A concurrent design approach for model-based technology roadmapping
Overview

• Roadmapping in general
• Technology infusion assessment
• Concurrent Design approach
• Roadmap modeling
• Use case: Solar Electric Plane
• Outlook
Technology Roadmapping – Metaphor

where are we today?  
Technology assessment

where could we go?  
Technology roadmapping

where should we go?  
Technology planning
• **Strategy Development Process**
  1. Assessment – identifying status and opportunities
  2. Roadmapping – evaluating alternative options
  3. Planning – choosing possibilities
Technology Infusion Assessment

• Quantitative assessment → Figures of Merit

• Multiple Attributes in tension → Tradespace exploration (Ross & Hastings 2005)

• Technological evolution → shifts the Pareto front (de Weck & Chang 2003)
Concurrent Design Approach

• Used for space mission feasibility studies (Bandecchi et al., 2000; Braukhane & Romberg, 2010)
  + Encode knowledge in models where possible
  + Include multiple disciplines
  + Value human expertise and in-person discussion
  + Collaboration supported by tools and process
Concurrent Roadmapping Process

3 Steps
1) Formulation
2) Modeling,
3) Landscaping
Model-based Roadmapping

• Documenting technology assessment
• Enabling reliable and repeatable evaluation
• Providing data for technology investment
  1) Contextual data
  2) Descriptive Model (in OPM)
  3) Analytic (parametric) Model
  4) Resulting Tradespace data
As Object Process Diagram

• Visual representation for quick understanding of roadmap content

• Formalization for comparison
  • Product instances
  • System breakdown structure
  • Functions
  • Figures of Merit
Parametric System Model

• Decomposition of System into Subsystems / Disciplines

• Technology models:
  mapping design variables to figures of merit
  a) Transfer Function – Physics based first principles
  b) Response Surface – Data from prototypes / tests
  c) Expert Heuristics – Empirical relationships

• Collaborative tradespace exploration through iterative design session
Notional Roadmap Example: Solar Electric Airplane SEA

-翼面积
-太阳能电池
-电池包
-机身
-机翼面积
-机翼展
-机翼
-太阳能
-辐射
-负载（有人或无人）
-螺旋桨或鼓风风扇
-电动机
-尾部

Solar Radiation

Payload (manned or unmanned)
Integrated analytic model:
Sizing parameters map to performance characteristics
SEA - Tradespace

Payload mass vs. Endurance

Future Pareto front in red.

Current Pareto front in black
++ Model-based roadmaps provide reliable data for decision support
--- Building models for new technologies remains challenging

- Forecasting of future evolution Figures of Merit
- Taking into account market competitors
- Expert opinion elicitation with Delphi method
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