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Estimating the Costs of Future Air-to-Ground Weapons

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Abstract

The weapons acquisition community has been acquiring air-to-ground weapons in a slowly-evolving manner for years. While technologies experience great leaps forward, acquisition strategies evolve at a slower pace. The AF Research Lab is evaluating revolutionary weapons designs that facilitate newly-emerging acquisition strategies…thereby presenting real challenges to cost estimators. This paper documents techniques for estimating costs of those future weapons.

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Overview

- Background
- Conventional Wisdom and Community Expectations
- The Cost Model (PRICE, SEER, Analogies)
  - Business Model Features Analysis
  - Design Features Analysis
- Accounting for Risk and Uncertainty
- Summary and Conclusions

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Analytic Tools for the Analysis

- Business Model Features Analysis
  - Measures the impact of business model features, suggesting optimal acquisition strategies

- Future Weapons Cost Model
  - Combines the impacts of different combinations of business model features with parametric and analogous cost estimates of Future Weapons designs. Uses traditional cost models and processes to estimate costs of an all-up round, then adjusts those costs based on findings from the Business Model Features Analysis..

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Legacy Weapons That May be Replaced

GBU-12 Paveway II

GBU-31 JDAM

GBU-32 JDAM

GBU-38 JDAM

GBU-39 SDB1

GBU-53 SDB2

GBU-54 Laser JDAM

AGM-65 MAVERICK

AGM-114 HELLFIRE

AGM-158/A JASSM

AGM-158/B JASSM-ER

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Acquisition Costs – Legacy Weapons

	RDT&E (BY14$K)	PROD AUPC (BY14$)	
JDAM	**598,550**	See variants	
GBU-12 MK82 Paveway II	Not Available	**19,323**	
GBU-31 BLU109 JDAM	See JDAM	**56,432**	
GBU-32 BLU-110 JDAM	**127,728**	**37,922**	
GBU-38 MK82 (JDAM)	See JDAM	**42,388**	
GBU-39 PH1 (SDB)	**441,229**	**58,695**	
GBU-53 (SDB2)	**1,008,983**	**132,176**	*
GBU-54 LJDAM MK82 (Laser JDAM)	See JDAM	**48,586**	
AGM-114 HELLFIRE	**601,721**	**81,615**	
AGM-65 MAVERICK	Not Available	**153,237**	
AGM-158/A JASSM	**1,267,005**	**984,482**	
AGM-158/B JASSM-ER	**274,100**	**1,186,652**	*
Total	**$4,319,316**		
Average		**$254,683**	
Wtd Avg Cost		**$74,660**	
Wtd. Avg Unit Procurement Cost		**$63,870**	
w/o JASSM			
Total	**$2,778,211**		
Average		**$70,042**	
Wtd Avg Cost		**$54,774**	
Wtd. Avg Unit Procurement Cost		**$49,139**	

* - Estimated

Detail

Sources: DAMIR, AMST, President's Budget

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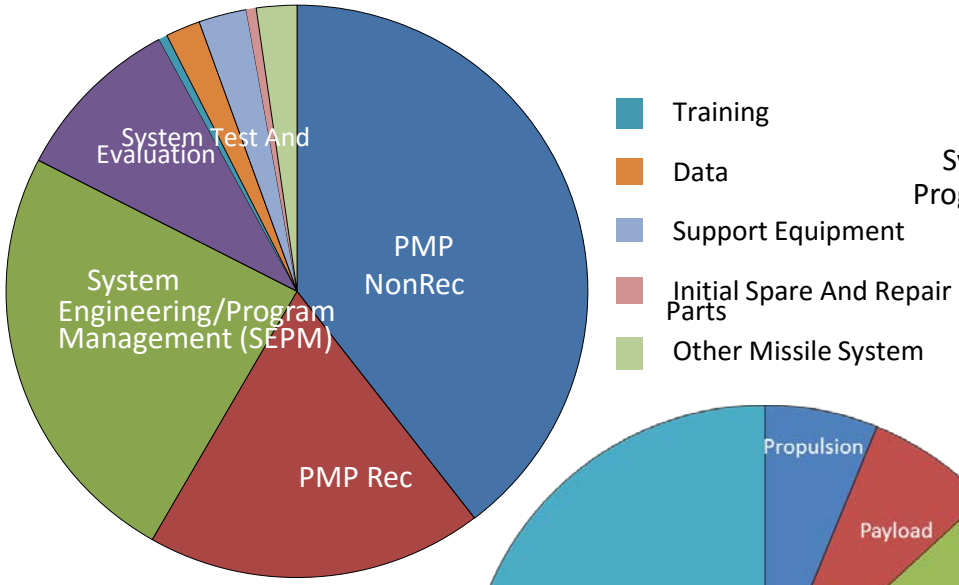
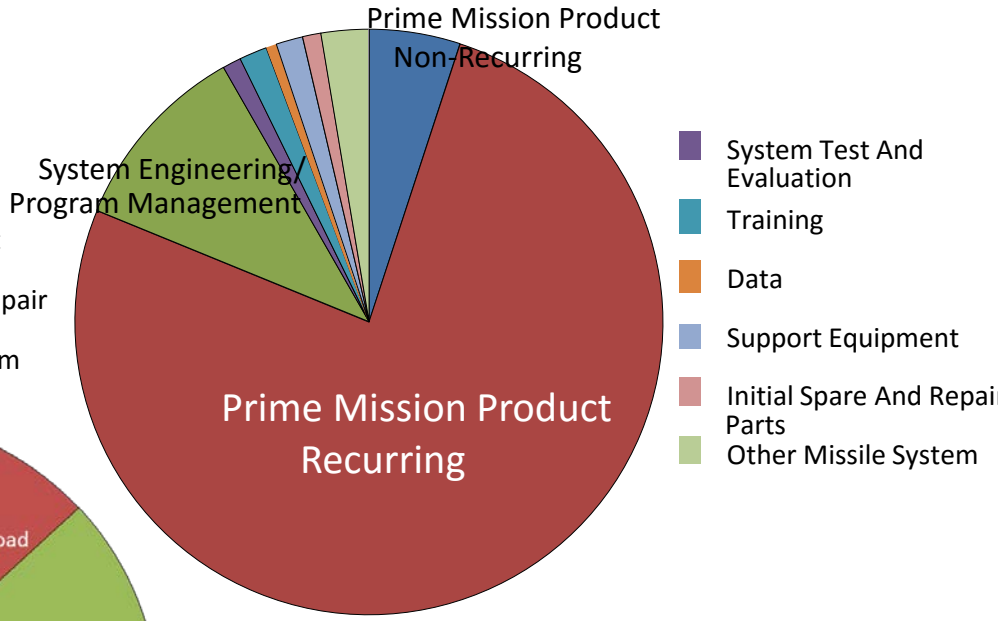
Average of Select GBUs/AGMs

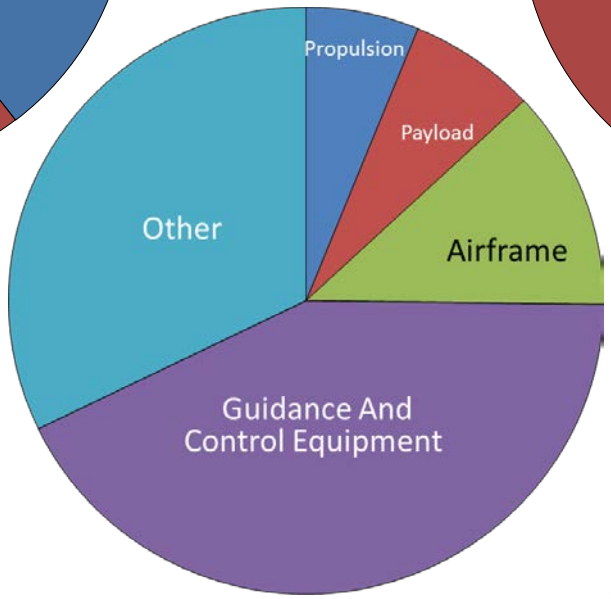
RDT&E Cost



PROD Cost



Recurring PMP PROD Cost



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Making the Business Case for Future Weapons

An alternative family of future weapons must:

- Collectively deliver operational benefits beyond those of current weapons.
- Meet affordability goals, however they are defined.
  - Staying within currently-identified TOA.
  - Delivering more “bang for the buck” than current weapons.
  - Adhering to “Better Buying Power” tenets.
- Insure a viable long-term business climate.

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The Future Weapons Business Model Features Analysis

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Characterizing the Future Weapons Business Model

Designing to an open architecture standard by which current and future technologies can be integrated into weapons can lead to novel acquisition strategies. That single basic design assumption is the basis for the business model features examined in this Assessment.

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Future Weapons Business Model Features

- CORE
  - Open Architecture Design
- CRITICAL
  - Technology insertion
  - Weapons production & assembly flexibility
  - Sustainment and logistics footprint

Operational advantages

- ENABLERS
  - Competition of subsystems and components
  - Source selection
  - Test & Eval
  - Reconfigured SPOs
  - Warranties & Liability
  - Awarding to optimal production rates

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Business Model Feature Description - Weapons Production & Assembly Flexibility

- RDT&E effort to create an Open Architecture design.
- Major subsystems will be delivered by contractors and accepted by the USAF prior to insertion into an all-up round (AUR).
- AUR assembly may occur outside of a systems integration facility.
  - This approach reduces the need for a robust, full-up integration facility and equipment as a significant part of production, and almost certainly reduces that set of equipment and a highly-trained team to assemble and test it.

		Prod & Assy Flexibility
RDTE Cost Data	Integration, Assembly, Test, And Checkout NonRec	0.25
RDTE Cost Data	Integration NonRec	0.25
RDTE Cost Data	Integration, Assembly, Test, And Checkout Rec	0.15
RDTE Cost Data	System Engineering/Program Management (SEPM)	0.2
RDTE Cost Data	Development Facilities	15
RDTE Cost Data	Producibility, Engineering, and Planning (PEP)	15
RDTE Cost Data	Tooling	0.15
Production Cost Data	Telemetry NonRec	
Production Cost Data	Integration, Assembly, Test, And Checkout NonRec	0.1
Production Cost Data	Integration NonRec	0.1
Production Cost Data	Integration, Assembly, Test, And Checkout Rec	-0.7
Production Cost Data	Integration Rec	-0.7
	Government Costs	
	Program Office (LOE)	0.2
	Test & Eval	0.3
	O&S Cost	0.1

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Business Model Feature Description – Technology insertion

- RDT&E effort to create an Open Architecture design.
- New components can be swapped out easily, without any modification to the weapon design or other functional components.
- Minimal recurring Integration, Assembly, & Test.

		Technology Insertion
RDTE Cost Data	PMP NonRec	0.05
RDTE Cost Data	System Engineering/Program Management (SEPM)	0.1
RDTE Cost Data	Data	0.4
Production Cost Data	PMP Rec	-0.15
	Government Costs	
	Program Office (LOE)	
	Test & Eval	0.025

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Business Model Feature Description – Sustainment and logistics footprint

The logistics footprint includes all effort to sustain munitions.

- Manpower (Training, handling,)
- Transportation
- Storage
- Support Equipment

Each type of weapon in the current inventory requires a separate logistics footprint today.

In a Flex Weapons scenario, there will only be three physical weapon configurations, although there will be many functionally-different weapons in the FW inventory.

On the other hand, there may be 6 or 7 modules/components being shipped directly to several locations, complicating the current AUR delivery/materials management construct. Instead of unique logistics footprints for 20 different weapons, there are only 3 basic AUR footprints.

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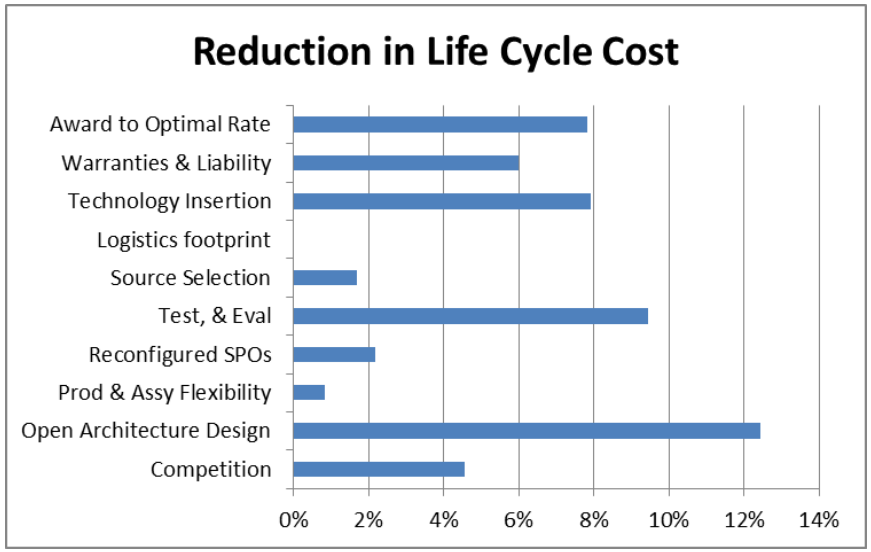
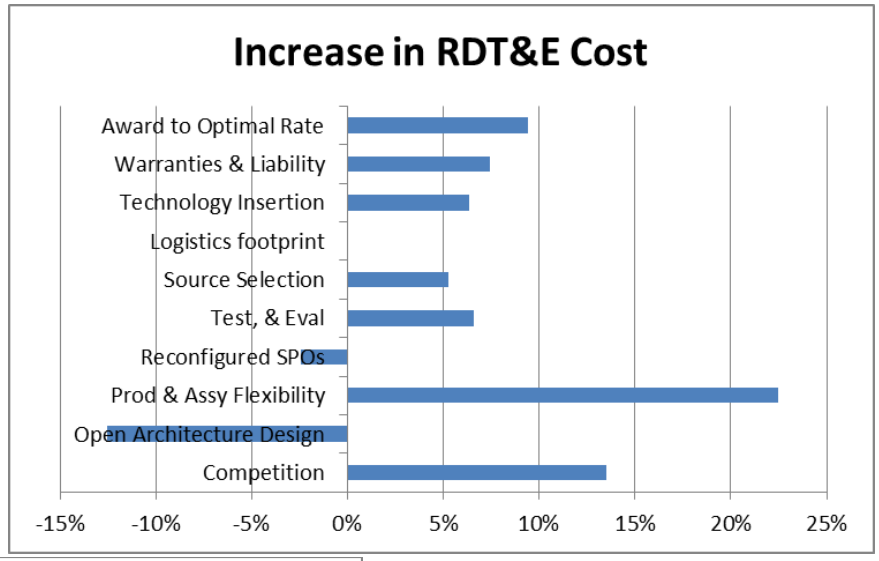
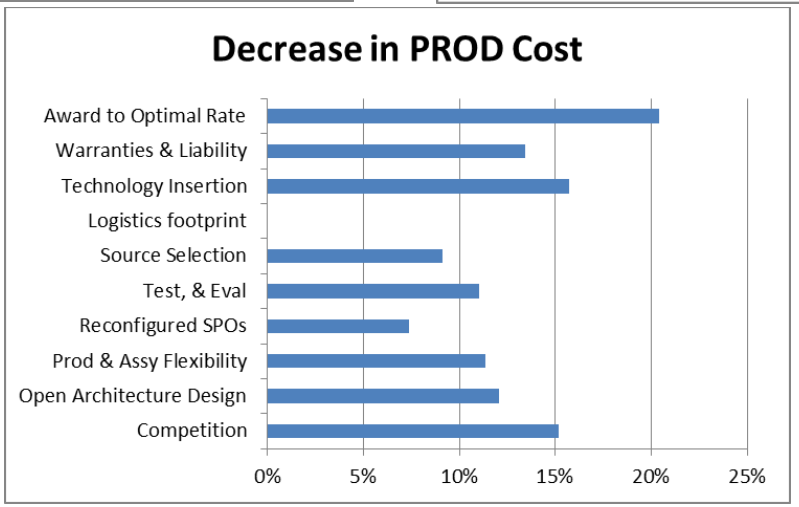
Business Model Features Analysis (BMFA) Results







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The FW Business Model Analysis – Findings

- Features that offer the most promise for reducing program LCC
  - Open Architecture Design
  - Test & Evaluation
  - Technology Insertion
- Best opportunity for reduced recurring PROD unit costs:
  - Awarding to Optimal Production rates
  - Technology Insertion
  - Competition

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The Future Weapons Acquisition Strategy

Findings suggest an Acquisition Strategy that establishes close collaboration with the Defense Industrial Base to provide constant technology refresh and value engineering by encouraging / insuring:

- Multiple awards to a range of industry partners
- Frequent competitions between near-substitutes
- Tighter links to innovative engineering solutions

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Validating the Business Model Features Analysis (BMFA) Findings

- Update Literature Search incorporating lessons learned
- Questionnaire/survey/interviews with Industry / USAF
- Conduct an Acquisition Simulation or Wargame
- Build a series of Flex Weapons Acquisition Strategies
  - Increases community buy-in
  - Essential to estimate costs, which is the next step

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Further Analyses

The Future Weapons Cost Model (FWECM)

The **Future Weapons Cost Model (FWECM)** combines the impacts of different combinations of business model features with parametric and analogous cost estimates of Future Weapons designs. The FWECM uses traditional cost models and processes to estimate costs of an all-up round, then adjusts those costs based on findings from the Business Model Features Analysis.

We designed the FWECM to specifically account for design uncertainty by allowing AURs to be assembled using combinations of seekers, G&C systems, warheads, propulsion systems, and other components.

The Future Weapons Value Model

The **Future Weapons Value Model** compares the costs of resources required to employ a suite of legacy weapons to those required to employ a suite of Flexible Weapons. Resources include weapons, delivery platforms (sorties, flying hours, duration, aircraft losses), and weapons and aircraft O&M. Both suites of weapons deliver an identical level of military value, or worth.

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The Future Weapons Cost Model

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Developing the FWECM

- Engineering Estimate Model
  - Market research to price weapons components
  - Apply IA&T costs based on BMFA findings
- Comparative Parametric Models
  - Calibrate to legacy weapons program costs
  - Apply Flex Weapons physical, performance parameters based on SME inputs
- Generate cost estimates
- Compare and reconcile
- Design Model for maximum design flexibility
  - # of components
  - Differing military worth features

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Determining Optimal Design Features

Modeling and Simulation analyses determine some design features

- Mission Analysis Modeling
  - Survivability (Trajectories/angle of attack)
  - Lethality (Warhead size)
  - Physical design features (Diameter, Weight and cube)
- Engagement Analysis Modeling
  - Effects of enhanced capability/evolving technologies
  - Complexity of components/integrated functionality
- Campaign Analysis Modeling
  - Integrated weapon suites and delivery platforms delivering optimal battlefield results (military worth)
  - Real-life campaign scenarios

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Analogous Cost Estimates

- Process
  - Estimate non-recurring costs of initial RDT&E effort
    - Select Integrator
    - Refine USAF standards and interfaces
    - Mature technologies to insure industry competition
  - Identify components for integration

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Parametric Cost Estimates

- Process
  - SEER
    - Employ CostIQ to derive baseline estimate, initially populate generic weapon database
    - Modify programmatic parameters to account for alternative acquisition strategy
    - Note % change in NR and unit costs
  - TruePlanning
    - Run model as a new build
    - Run model using combinations of purchased parts/GFE integrated at varying levels and subassemblies
    - Note % change in NR and unit costs

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Estimate Results

- Analogous Estimates, Optimal design
  - Xxx NRE in RDT&E
  - Yyy AUPC @ qty = 1000
- Parametric Estimates
  - SEER
    - Xxx NRE in RDT&E
    - Yyy AUPC @ qty = 1000
  - TruePlanning
    - Xxx NRE in RDT&E
    - Yyy AUPC @ qty = 1000

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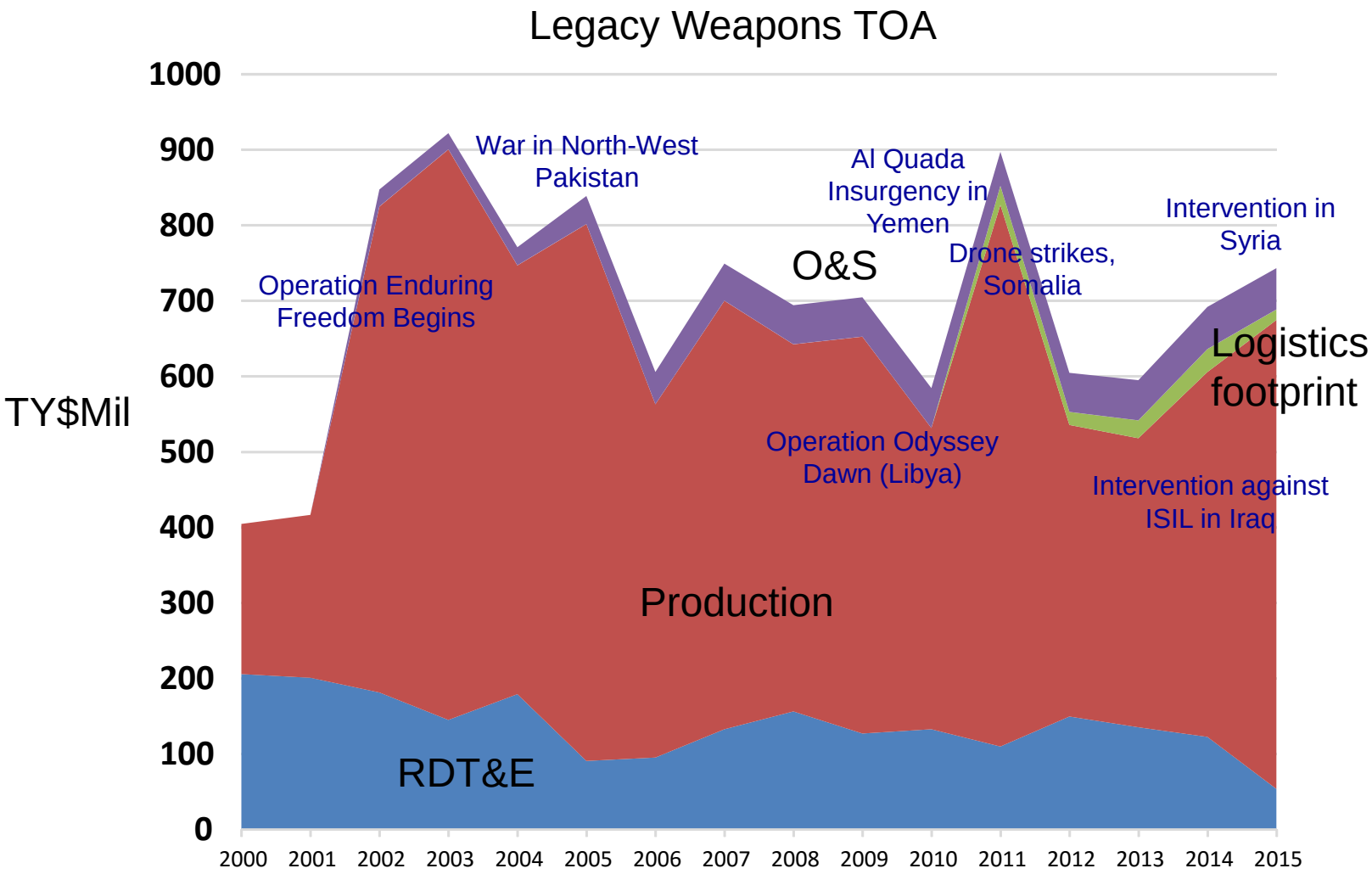
The Value Model for Future Weapons



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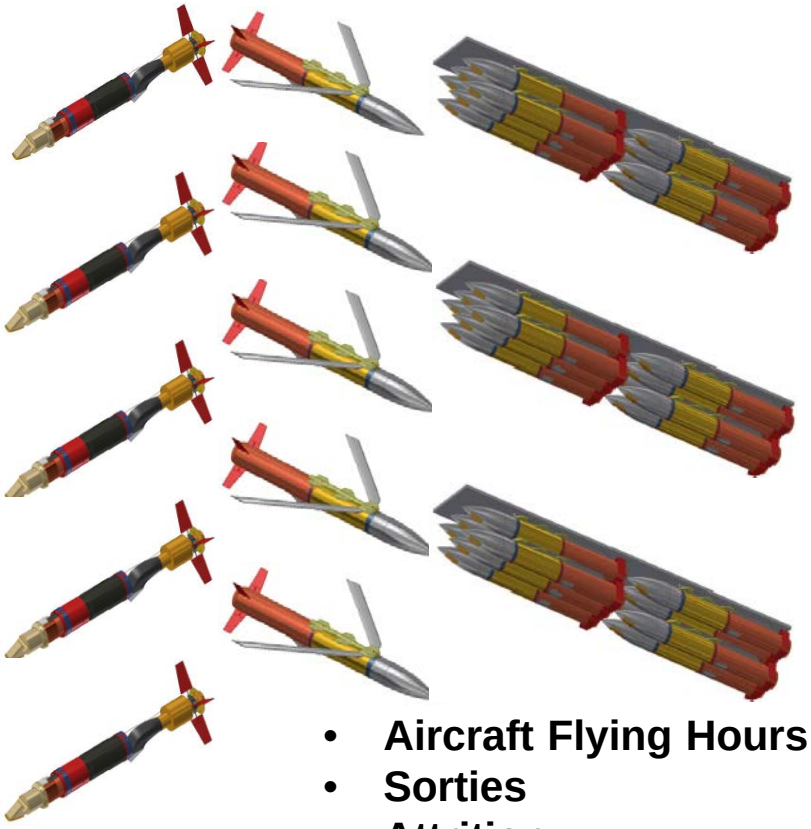
An alternative Value Model for Future Weapons

Average Cost of Winning Campaigns using Legacy Weapons

- Aircraft Flying Hours
- Sorties
- Attrition

= < > ? Average Cost of Winning Campaigns using Flex Weapons



- Aircraft Flying Hours
- Sorties
- Attrition

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