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Scale and Scope of Engineering Projects

AvaTech Snow Profiler  Virgin Galactic Spaceship
Three Perspectives in Planning Development of Complex Products

- Product/System

- Process

- Organization

Decomposition: The Key to Managing Complexity

- Decompose a complex product/system into sub-systems and components
- Decompose a complex process into sub-processes and tasks
- Decompose a large organization into teams and individuals
Decompositions Exhibit Architecture

- The pattern of interactions between the decomposed elements define the architecture
  - Product/system architecture
  - Process architecture
  - Organization architecture

“simple architecture”

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“complex architecture”
Design Structure Matrix (DSM): Product/System Architecture

Systems Engineering N² Chart

Design Structure Matrix (DSM): Process Architecture

Gantt Chart
PERT and CPM Charts

Design Structure Matrix (DSM): Organization Architecture
Organization Chart

Three Primary DSM Types

Product Architecture DSM

Process Architecture DSM

Organization Architecture DSM
PICMET’15 Keynote

Process DSM: Semiconductor Development

Cross-Functional Interactions: Real Estate Development
Organization DSM Example: Engine Development

- Site: General Motors Powertrain Division
- Product: “new-generation” engine
- Structure: 22 PDTs involved simultaneously

PDT Interactions

Frequency of Team Interactions
- Daily
- Weekly
- Monthly
PICMET '15 Keynote

Existing System Teams

Proposed System Teams
System Architecture DSM Example: Pratt & Whitney 4098 Jet Engine

- 8 Sub-Systems
- 54 Components
- 569 Interfaces

Design Interfaces:
- Spatial
- Structural
- Energy
- Materials
- Data/Controls

Comparing System Architecture to Organization Structure:
Mapping Component Interfaces to Team Interactions
Component Interfaces: P&W 4098 Jet Engine

- 8 Sub-Systems
- 54 Components
- 569 Interfaces

Design Interfaces:
- Spatial
- Structural
- Energy
- Materials
- Data/Controls

Team Interactions: P&W 4098 Jet Engine

60 design teams:
- 54 component teams (grouped into 8 module teams)
- 6 system integration teams

Low intensity interaction
High intensity interaction
**Most Team Interactions Match Component Interfaces**

<table>
<thead>
<tr>
<th>Team Interactions</th>
<th>Component Interfaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes (409)</td>
<td>341 (12%)</td>
</tr>
<tr>
<td>No (2453)</td>
<td>228 (8%)</td>
</tr>
<tr>
<td></td>
<td>225 (78%)</td>
</tr>
<tr>
<td></td>
<td>68 (2%)</td>
</tr>
</tbody>
</table>


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**Effect of Organization/System Boundaries**

**Data set:** 569 component interfaces

**First criterion:**
- Interfaces matched by team interactions: 59.9%
- Interfaces NOT matched by team interactions: 40.1%

**Second criterion:**
- Interfaces WITHIN organizational boundaries: 78.8% are matched
- Interfaces ACROSS organizational boundaries: 47.8% are matched
**Organizational/System Boundaries:**

**Modular vs. Distributed Sub-Systems**

*Data set: 569 design interfaces*

Overall:

- Interfaces WITHIN organizational boundaries: 78.8% are matched
- Interfaces ACROSS organizational boundaries: 47.8% are matched

**Design Structure Matrix**

*Methods and Applications*

- 330 pages
- 200 color illustrations
- 44 DSM examples
- 80 contributors
- 12 reviewers

*Steven D. Eppinger and Tyson R. Browning*

*Design Structure Matrix Methods and Applications*

Design Structure Matrix
Methods and Applications

1. Introduction to DSM Methods
2. Product Architecture DSM Models
3. Product Architecture DSM Examples
4. Organization Architecture DSM Models
5. Organization Architecture DSM Examples
6. Process Architecture DSM Models
7. Process Architecture DSM Examples
8. Multi-Domain Architecture MDM Models
9. Multi-Domain Architecture MDM Examples
10. The Future of DSM

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