LAI Annual Meeting

Session: Pushing the Enterprise Modeling Envelope

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LEAN ADVANCEMENT INITIATIVE ™

Increasing Value of a Family of Products through Flexibility: Hedging Against Uncertainty

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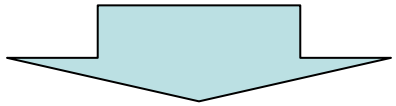
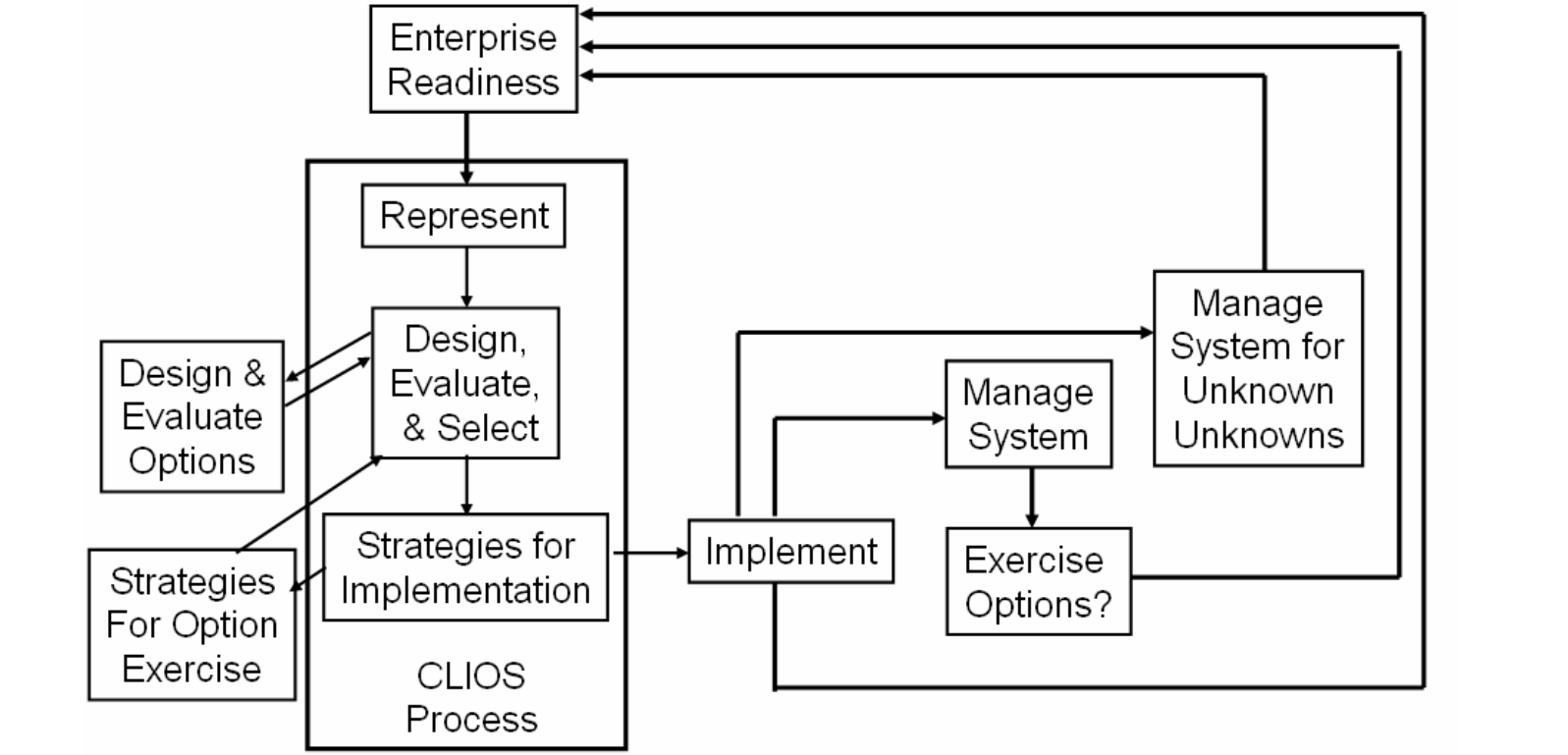
Background and Intuition

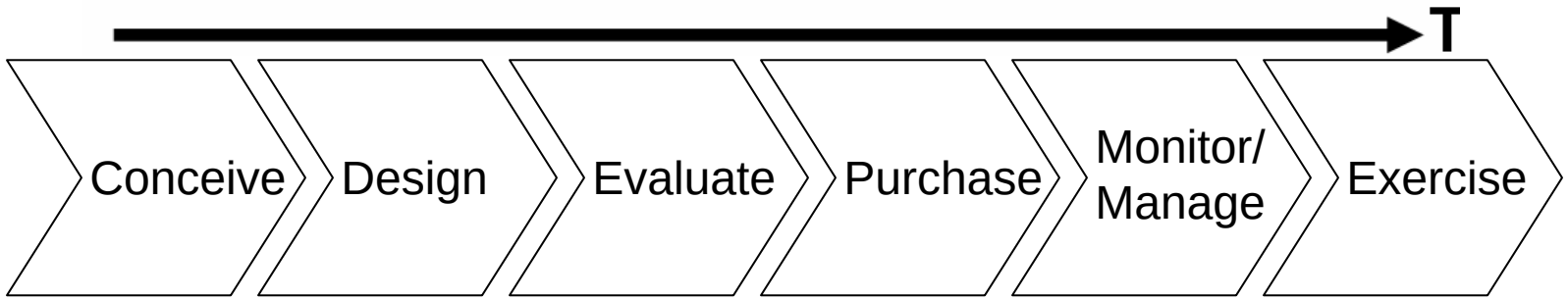
1. Uncertainty exists in complex systems
2. Flexibility is one way to cope with uncertainty
3. Real Options are a way to operationalize and value flexibility
4. Real Options can be designed in a physical system



There appears to exist a need to consider real options from both a physical and social system perspective, i.e "Complex" Real Options in Complex Systems

Complete Life-Cycle Flexibility Framework





Case Study

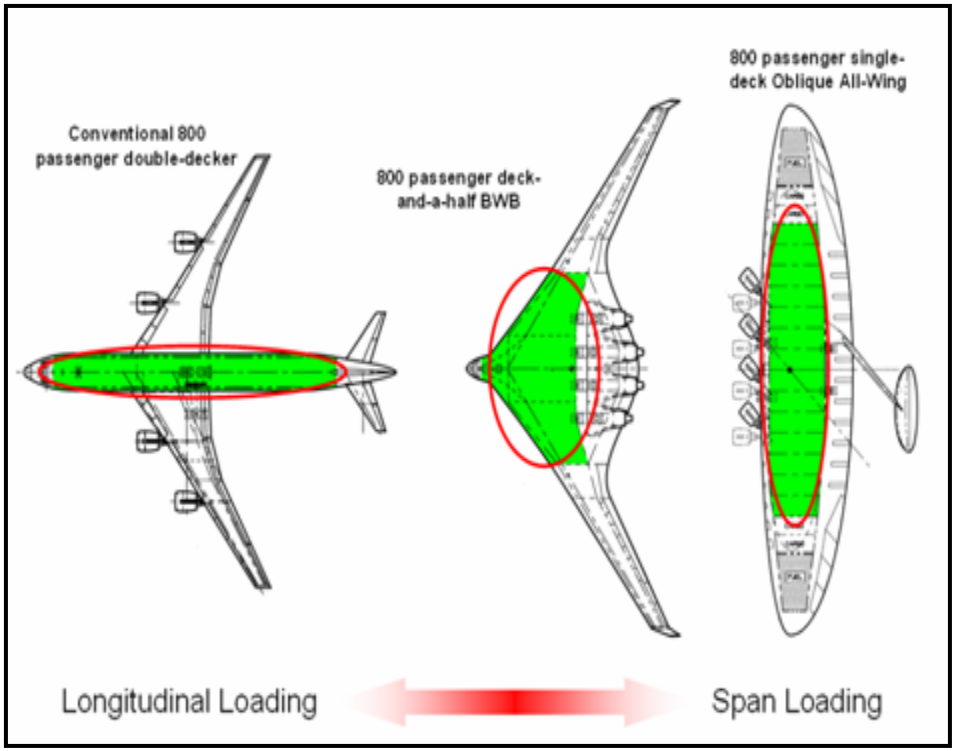
- **Boeing BWB**
  - **Explore inherent and flexibility value in technology/technical architecture**
  - **Explore systemic effects through quantitative models**
  - **Better understand "real world" challenges and constraints**

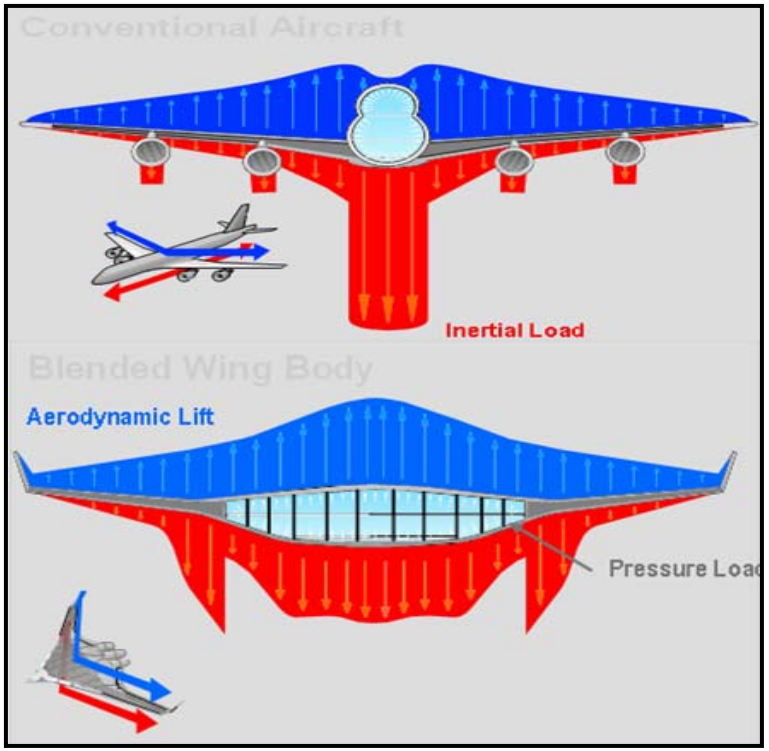
Boeing: BWB

- Technical architecture – commonalty enabled
- Enterprise Architecture – Boeing and extended enterprise

Benefits of BWB

- Inherent benefits of BWB
  - **Technical architecture results in improved aerodynamics, which leads to reduce fuel burn per passenger (27% reduction at 800 passenger plane)**
  - **Reduced noise (increased airport operational states, change to airline business model?)**

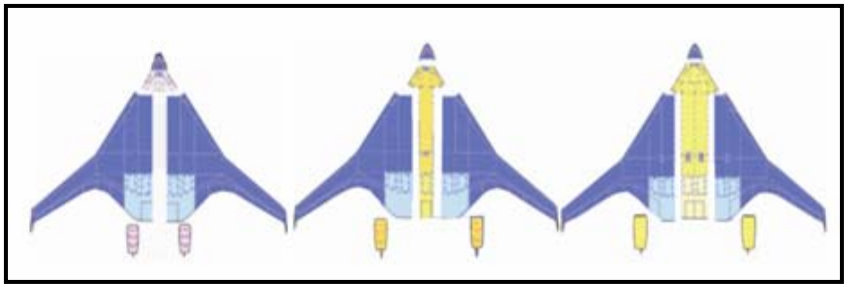


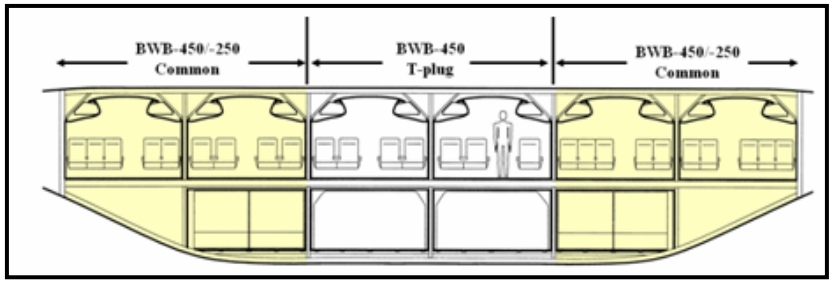


All BWB figures from Liebeck

Benefits of BWB

- Flexibility Benefits of BWB
  - **Commonality due to BWB technical architecture leads to improved options, relative to conventional architecture for "cross-family" derivatives:**



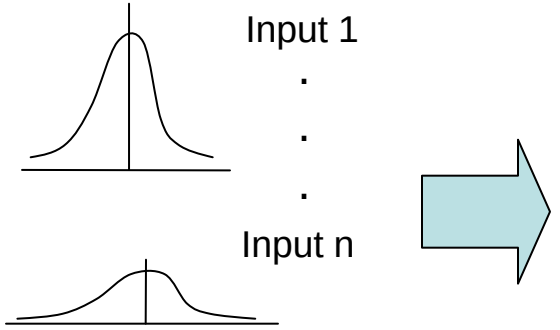


Increased commonalty across family sizes (250 – 450)

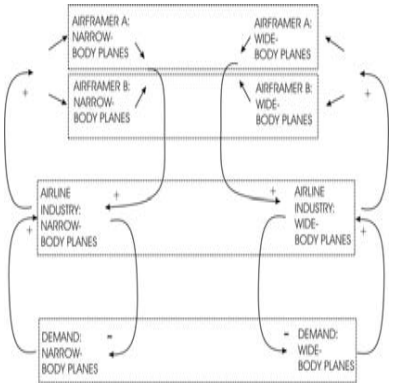
Larger family of "derivatives"

→ Increased scale of economics and learning curve effects
→ Lower costs per plane
→ Faster time to market
→ Increased market share
→ Increased NPV

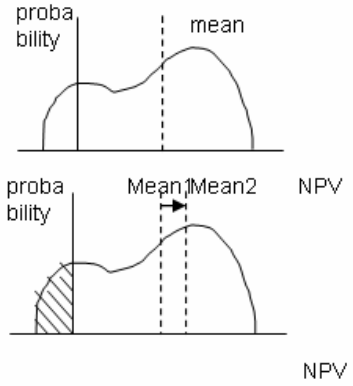
Value of Flexibility in BWB: Evaluation



Flexibility evaluated under different conditions
- uncertainty in fuel prices
- uncertainty in demand
- different competing products
- different competitor strategies



System dynamics model provides value of underlying asset (BWB anticipated sales and market share) under different future states



Real Option analysis using expected benefit distributions and changes in expected mean value*

* Value of flexibility = Value project with flexibility – value of project without flexibility
Tufano and Moel 1997, Clemons and Gu 2003, Greden et al. 2005, Miller 2006

Challenges to Flexibility in BWB

BWB improves options by:

→Decreasing costs with increased commonality across families

…but requires

- Commonality across programs
- Perceived value in spreading costs across program
- Top down direction for ID'ing areas of commonalty
- Evaluation methods

Boeing challenges

- Program-centric enterprise architecture
- Cultural emphasis on standalone, cutting edge technology
- Multiple evaluation methods for investment

Conclusions- Flexibility

- Proof of Concept of Life-Cycle Flexibility Framework
- It is one thing to design in flexibility in technical terms and quite another to be able to trigger a real option - “complex” real options in complex systems
- When the benefits and costs of flexibility accrue to different managers at different stages of the process, we have problems in deployment.

Final Comments

- A doctoral-level study--valuing flexibility in the aerospace context
- The research perspective is at the enterprise level
- Questions or comments?

