Flexibility in an Aircraft Assembly Plant

ESD.71 Final Application Portfolio

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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 form 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

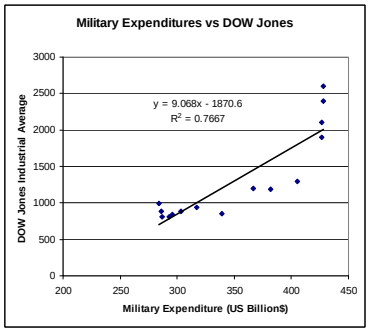
Design Considerations

- 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

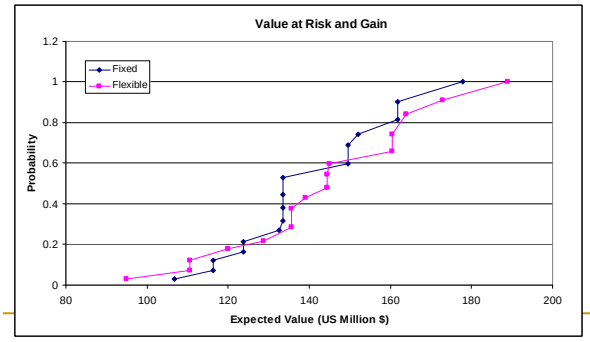


Decision Analysis Model

- 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



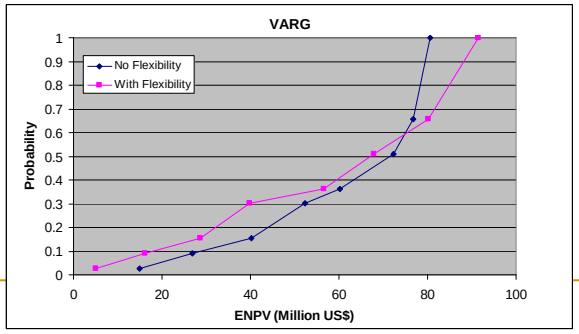
	Flexible	Fixed
Expected Value	$146	$142
Min	$95	$106
Max	$188	$177
B/C	1.52	1.5

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

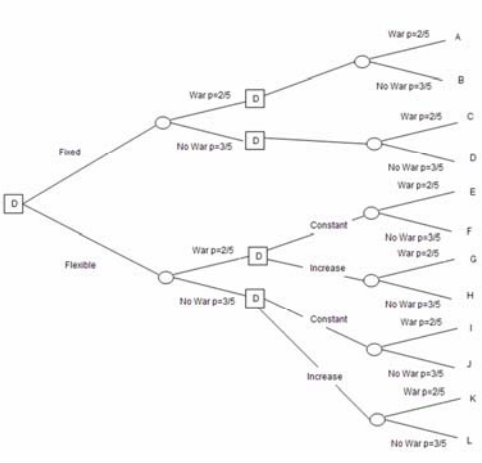
- The contractor should decide to exercise flexibility at year 1
- Obtain a higher expected value for the flexible design ($156 million) than for the fixed design ($153 million)



	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

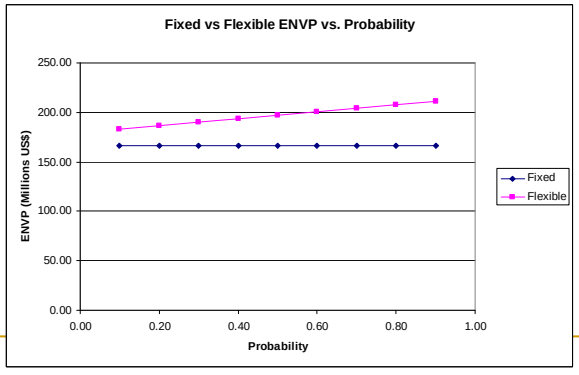


Hybrid Results

- 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