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Design For
the Marketplace



Stakeholder Value and the Evolution of Commercial Aircraft

Paul Collopy
Engineering Economist
DFM Consulting, Inc.

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Stakeholder Value and the Evolution of Commercial Aircraft

- Evolution of Commercial Aircraft
 - Aerospace Products are Complex Adaptive Systems
- Stakeholder Value
 - Who are Stakeholders?
 - Surplus Value Theory
 - Applications

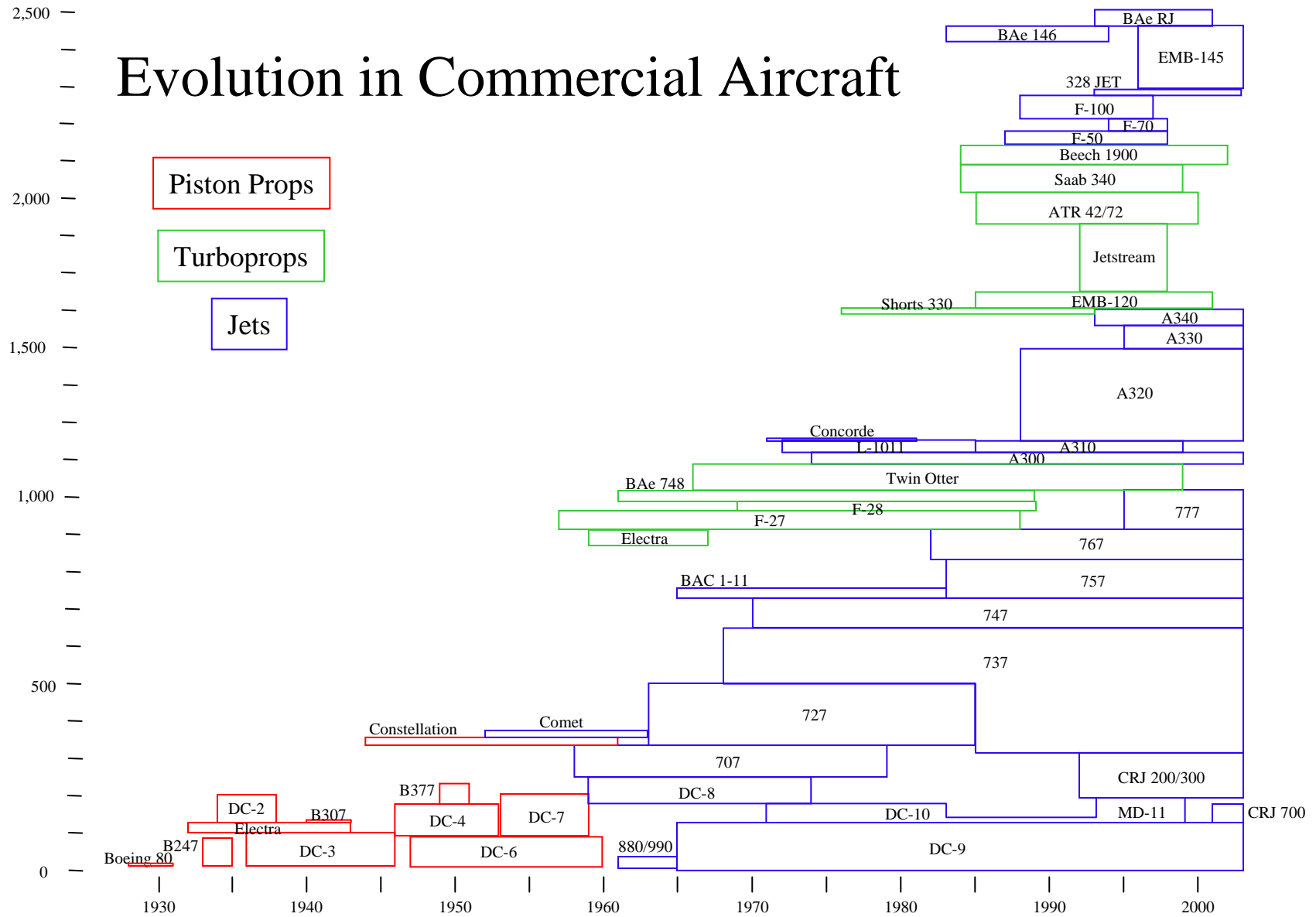
Motivation for this Research

- A simple paradigm for understanding success and failure in commercial air transport
- A guide to developing successful air transportation equipment
- A decision support model for airline strategies
- Basis for a technology evaluation model over the domain of aircraft, airlines, airports, etc.



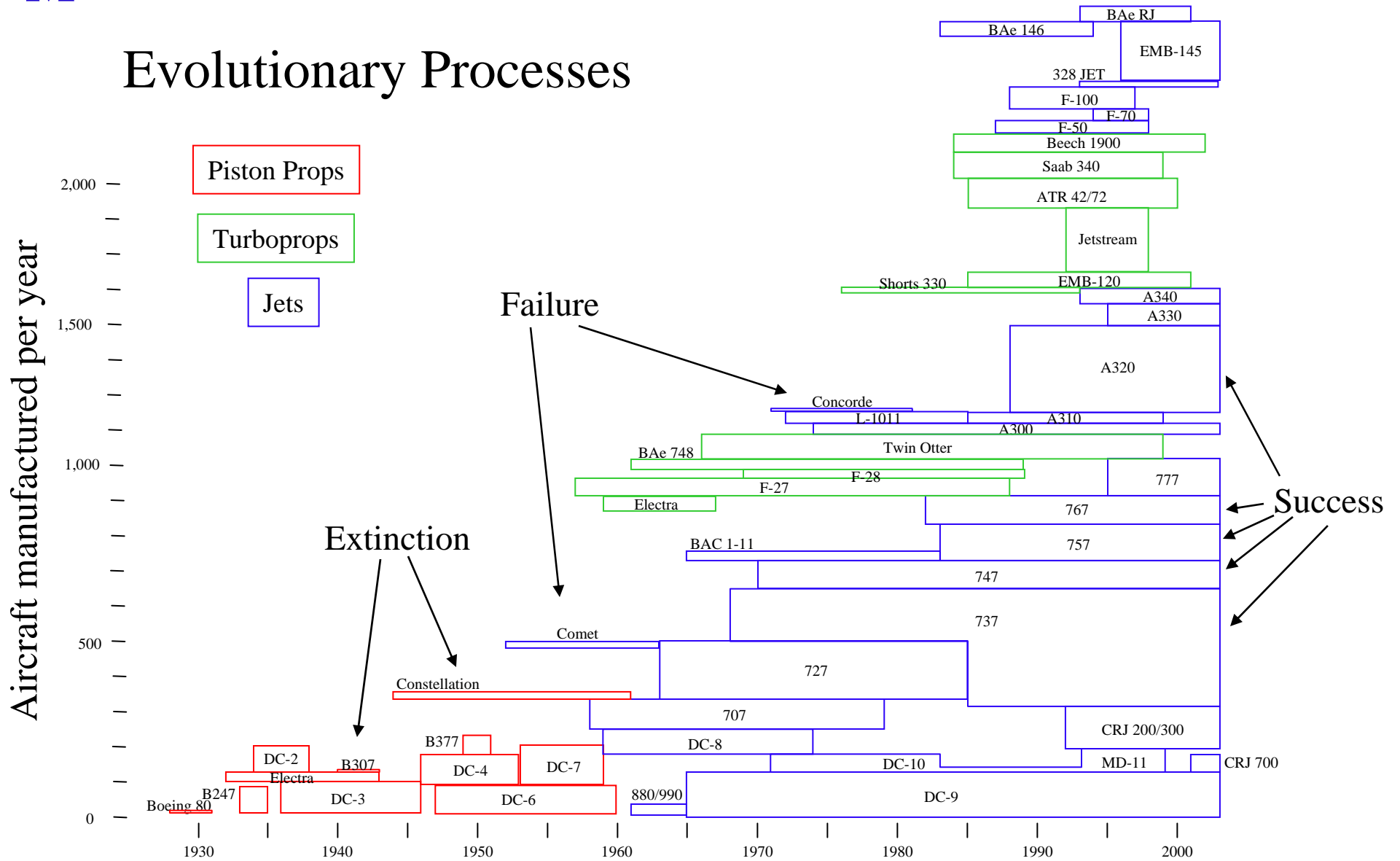
Evolution in Commercial Aircraft

Aircraft manufactured per year



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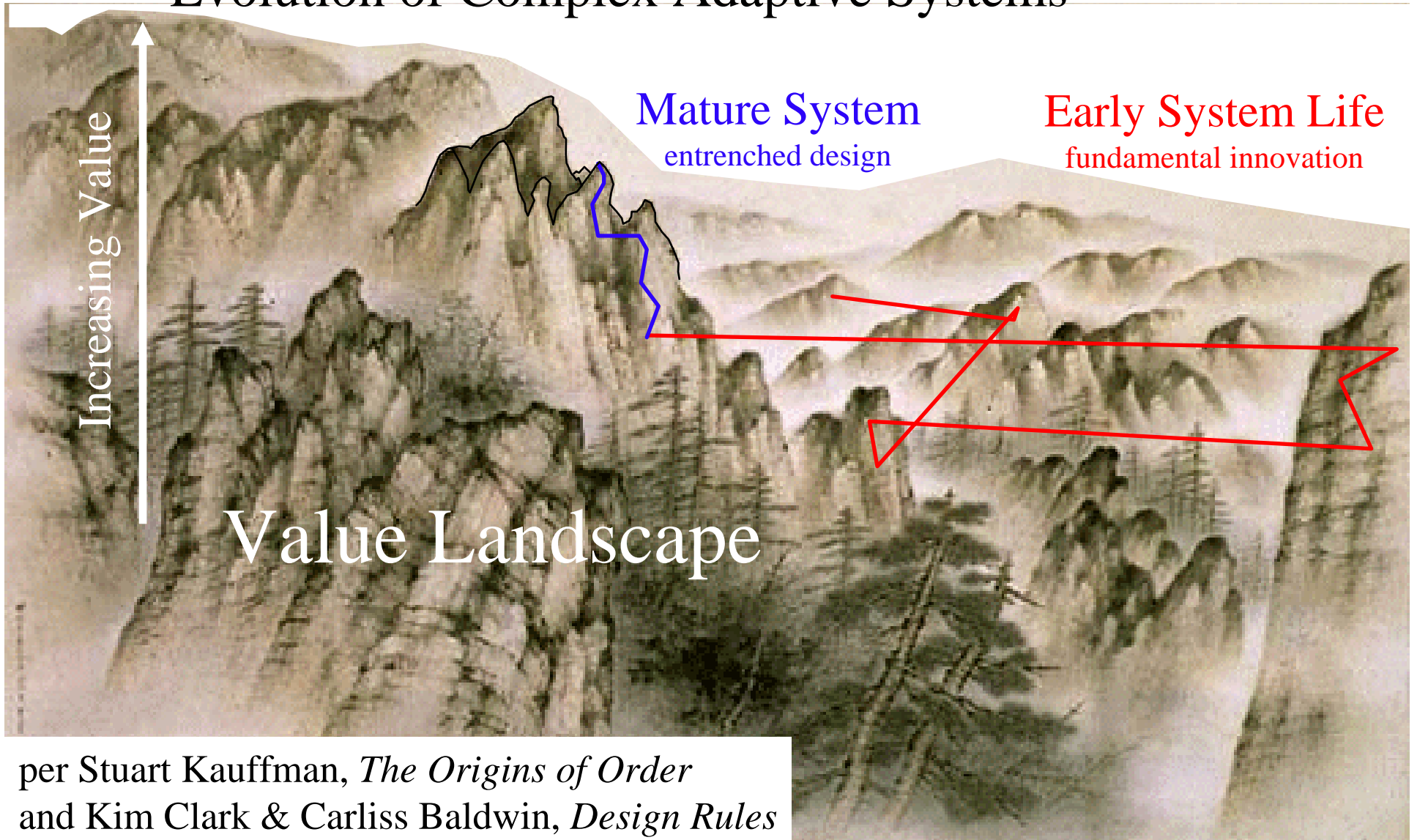
Evolutionary Processes



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Evolution of Complex Adaptive Systems



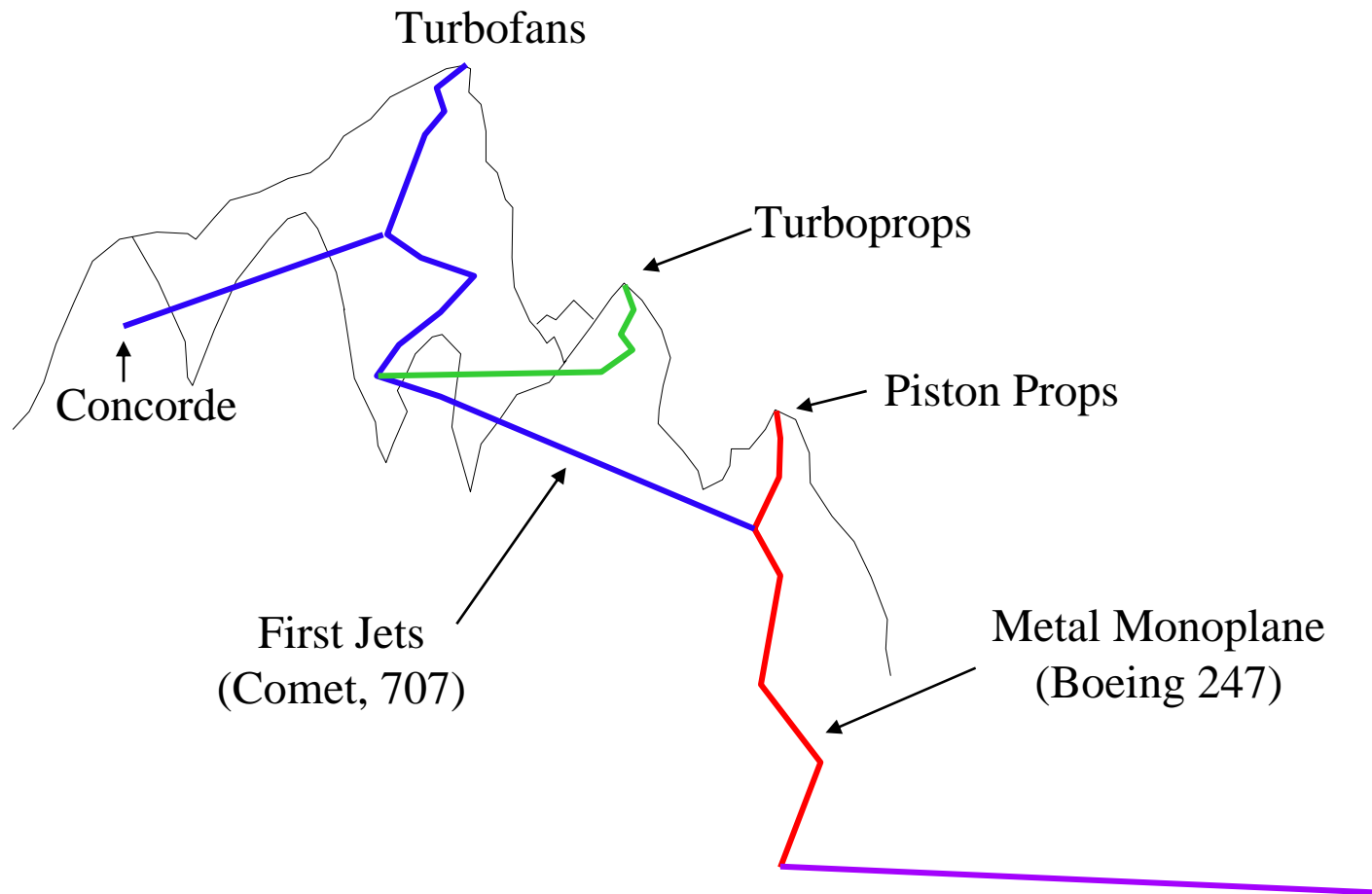
per Stuart Kauffman, *The Origins of Order*
and Kim Clark & Carliss Baldwin, *Design Rules*

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A Closer Look at Evolution



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What Is Value?

Altitude in the Mountain Metaphor

- Net Value delivered to Stakeholders
 - Benefits minus costs or penalties
- Almarin Phillips (RAND) rule:
 - $\text{New DOC} + \text{Cost of Capital} < \text{Old DOC}$
- Questions Remain:
 - Who are Stakeholders?
 - How is value to particular Stakeholders combined?

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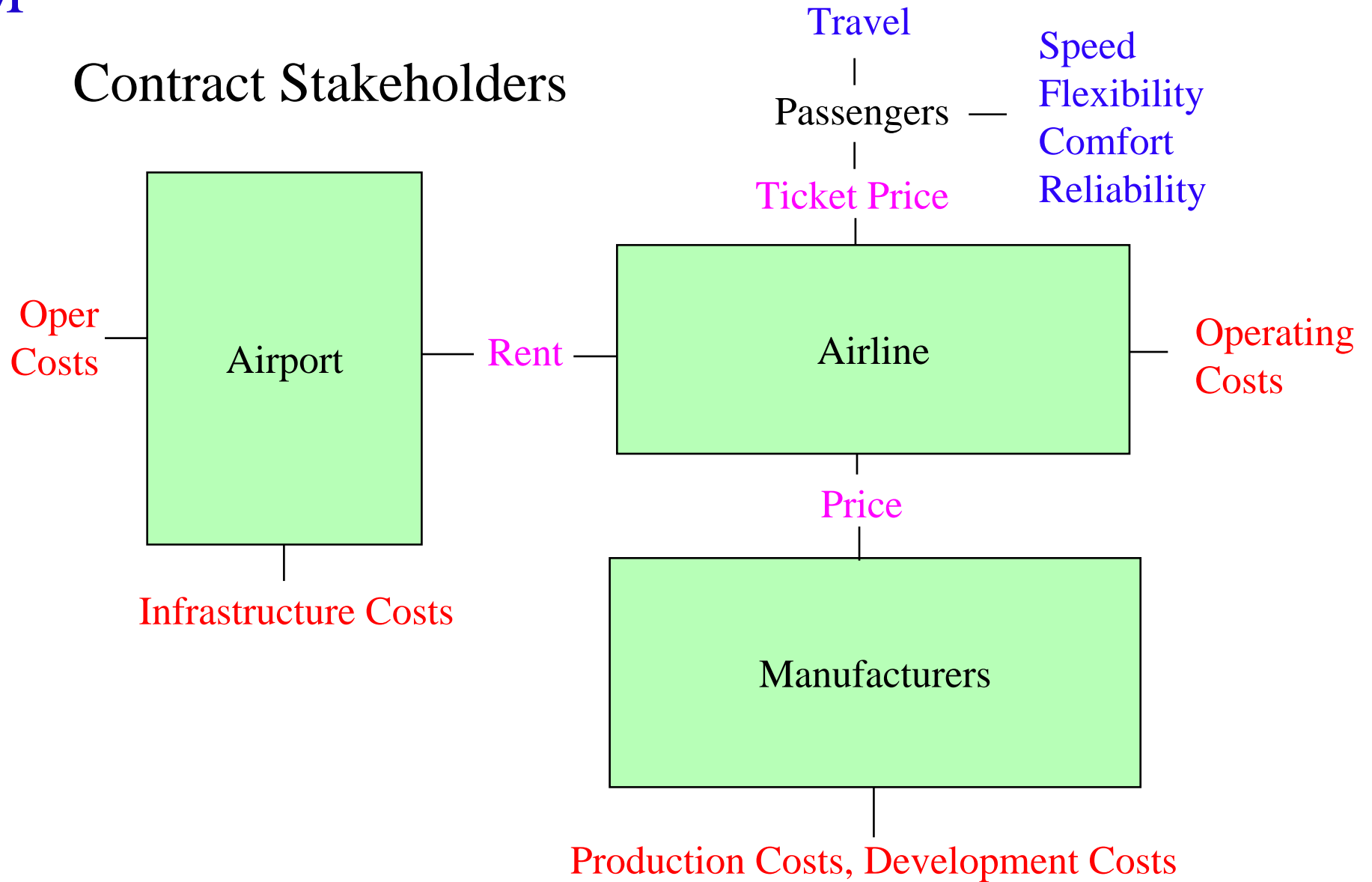


Stakeholders

- Passengers
 - Freight Customers
- Airlines
- Airports
- Equipment Manufacturers
 - Airframes
 - Engines
- Society (Externalities)
 - Noise and Pollution
 - Economic Growth

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Contract Stakeholders

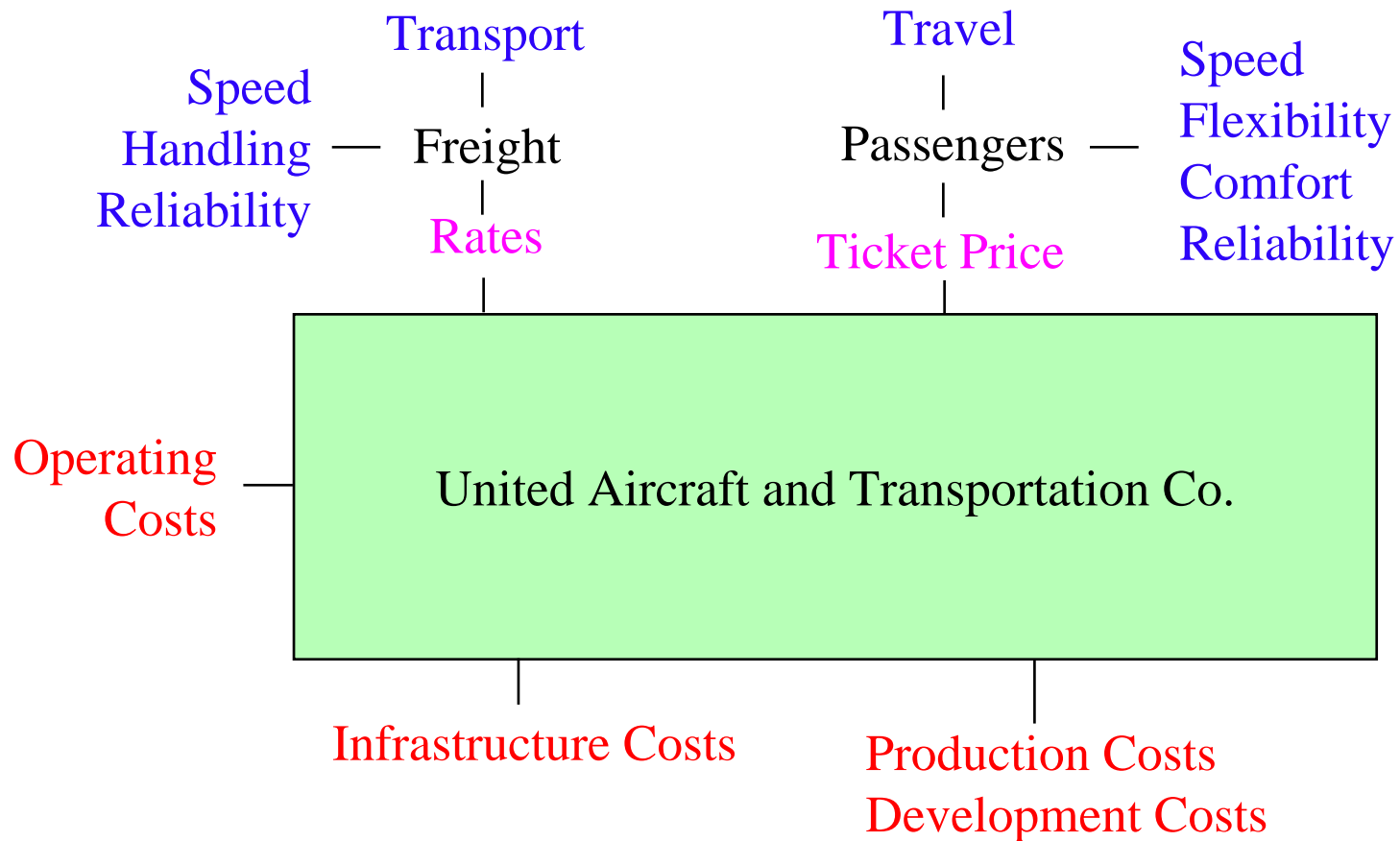


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Single Firm Model

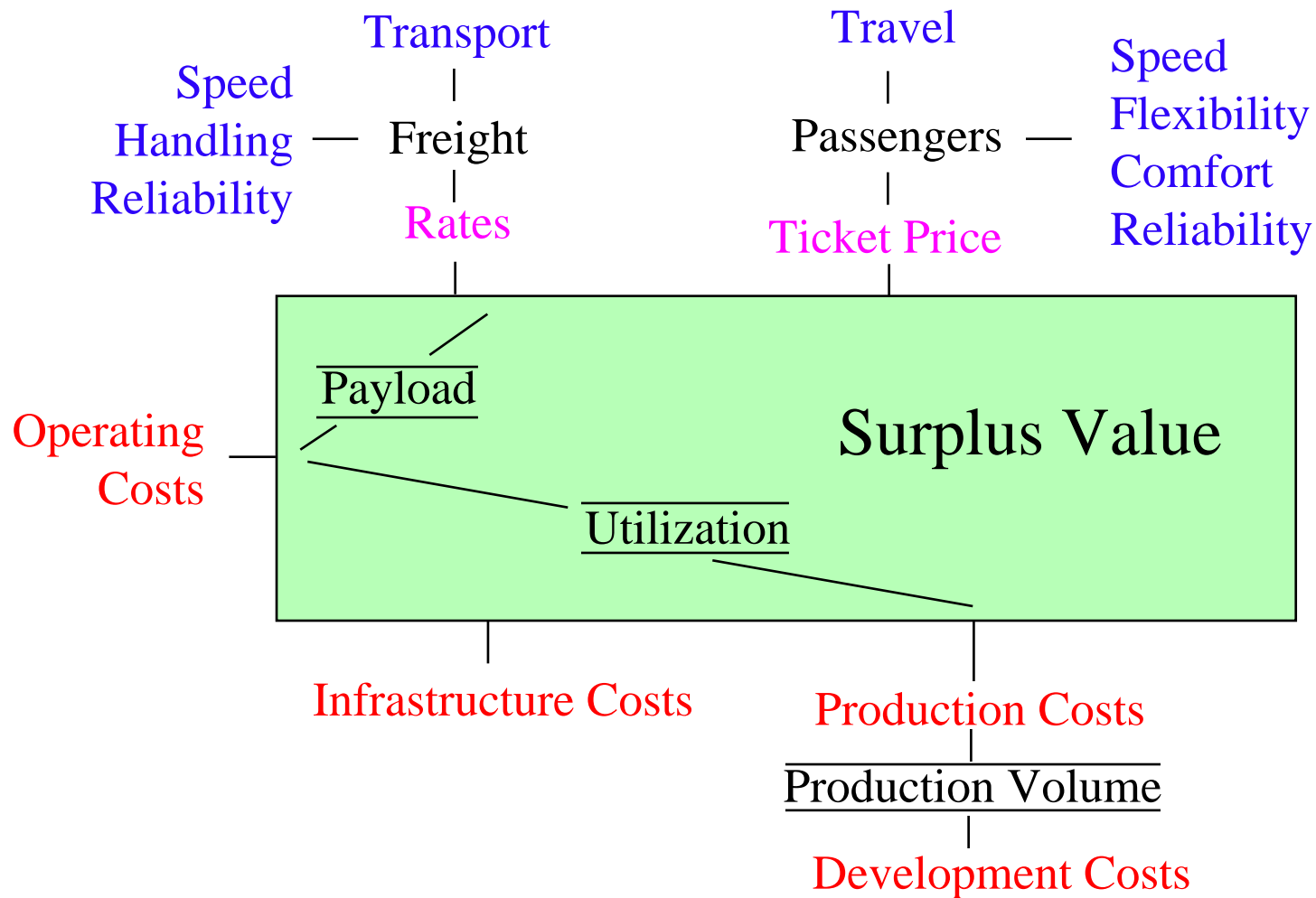


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Single Firm Model — Elaborated

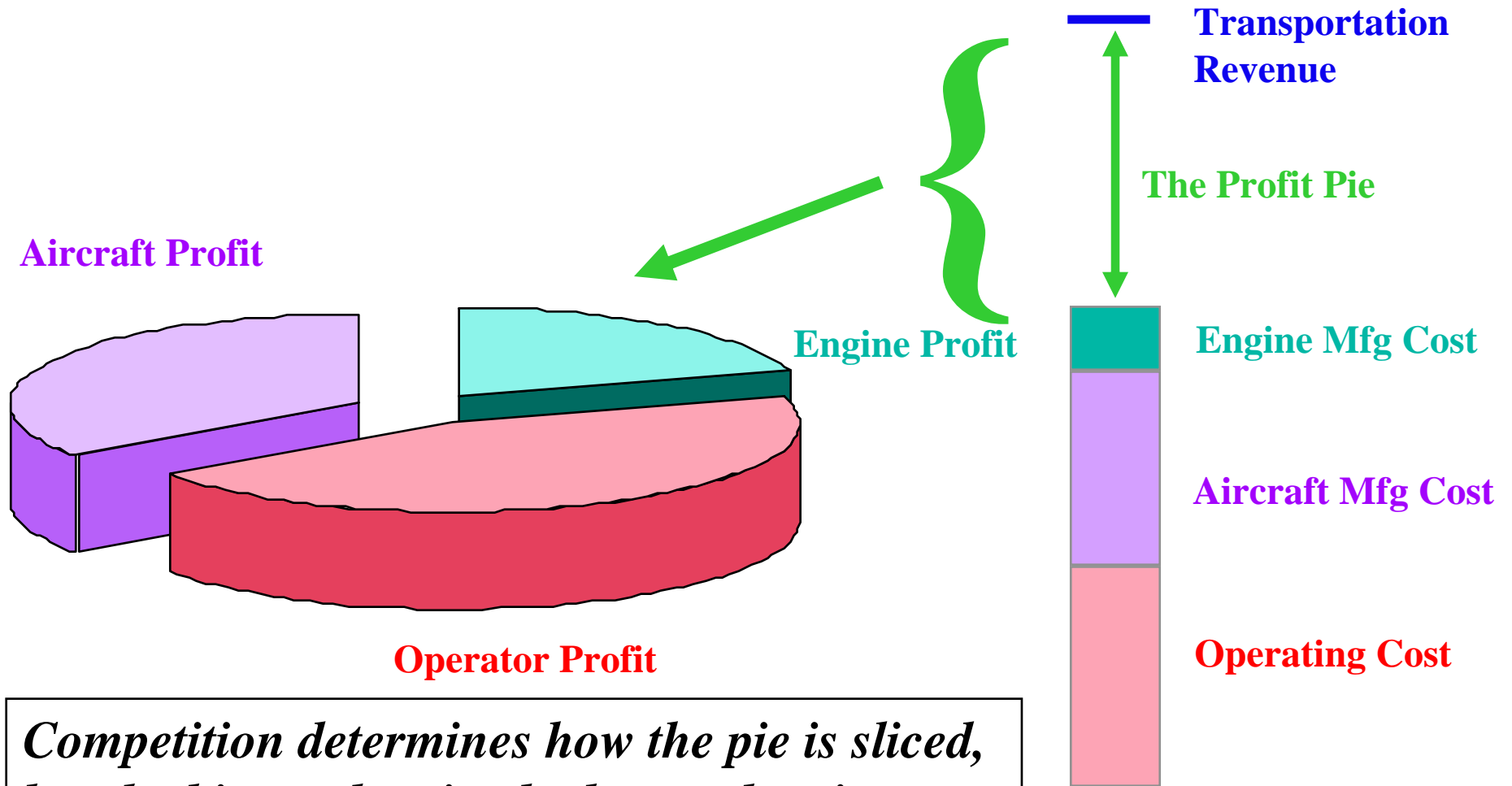


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Surplus Value Theory



*Competition determines how the pie is sliced,
but the bigger the pie, the larger the pieces*

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Key Theorem of Surplus Value Theory

Any technology, product design, or strategy that increases surplus value will increase or not affect the profits of each contract stakeholder, assuming effective bargaining.

A rising tide lifts all boats

Example: Surplus Value Maximizing Networks

- Lowest cost per mile traveled is on point to point service
- Surplus Value maximizing networks concentrate traffic on point-to-point service by discounting nonstop flights
- Revenue maximization, on the other hand, leads to
 - hub and spoke network
 - premium charge for point to point (what the market will bear)
- In the long run, Surplus Value maximizers will drive revenue maximizers to extinction
 - or, at least, to small niche operation

Some Implications for the Future

- Great leaps across the design space are difficult until we better understand optimal design
 - Blended wing body aircraft are out of reach
- Passenger networks will tend more toward point-to-point
 - Aircraft designs that cater to point-to-point service will be more successful
 - Boeing's 7E7 is better targeted than Airbus A380
 - However, 7E7 does not seem to balance cost / performance to maximize surplus value (trade \$250 mfg cost / lb. of weight)
 - Same argument suggests engine bypass ratio should be < 8

Evolution of Commercial Aircraft — Summary

- Commercial aircraft can be viewed as a community of complex adaptive systems
 - branching and extinction are common processes
- Evolutionary success is determined by relative contribution to surplus value
 - Revenues minus costs around the boundaries of unified contract stakeholders provides a simple model of surplus value, the driving force for evolutionary success
- Surplus value model provides a metric for comparing aircraft designs, prospective technologies & airline networks