

Toyota's Use of Real Options to Improve Product Development and Manage Risk

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June 5, 2006

Development Challenges

- Competitive development requires *continuous design innovation*
- The performance of innovative designs are inherently uncertain, creating *design risk*
- ***How can firms increase the chances of including developing, and selecting high performing designs?***

Multiple design alternatives are characteristic of “good” design processes.

“...the single solution path to failure...”

- *DOE project manager, 2001*

“...single solutions are usually a disaster”

- *Pugh, 1991*

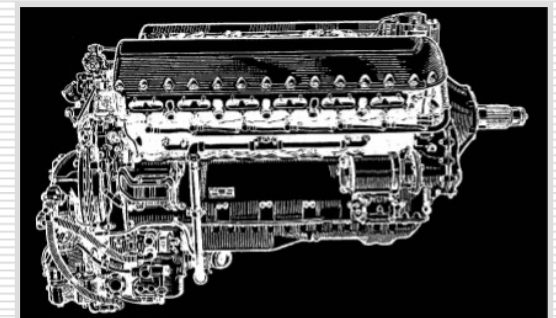
Multiple Design Alternatives

Solution:

Parallel development of multiple alternatives and selection of the best alternative.


Managing multiple alternatives is difficult...

- Starting with a fertile set of alternatives
- Relative performance of alternatives evolve
- Costs increase with the number of alternatives
- ***Selecting the best alternative ...***



Traditional Development Methodology

Point-based or "Design-Freeze" approach

Need fast development + Concurrency costs  *Converge quickly*

Traditional Wisdom: Freeze design early to improve the chosen design more

Development Strategy:

- 1) Lock-in on one alternative as quickly as possible.
- 2) Iterate to improve that alternative.
 - Efficient use of limited resources
 - Clear focus of design team efforts
 - Less internal competition, friction, etc.

Toyota Development Methodology

Set-based approach:

Uncertain best alternative + High value of quality → **Converge slowly**

Toyota Wisdom: Delay decisions to improve alternative selection

Development Strategy:

- 1) Develop multiple alternatives in parallel
- 2) Continuously gather information on alternative attractiveness
- 3) Frequently compare alternatives and choose or abandon when relative attractiveness is clear

Research Questions

- **How** does delaying alternative selection improve Toyota's design and development performance?
- What is the **value** (\$) of delaying decisions Toyota?
- **When** should alternatives be eliminated?



Real Options Theory

Option: Right without obligation to change strategy in the future based on how uncertainty resolves

Design and Development Examples

- Exit strategies from development projects
- Extra capacity for future expansion
- Modularity

Retaining flexibility with options can increase project value

- + *Increased benefits* (e.g. from better quality)
- + Decreased costs or income losses
- *Costs to obtain and retain flexibility*
- Costs to change strategy
- Lost benefits of deciding early

A Real Options Perspective of Development at Toyota

Parallel staged development purchases options.

- Options to abandon (separate alternatives)
- Options to switch (interdependent alternatives)

Delaying abandoning alternatives retains the “All-Alternatives-Available” strategy

Option benefits and costs

- + Increased quality of final alternative
- - Cost of keeping alternatives alive

A Simulation Model of Toyota Development

1 auto system through 3 major development phases

Reflects development (e.g. quality of development, schedule control, labor quantity and allocation, costs)

Four stylized design alternatives

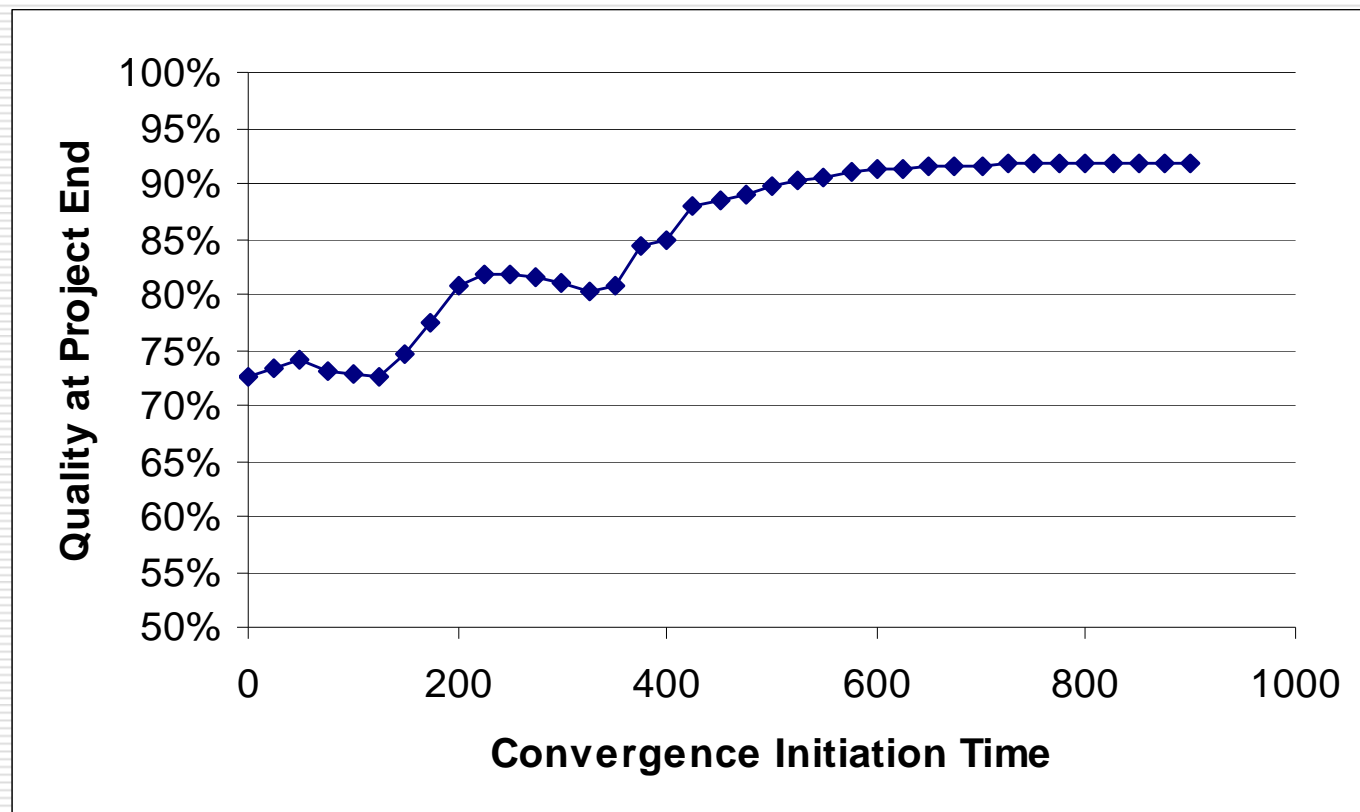
- Uncertain path-dependent evolutions (creates "cross over")
- Differ only in complexity and tractability
- Clear gradation from best (#1) to worst (#4)

Decision Variable: All-Alternatives-Available Option Life

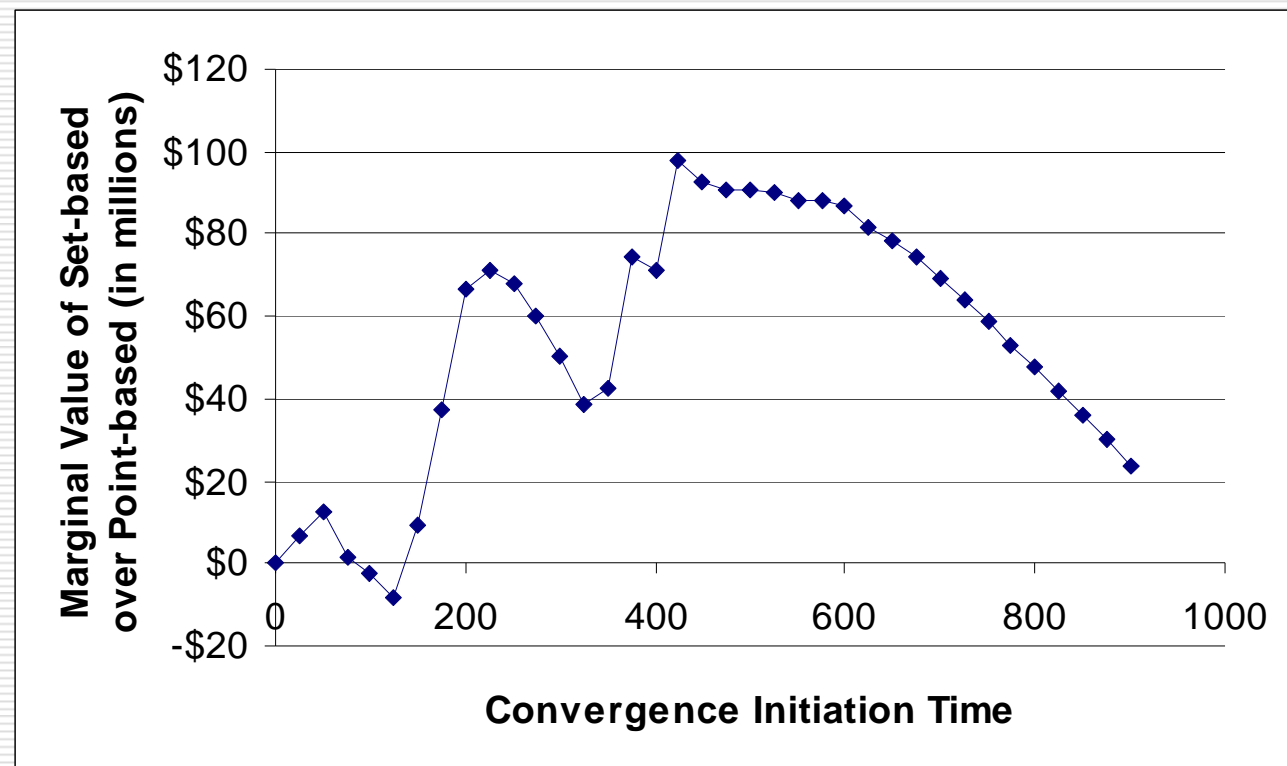
Alternative Selection Policy:

Abandon alternative IF Probation Period_{alt} \geq 1 month
AND Time \geq All-Alt Option Life

Impacts of Start of Design Convergence on Quality



Value Added by Delaying Start of Design Convergence



Development costs increase approximately linearly with Start of Design Convergence.

Application Issues

Real options at Toyota are one part of set-based development

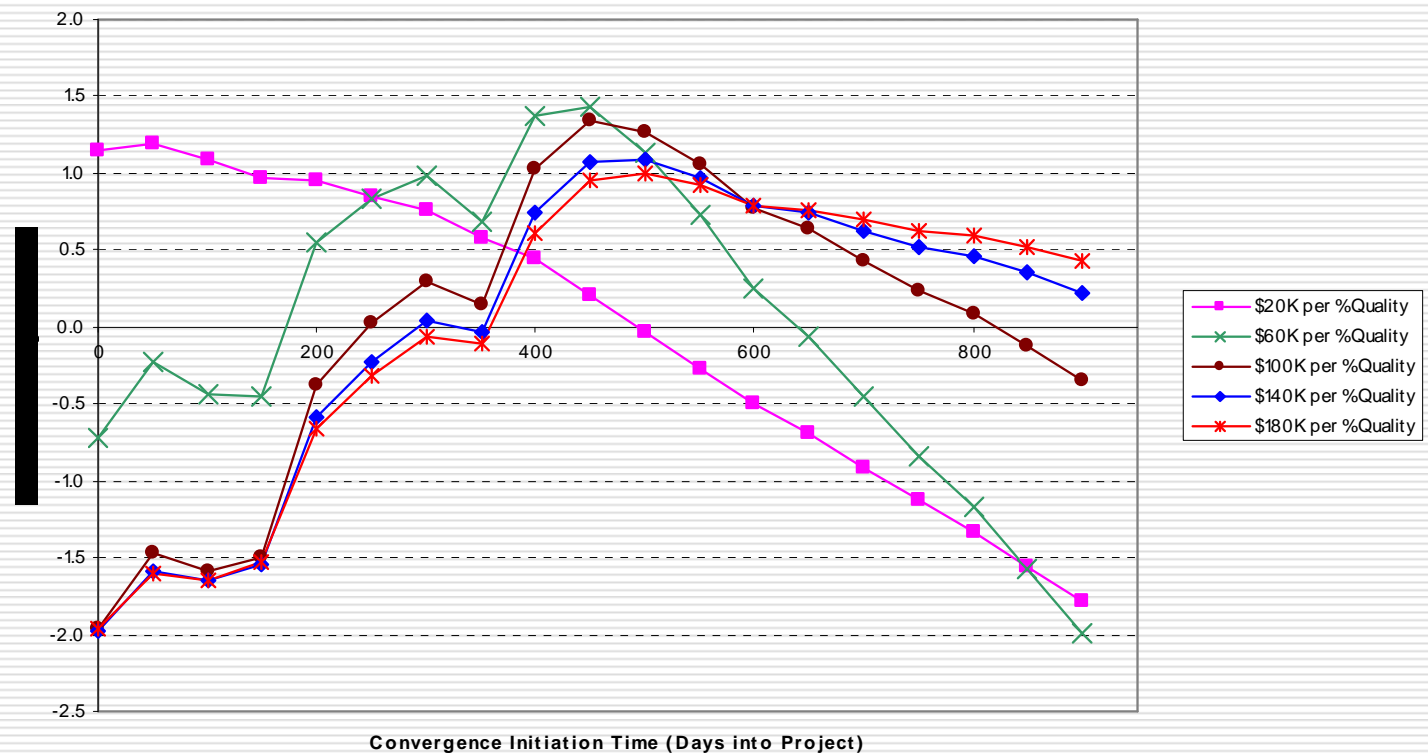
- Continuous learning environment and processes
- Process vs. performance focus

Part of “The Toyota Way” – tightly interwoven culture, processes, management, etc.

Value-added can be sensitive

- To other decisions variables
- To development processes
- To product characteristics...

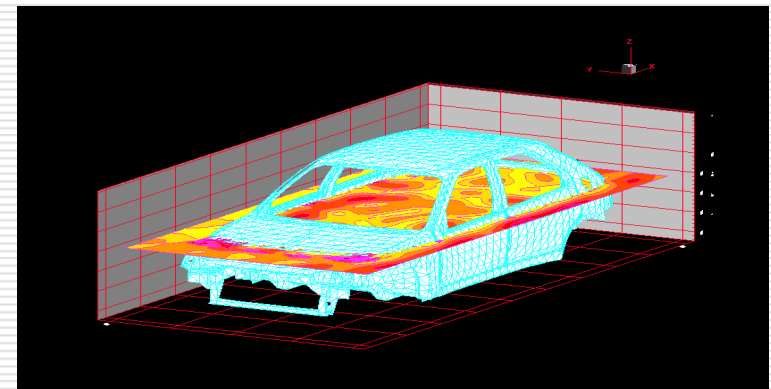
Example Application Issue: The Relative Value of Quality



Start of Design Convergence impact on value-added can be very sensitive to the value of quality.

Conclusions

- Real options add value to Toyota development projects and partially explain Toyota's success
- Flexibility with managerial real options has large strategic potential to add value to development projects
- Application challenges remain (no “plug-and-play”)



Questions
Comments
Discussion