



# **TWO METHODS FOR PRODUCT DESIGN SELECTION**

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**Acknowledgements: *Hui Li* and *Cliff Whitcomb***

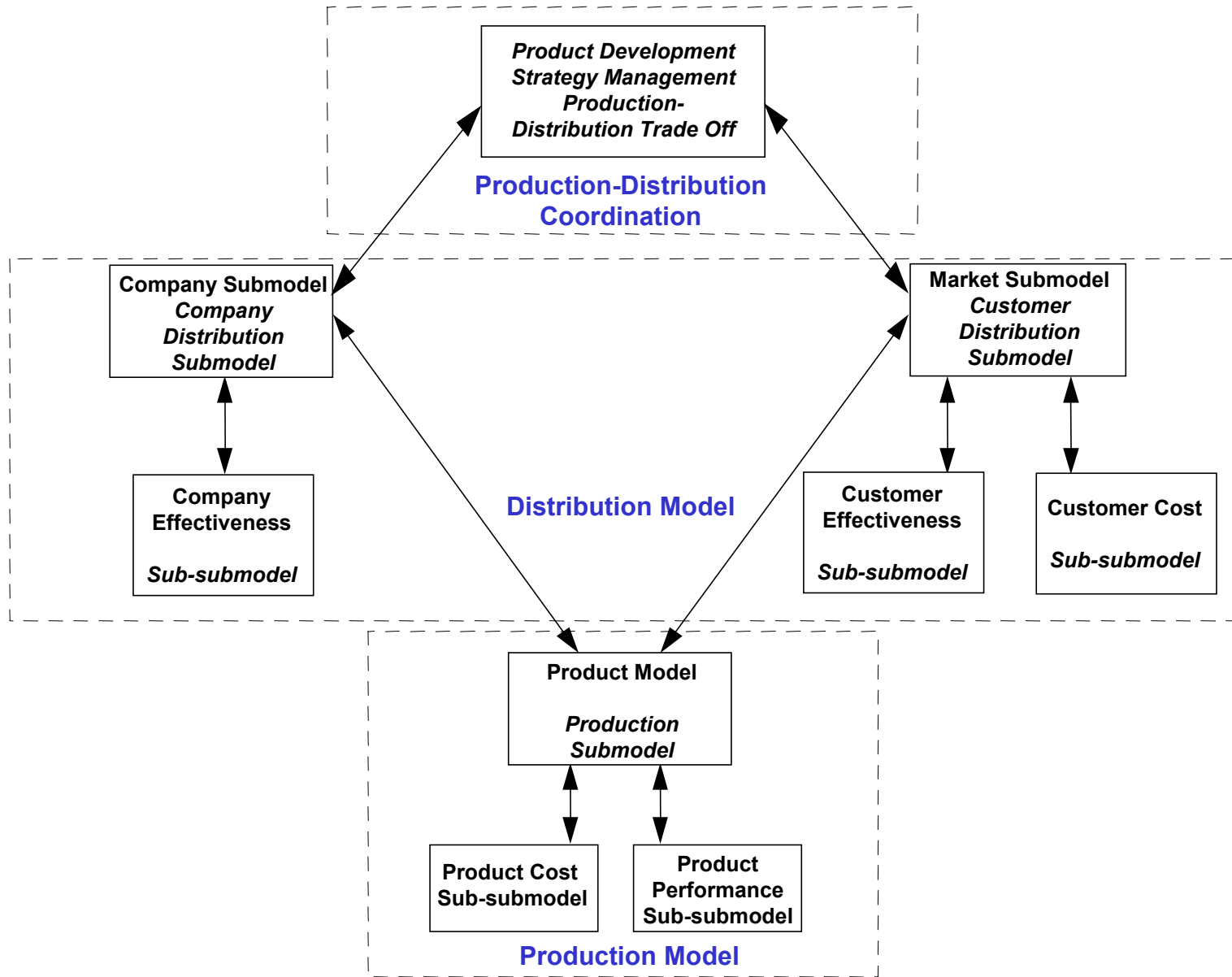
## Typically involves multiple aspects, many in conflict:

- People involved take on their own 'view' of the problem, (e.g., design, marketing)
- Engineer designs a product consisting of multiple subsystems with multiple, conflicting, non-commensurate 'performance' objectives
- Customers with different preferences:
  - Few customers (e.g., market segments)
  - Many customers
- Company *usually* uses profit for measuring benefit

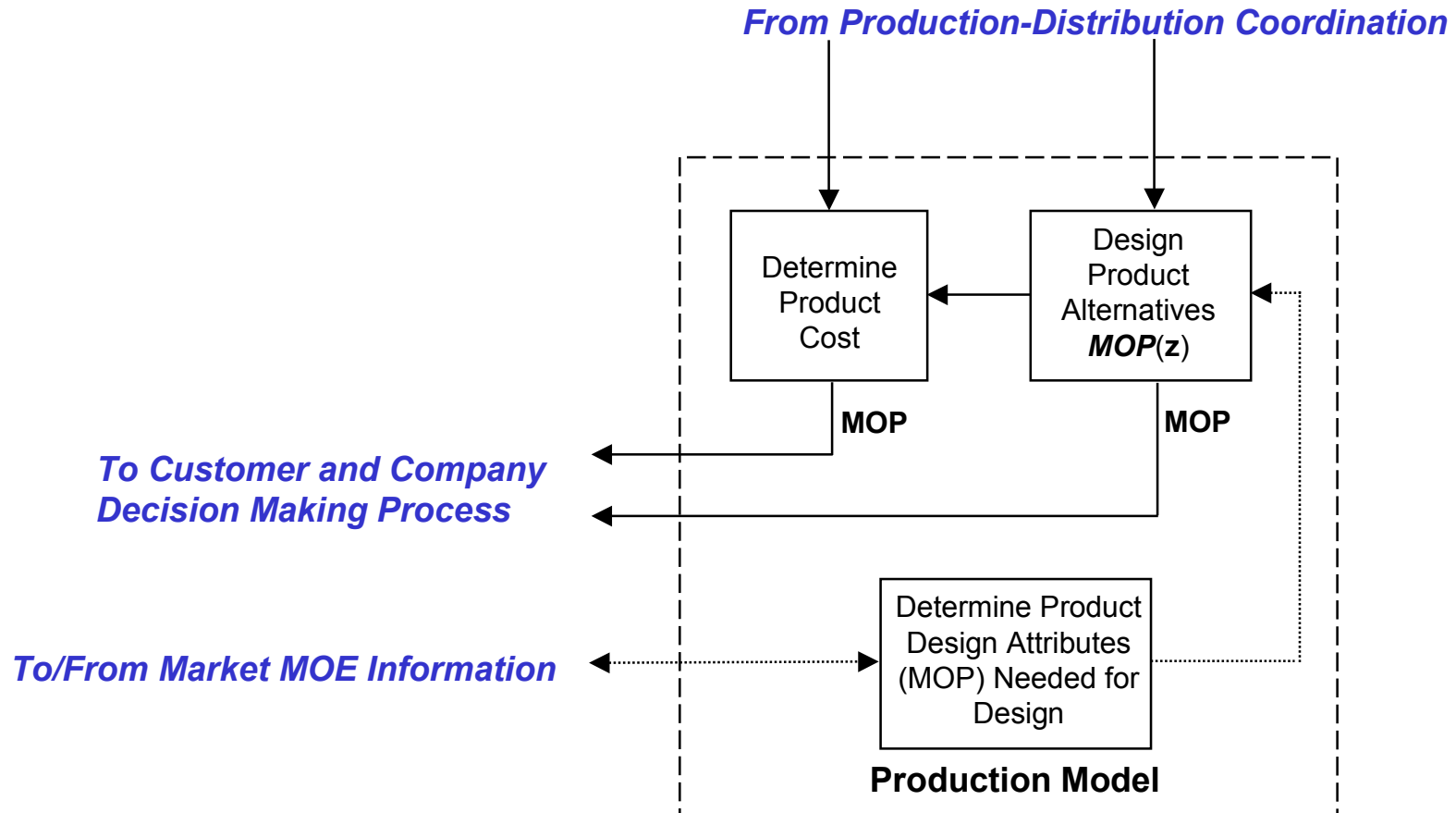
# SELECTION WITH FEW CUSTOMERS\*

- \* Whitcomb, C.A., N. Palli, and S. Azarm, "A Prescriptive Production-Distribution Approach for Decision Making in New Product Design," *IEEE Transactions on Systems, Man, and Cybernetics*, 29 (3), pp. 336-348, 1999.

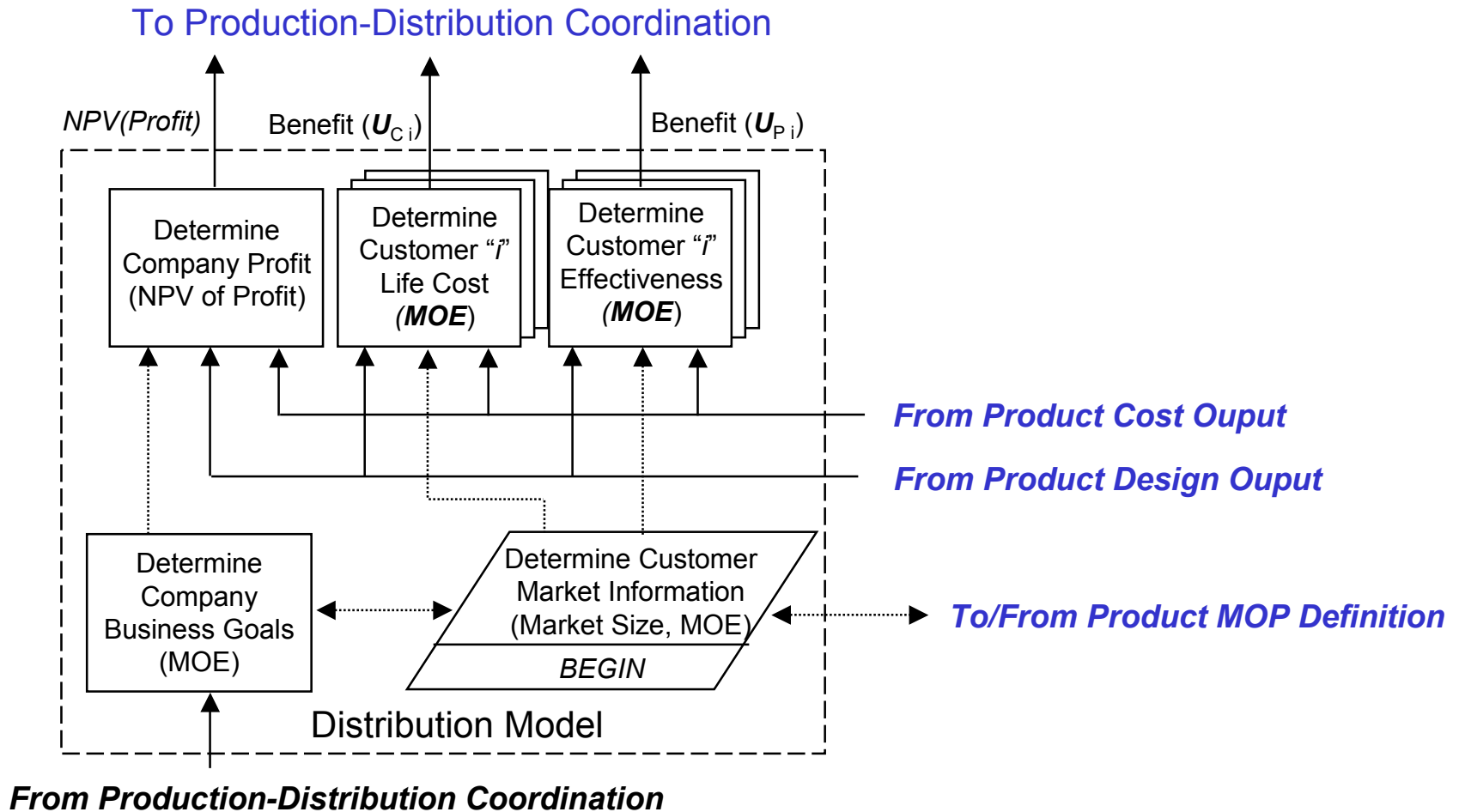
# Selection Model with Few Customers



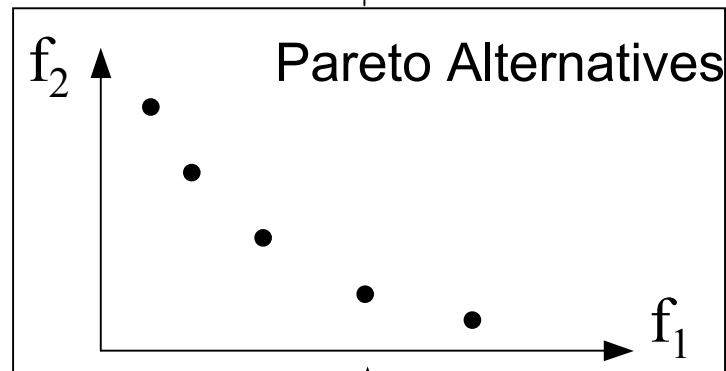
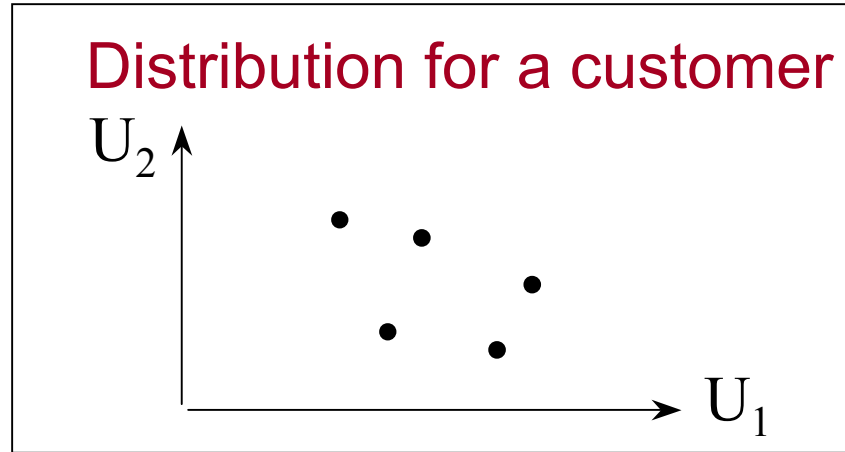
# Production Model



*Production is the optimization of the product performance.*



*Distribution is the consideration of individuals in the group decision.*



**Production:** Multi-Objective Optimization

**Step 1:** Obtain market information

**Step 2:** Define measures of performance (MOPs)

**Step 3:** Generate design alternatives, the 'best' possible

**Step 4:** Determine product cost

**Step 5:** Determine customer and *company* MOEs *and* utilities

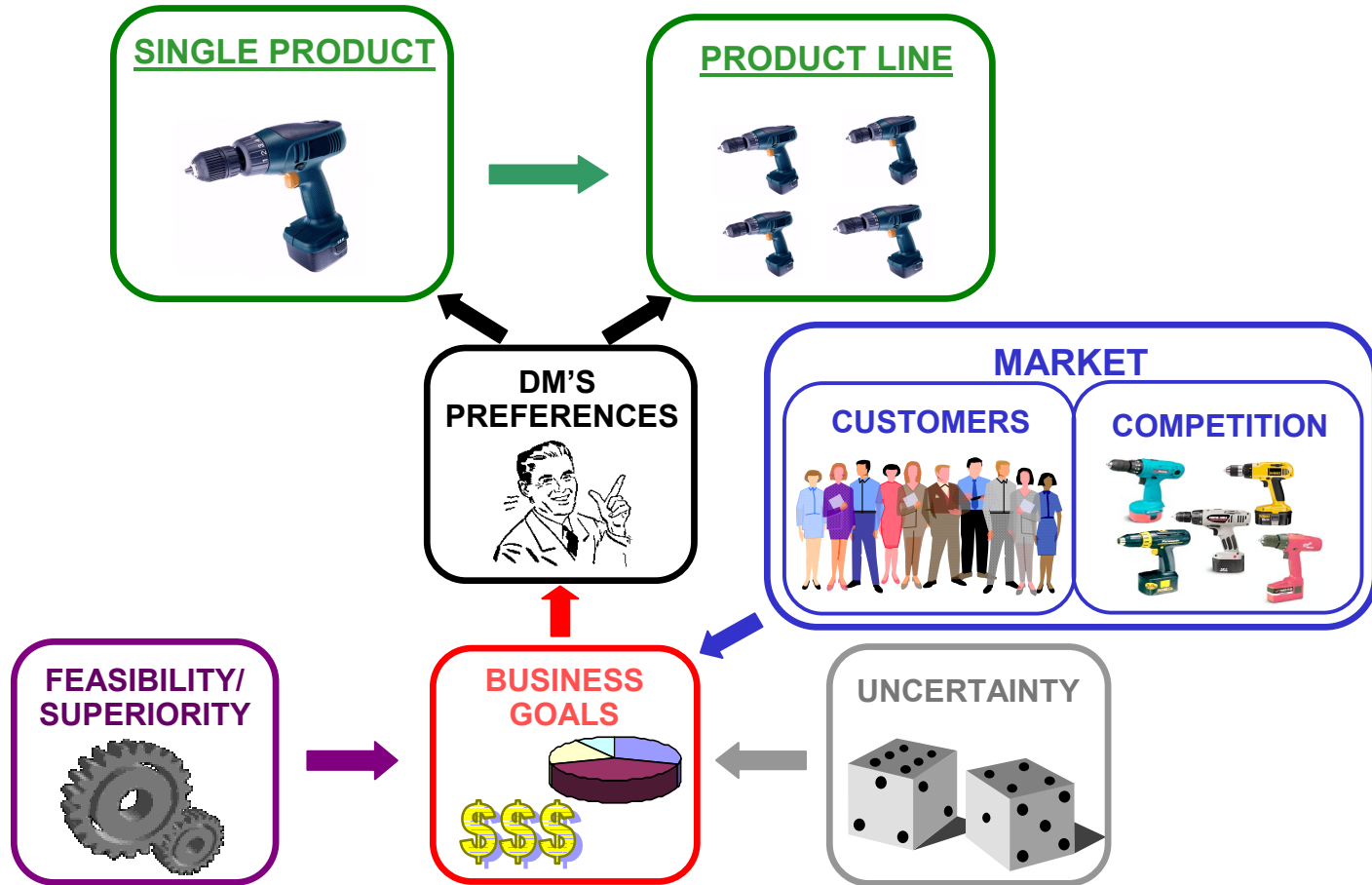
**Step 6:** Choose *m*-best ranked alternatives for customers and  
company

**Step 7:** Apply a business strategy to select the alternative

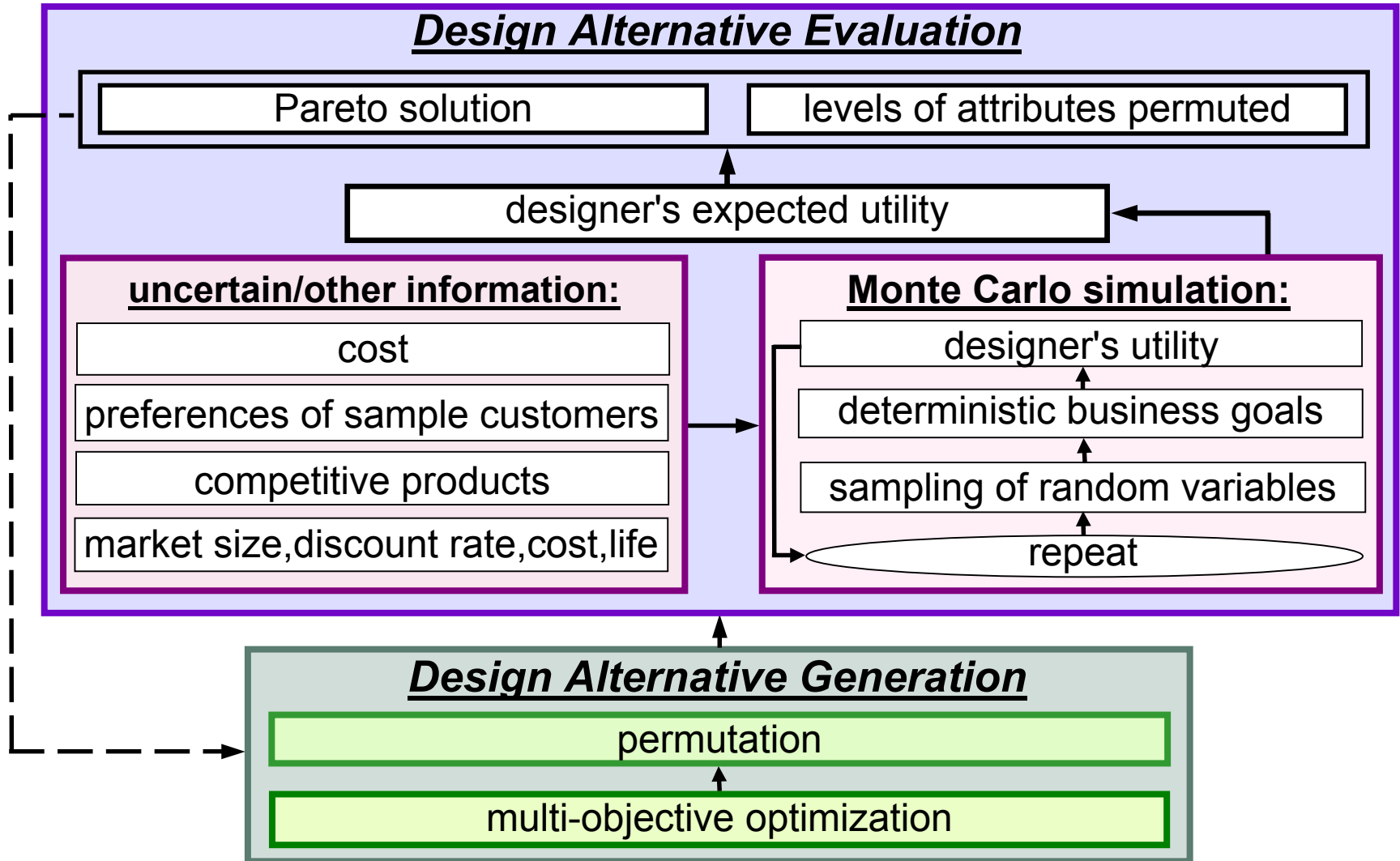
# SELECTION WITH MANY CUSTOMERS\*

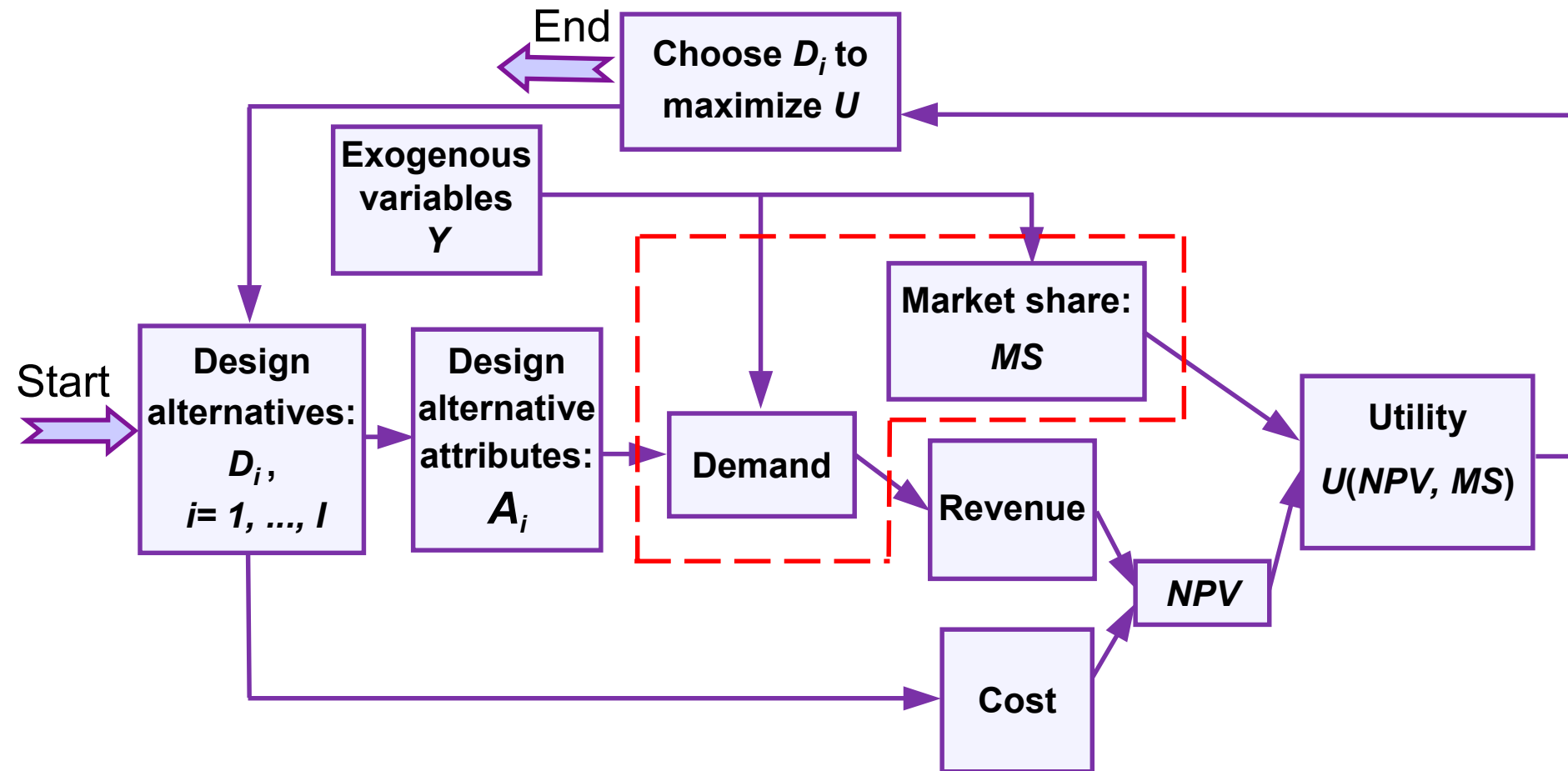
- \* Li, H., and Azarm, S. "Product Design Selection under Uncertainty and with Competitive Advantage," *Transactions of the ASME, Journal of Mechanical Design*, 122, pp. 411-418, 2000.

# Selection with Many Customers



# Overall Flowchart





- Step 1:** Define the market, attributes, assume distributions
- Step 2:** Sample customer preferences
- Step 3:** Generate design alternatives
- Step 4:** Assume a choice model, obtain demand
- Step 5:** Estimate NPV and market share of each alternative
- Step 6:** Construct designer's expected utility function
- Step 7:** Select alternative with maximum designer utility

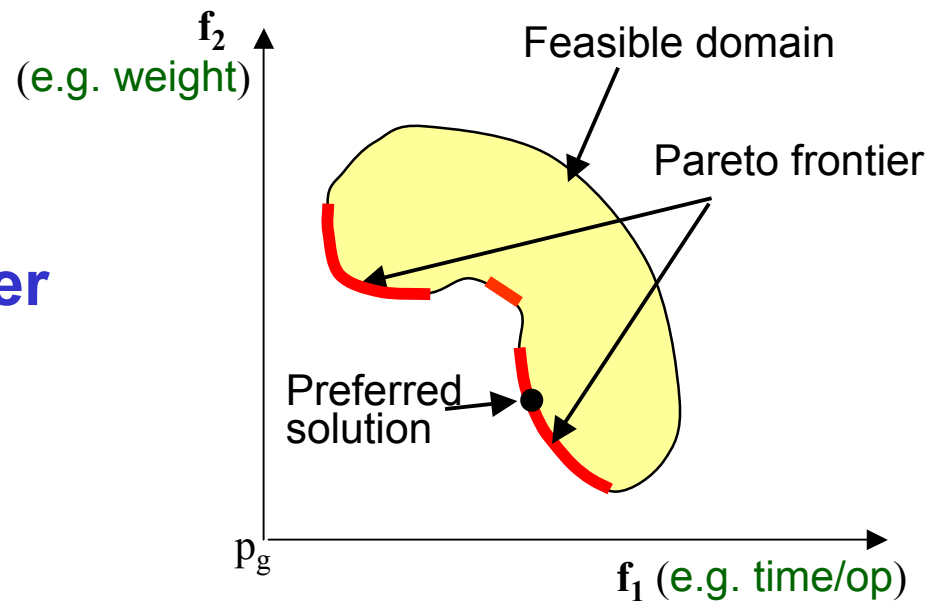
**Follow ups!**

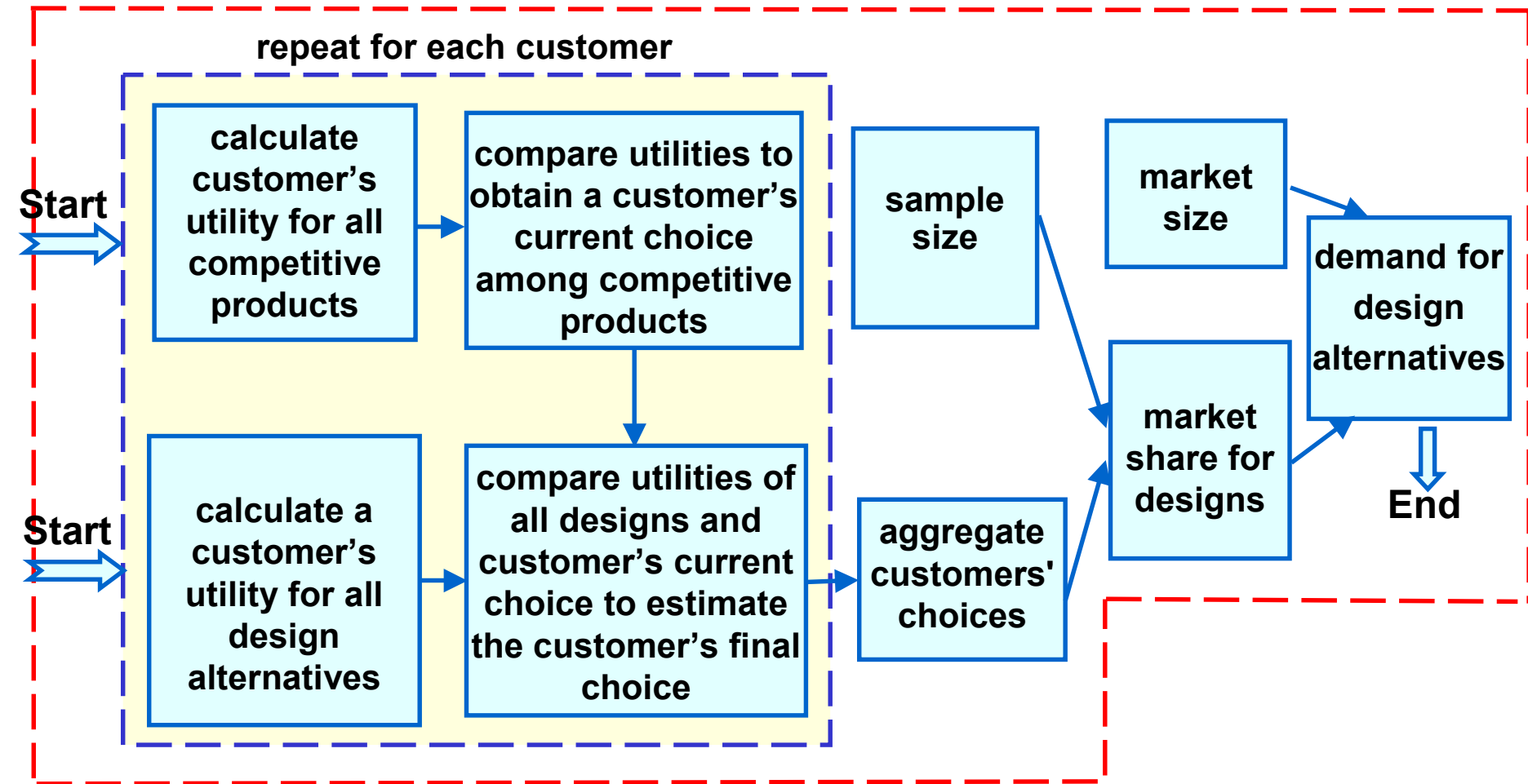
Minimize  $\mathbf{f}(\mathbf{x}) = \{f_1(\mathbf{x}), \dots, f_i(\mathbf{x}), \dots, f_m(\mathbf{x})\}$

subject to:  $\mathbf{x} \in D$

$$D = \{\mathbf{x} : g_j(\mathbf{x}) \leq 0, j = 1, \dots, J, h_k(\mathbf{x}) = 0, k = 1, \dots, K\}$$

- **Pareto/non-dominated frontier**
- **Preferred optimum solution**

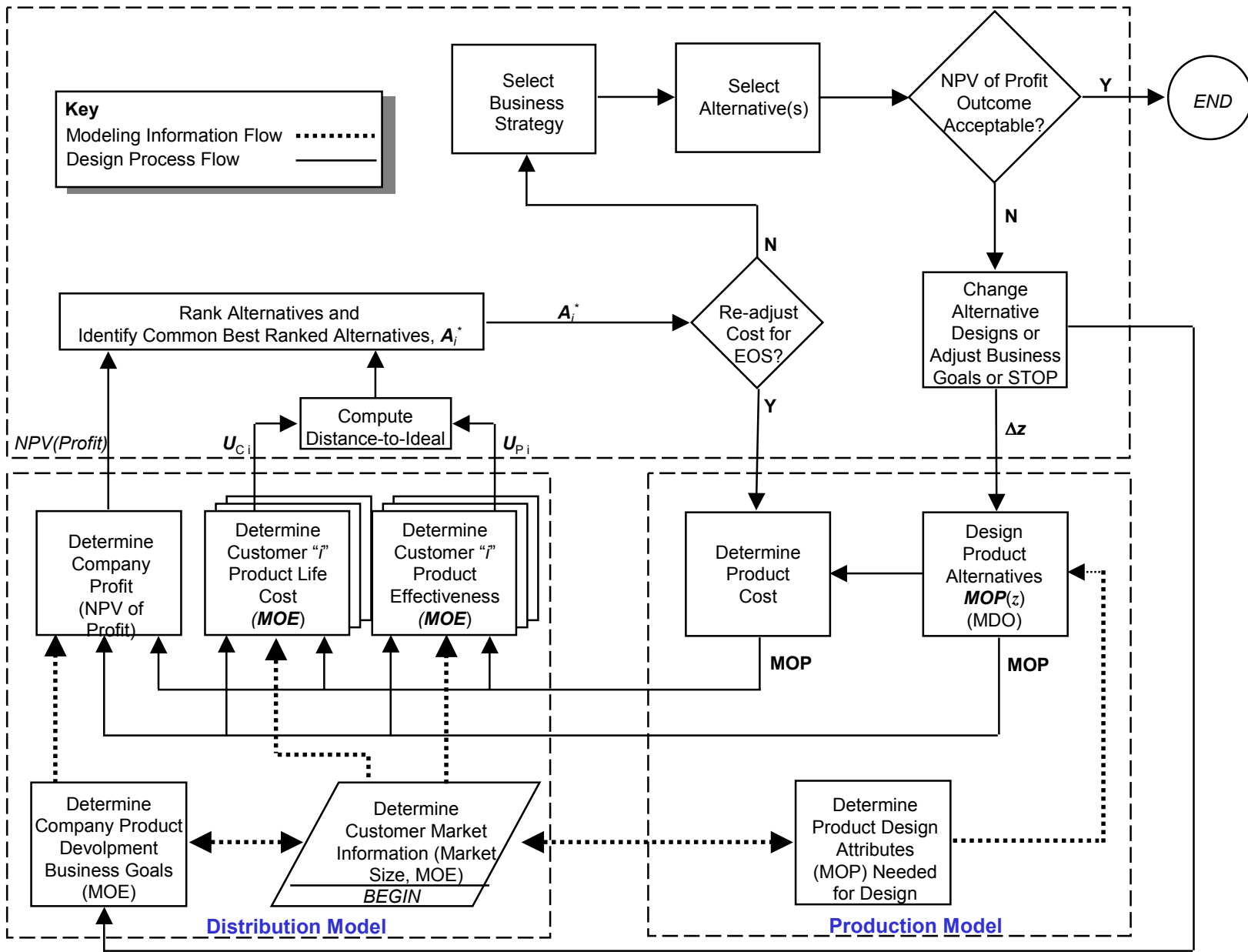




Choice model: customer will choose a design alternative with highest utility.

- 1) Compromise: Satisfy all customer markets with a single product.
- 2) Market Capture: Identify most influential customer market and select their best alternative.
- 3) Market Share: Identify common customer markets and select their best alternative.
- 4) Customize Product: Develop the best product for each customer market.
- 5) Modularize Product: Develop products by varying their characteristics, divided into baseline and optional attributes, to create a line of products that are best for each different customer market.

# Approach with Few Customers



# Concluding Remarks

- **Segmentation feasibility**
- **Generation of design (preferably ‘best’) alternatives**
- **Stable customer preferences**
- **No uncertainty**
- **Known cost, demand, price**

- **Generation of design (preferably ‘best’) alternatives**
- **Same attributes for generation and evaluation**
- **New or improved product for an existing market**
- **Same time-to-market for all alternatives**
- **First choice model**
- **Stable customer preferences**
- **Static market competition**

- **Selection methods with few/many customers:**
  - Engineering design with marketing aspects
  - Few or large variety of customer preferences
  - Competition in market
  - Implicit demand
  - Uncertainty
- **Directions for future research:**
  - Some of the assumptions need to be relaxed, e.g.,
    - Other choice models
    - Dynamic market competition