Motivation

To determine the value of imbedding flexibility in the production buy schedule of the proposed US Air Force KC-X tanker aircraft by using the principles of Real Options

- The current arrangement locks the United States Government (USG) into a long-term, deterministic financial agreement which fails to account for future uncertainty.
- The forces of uncertainty may prevent USG from acting upon future opportunities or responding to unforeseen demands and requirements.
- Flexibility may be added to this agreement by either delaying the purchase decision and/or allowing the USG to modify the production quantity.
Background: KC-X Tanker Program

- KC-X program is the first of three acquisition programs needed to replace the entire fleet of aging USAF KC-135 Stratotankers.
- Primary mission of the KC-X will be to provide aerial refueling to United States military and coalition aircraft.

Deterministic Production Schedule

- Effort Contracted to produce 179 aircraft
  – Worth $40B
  – Procured over a 15-20 year period

<table>
<thead>
<tr>
<th>FYXX</th>
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<tbody>
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Note: Schedule should be predicated on bidders IMB and entrance criteria for LRIP

Retrofit Schedule

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Sources of Uncertainty

• Demand uncertainty
  – Dubious forecast of how many aircraft are needed
• Uncertainty in the price of jet fuel
  – Seismic shifts in the price of jet fuel
  – Affects long-term cost of operations

Exercising Options

• **Inflexible**: Purchase full lot of 179 aircraft at the given production rate
• **Flexible**: Purchase 79 Boeing 767 aircraft at the given production rate.
  – Re-evaluate decision to purchase remaining 99 based on oil prices and US government update to actual demand during the sixth fiscal year of production.
  – Following outcomes are possible in this scenario:
    ➢ Continue with purchase of 99 aircraft
    ➢ Purchase more than 99 aircraft
    ➢ Purchase less than 99 aircraft
Models

- Aircraft Cost Model
  - DAPCA IV computer model based on industry data
  - \( C_M = 11W_0^{0.921} \times \sqrt{0.621 \times Q^{0.799}} \)
- Fuel Cost Model
  - Geometric Brownian Motion (Stochastic process)
  - \( dS = \mu S dt + \sigma S dz \)
  - Regression analysis performed
- Demand Model
  - Affected by fuel cost
  - Conditional probabilities

<table>
<thead>
<tr>
<th>Fuel Cost</th>
<th>P(HD/FC)</th>
<th>P(MD/FC)</th>
<th>P(LD/FC)</th>
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<tbody>
<tr>
<td>High</td>
<td>1/6</td>
<td>1/3</td>
<td>1/2</td>
</tr>
<tr>
<td>Med</td>
<td>1/3</td>
<td>1/3</td>
<td>1/3</td>
</tr>
<tr>
<td>Low</td>
<td>1/2</td>
<td>1/3</td>
<td>1/6</td>
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Conditional Probability of Demand in Light of Fuel Cost

149: High Demand= Original requirement +50%
99: Medium Demand= original demand
50: Low Demand=original demand-50%
99: = Original Demand

Operational Considerations

- Each aircraft will operate for 750 hours per year
- Each aircraft consumes 1722 gallons of jet fuel per hour
Decision Analysis

- Two-stage decision analysis
  - Fuel price at end of period 1 drives stage 2 decisions
- Results (Cost)
  - No option: $41.7B
  - Flexible: $39.2B
  - Savings: $1.5B

Lattice Analysis

- Binomial lattice framework
- Models the change in jet fuel price over time by considering the movement of the price at each time node
**Lattice Valuation**

<table>
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<th>Price Range</th>
<th>Price Build Level Build</th>
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<td>LOW</td>
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<tr>
<td>MED</td>
<td>$4.27</td>
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<tr>
<td>HIGH</td>
<td>≥ $6.28</td>
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Value of flexibility = $5.3M cost savings

**Conclusion**

- The flexible options produced procurement and operational cost savings
  - On the order of 1 to 6%
  - For a system price tag near $40B, the potential savings are noteworthy
- Flexibility option merits greater consideration
  - Consider other units of measure (contractor profit, capability gained, etc)
  - Structured for mutual benefit (military, taxpayer, industry)