
Flexibility in an Aircraft Assembly Plant

ESD.71 Final Application Portfolio
Anna Massie
12/15/2008

Overview

- In fiscal year 2008, the US government approved \$91.9 billion for procurement purposes, \$33.8 billion of which to the Air Force
 - Contractors to the DoD fulfill these acquisitions, including the purchasing of airplane tankers
 - Contractors have much to gain from such a contract, but there is still uncertainty in the total number of airplanes that will be demanded over the life of the contract
-

Problem Statement

- The contractor requires adequate facilities to manufacture and build these aircraft
- One of the primary facilities necessary is the assembly plant
- This project focuses on how flexibility in the design of the assembly plant can help a contractor in times of uncertainty

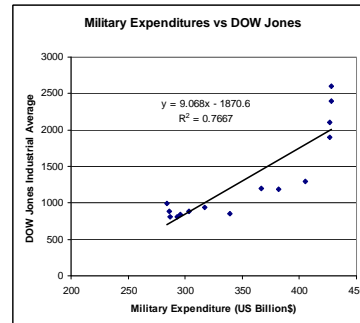
Design Considerations

- The assembly plant can either be built at a fixed size, or designed with flexibility to allow for future expansion
 - Additional land and equipment bought initially to have flexibility of increasing production later
- Each design has a separate cost and profit structure

| | | Flexibility | Fixed |
|-----------------------------|-----------|-------------|-------|
| Fixed Costs | Year 1 | \$70M | \$40M |
| | Year 2-10 | \$40M | \$40M |
| Marginal Cost per Plane | | \$2.50M | \$3M |
| Low supply fee | | \$10M | \$10M |
| Price per Plane | | \$10M | \$10M |
| Profit from decreasing size | | \$3M | NA |

Sources of Uncertainty

- Uncertainty will cause the demand of aircraft to fluctuate from the baseline
- Economic Uncertainty
 - Demand fluctuates with the economy, as benchmarked by the DOW Jones Industrial Average
- Political Uncertainty
 - Demand increases during times of war

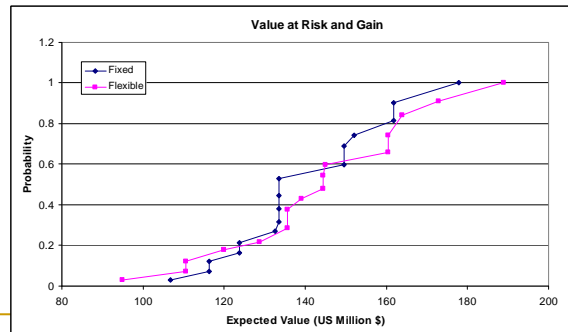


Decision Analysis Model

- Two stages of five years
- At the chance nodes
 - Demand follows a demand probability distribution as found by analyzing joint demand distributions from the uncertainties
- At the initial decision nodes
 - Contractor could choose a fixed or flexible design
- At decision node at year 5
 - For flexible, contractor can decide to expand, decrease or keep production the same
- Expected value is calculated after each node

Decision Analysis Results

- Obtain a higher expected value for the flexible design (\$146 million) than for the fixed design (\$142 million), but fixed design better under worst circumstances



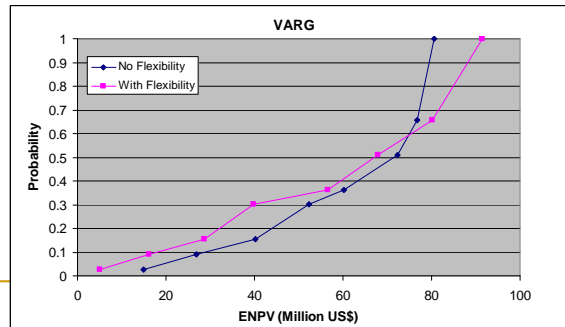
| | Flexible | Fixed |
|----------------|----------|-------|
| Expected Value | \$146 | \$142 |
| Min | \$95 | \$106 |
| Max | \$188 | \$177 |
| B/C | 1.52 | 1.5 |

Binomial Lattice Model

- Economic uncertainty modeled through DOW Jones Industrial average points
- DOW average growth rate 2.5%, volatility 12.5%
 - $u=1.31$, $d=0.882$, $p=0.615$
- Demand can be determined from this uncertainty by bucketing by DOW points
 - 0-5000 points: 6 aircraft/year
 - 5000-8000: 8 aircraft/year
 - 8000-10000: 10 aircraft/year
 - 10000-14000: 12 aircraft/year
 - 14000-20000: 14 aircraft/year
 - 20000+ points: 16 aircraft/year

Binomial Lattice Results

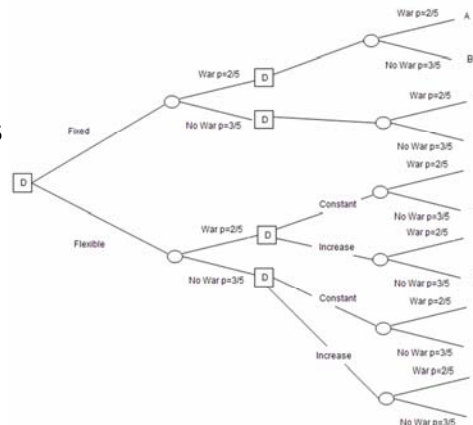
- The contractor should decide to exercise flexibility at year 1
- Obtain a higher expected value for the flexible design (\$156 million) than for the fixed design (\$153 million)



| | Flexible | Fixed |
|--------------------------|----------|-------|
| Expected Value (year 10) | \$159 | \$153 |
| Expected Value (year 4) | \$68 | \$64 |
| Min | \$4 | \$14 |
| Max | \$91 | \$70 |
| B/C | 1.51 | 1.69 |

Hybrid Model

- Used lattice to model economic uncertainty combined with a two-stage decision analysis to model political uncertainty
- Analyzed two resultant scenarios
- Based off of Nestor Quispez-Asin's Master of Science Thesis

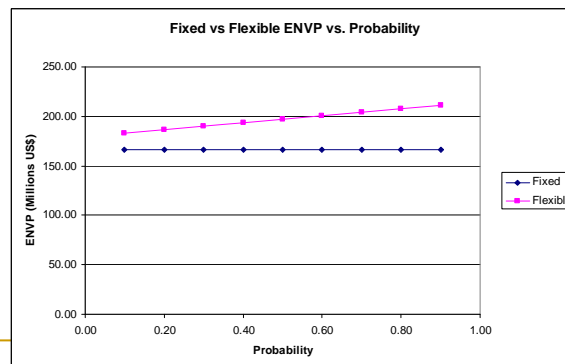


Hybrid Results

- Obtain a higher expected value for the flexible design (\$192 million) than for the fixed design (\$166 million)
- For flexible design, more beneficial to expand independent if there is or is not a war

Sensitivity of Political Uncertainty

- Tested sensitivity of results to the probability that a war would occur
- Found flexible design always superior



Comparison of Models

- Primary parameters that changed results of models were the uncertainties, the cost and profit structure, and the put option
- Value of flexibility varied from \$4-\$23 million
- Put option most influential parameter
 - Contractor would lose significantly in first 5 years if not able to expand

| Model: | Economic Uncertainty | Political Uncertainty | Costs/Profits | Put Option | EV Flexible | EV Fixed |
|-----------|---------------------------|---------------------------|---------------------------|------------|-------------|----------|
| Two-Stage | Modeled per 5 year period | Modeled per 5 year period | Modeled per 5 year period | European | \$146 | \$142 |
| Lattice | Modeled yearly | Not modeled | Modeled yearly | American | \$156 | \$148 |
| Hybrid | Modeled yearly | Modeled per 5 year period | Modeled Yearly | American | \$192 | \$166 |

Conclusion

- Hybrid analysis most appropriate for model as it encompasses both political and economic uncertainty, and uses the American call option
- Model would quickly explode with additional uncertainty factors
- The flexible design always better than the fixed design, but changes in the model could affect this conclusion