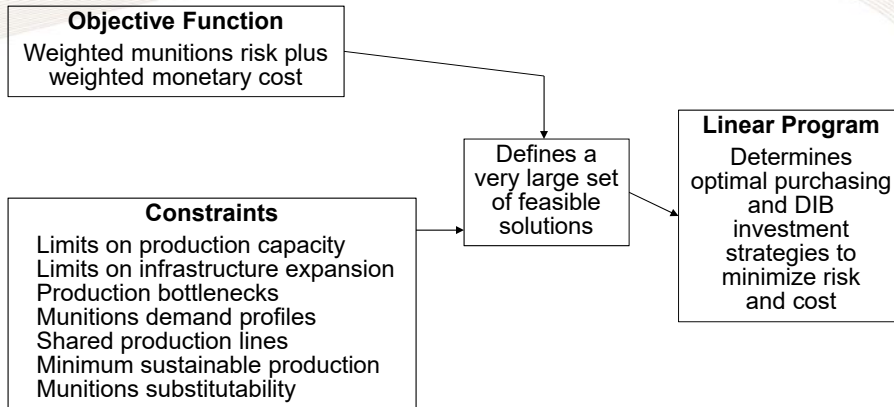
- In addition, MunOpt features have the potential capabilities to allow for excursions that accommodate the following:
 - Prioritization among munitions
 - Substitution effects
 - Fragility of single/sole sources
 - Disruption of foreign supply (by country, if desired)
- MunOpt could inform decision makers interested in investigating the following:
 - Which operational plans are feasible? If conflicts were to take place at a specified time, are there operational deficits and how big are they?
 - How prepared can we become to execute desired OPLANs and how quickly?
 - Given an infeasible OPLAN, are there any mitigating steps that could alleviate operational deficits? (e.g. substitution, OPLAN modifications, DIB investments)

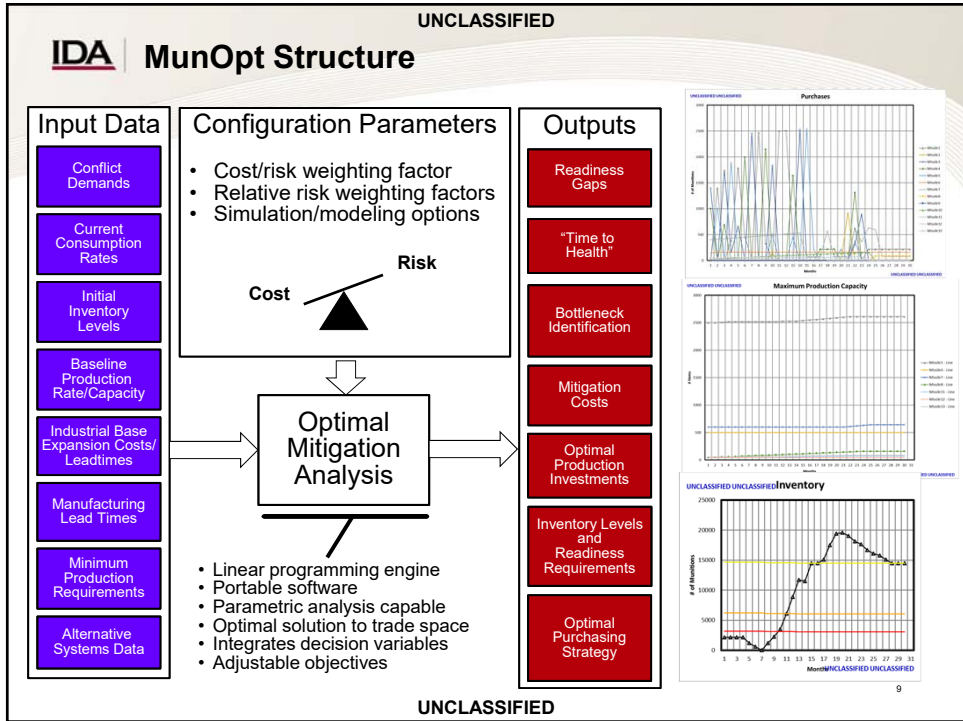
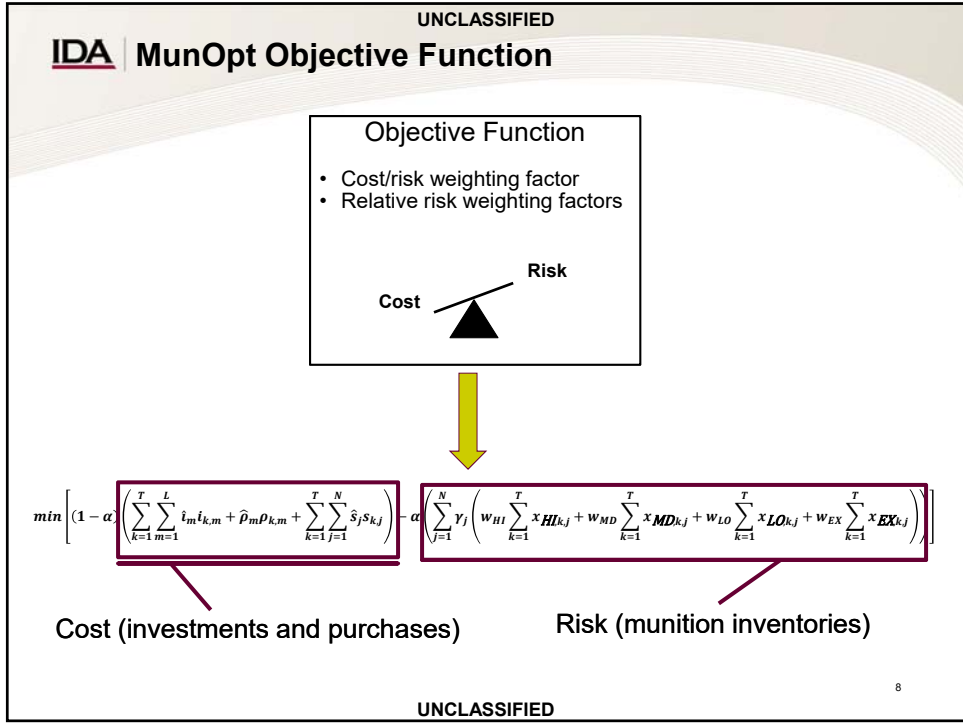
IDA | How Does MunOpt Work?

- Microsoft Windows console application
- Front-end graphical user interface
- Driven by an in-house C++ optimization library to facilitate model development, experimental builds, and collaborative development (Programming Tool for Optimization (ProTO))
- Data housed in a formal standard query language (SQL) database
- Fast runtime allows a wide range of parametric studies (i.e., 1–5 seconds for modeling a few dozen defense weapon systems)



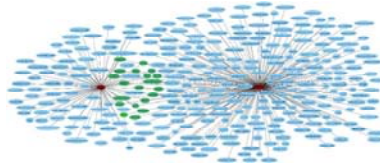
IDA | MunOpt Basic Design





IDA | MunOpt Today

- MunOpt has been leveraged by the Joint Staff (JS J8 and JS J4) and the Office of the Secretary of Defense (OSD/Industrial Policy) to help develop options for mitigating operational risk brought on by precision-guided munition (PGM) shortfalls for a curated set of munitions
- Assessments of current production capabilities of the supply chain
 - Steady-state and conflict-based assessments given current industrial base capacity
- Munitions DIB characterization
 - Network analytics and visualization could provide insight into the complex structure of the industrial base
- Investment strategies
 - Time and cost associated with expanding capacity at the prime level
 - Quantifying level of risk mitigation associated with investments to supply chain
- Data enclave
 - MunOpt database houses a collection of supply side and demand side munitions data at the prime producer level and sub-tier supplier level leveraged by the model to produce these assessments



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IDA | MunOpt Tomorrow: What MunOpt Could Do

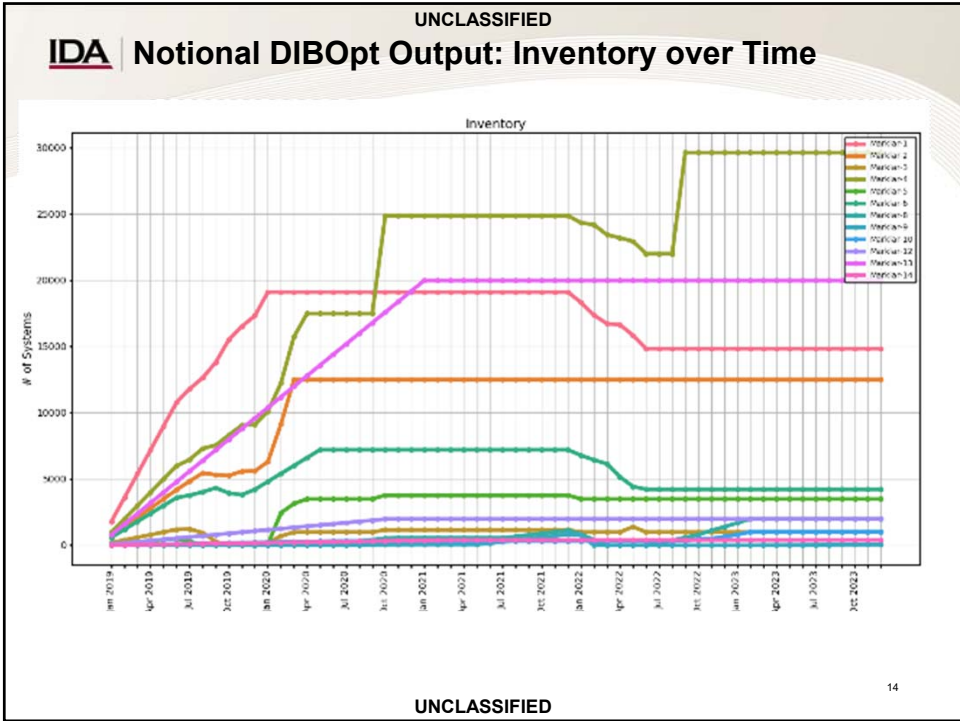
- MunOpt has additional capabilities available within its framework
 - Expand the set of munitions analyzed – MunOpt is capable of simulating and optimizing on hundreds of munitions given the requisite data
 - Assess the alternative strategies to alleviate operation deficits, including substitution of PGMs and components to meet demand
- Probabilistic risk assessment – uncertainty in supply and demand
 - Supply chain simulation coupled with optimization-based planning to quantify the impact of difficult-to-predict supply disruption scenarios and generate mitigating measures
 - Stochastic consideration of demand profile
- Potential iterative coupling with campaign modeling
 - Optimize on weapon mix to maximize weapon effectiveness and minimize attrition
 - Inform campaign models of available munitions inventories over time

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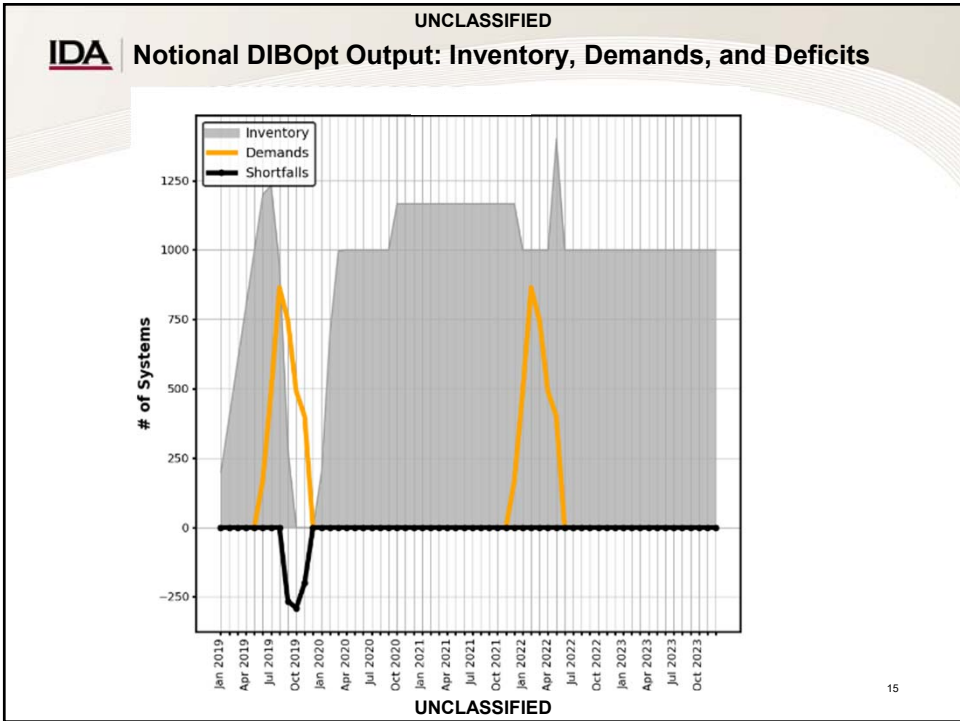
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