Organizations and Projects

Lecture 15

November 13, 2012
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http://necsi.edu/affiliates/braha/dan_braha-description.htm
AMF Bowling – a leading designer and manufacturer of bowling equipment: pin spotters, ball returns, scoring equipment

Pratt & Whitney – a world leader in the design, manufacture and service of aircraft engines, industrial gas turbines and space propulsion systems.
Project organization is the scheme by which individuals designers and developers are linked together into groups.

Organizations are formed by establishing links among individuals.

- Reporting Relationships
- Supervisor/Subordinate
- Financial Arrangements
- Budget Category/Profit & Loss Statement
- Office/Floor/Building/Site
- Physical Layout
- Coordination mechanisms
- Meetings/Collaborative Tools/Liaisons/Shared Rewards/Shared Knowledge
Influence (Functional) Project Organization

Weakest form of project organization

“Functional” organization, workers are “on loan” to project

Project coordinator, but has no budget or tasking authority
Classical Project Organizations

**Dedicated Project Organization**

Team members work 100% for the project

Empowered project manager

Organizationally recognized unit for a certain time
Classical Project Organizations

Matrix Organization

- Project manager has tasking and budget authority
- Line manager has functional authority, promotions
- Team members remain in their functional organizations (have 2 bosses)
- Potential for conflicts
Concept Question 1

Which type of project organization are you most familiar with or have you spent most of your career in?

- Dedicated Project Organization
- Matrix Organization
- Influence (Functional) Organization
- None of the above
Comparison of Project Organizations

Influence (Functional) Project Organization

**Strengths:** no org change, one person participates in multiple projects, in-depth expertise, low bureaucracy, easy post-project transition

**Weaknesses:** slow response time, poor integration, lack of focus, lack of ownership

**Examples:** customization development (custom motors, bearings, packaging)

**Major issues:** how to integrate different functions
Comparison of Project Organizations

Matrix Organization

**Strengths:** efficient use of resources, resource flexibility, easier post-project transition, strong project focus

**Weaknesses:** conflicts between functional (line) managers and PM, resource contention, stressful (at least two bosses)

**Examples:** automobile, electronics, aerospace companies

**Major issues:** how to balance functions and projects; how to evaluate simultaneously project & functional performance
Comparison of Project Organizations

**Dedicated Project Organization**

**Strengths:** uniform dedication towards project goals, fast, motivation & cohesiveness, cross-functional integration

**Weaknesses:** “projectitis”, limited technological expertise, expensive, recruitment difficult, difficult post-project transition,

**Examples:** start-up companies, “tiger teams”, “skunk works”, firms working in extremely dynamic environment

**Major issues:** how to maintain functional specialization over product generation, how to share technical learning from one project to another
# Project Organization Selection

<table>
<thead>
<tr>
<th>Influence PO</th>
<th>Matrix PO</th>
<th>Dedicated PO</th>
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<tbody>
<tr>
<td><strong>Scope</strong> (# tasks)</td>
<td>small</td>
<td>medium</td>
</tr>
<tr>
<td><strong>Duration</strong> (# years)</td>
<td>short (&lt;1y)</td>
<td>medium</td>
</tr>
<tr>
<td><strong>Uniqueness</strong> (# similar proj.)</td>
<td>small</td>
<td>neutral</td>
</tr>
<tr>
<td><strong>Complexity</strong> (# dependencies)</td>
<td>low</td>
<td>medium-high</td>
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<tr>
<td><strong>Ambitiousness</strong> (prob. of success)</td>
<td>easy success</td>
<td>achievable</td>
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<tr>
<td><strong>Significance</strong> (for company)</td>
<td>low priority</td>
<td>important</td>
</tr>
<tr>
<td><strong>Risk</strong> (impact of failure)</td>
<td>small</td>
<td>depends</td>
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<tr>
<td><strong>Cost</strong> (total budget)</td>
<td>&lt;M$1</td>
<td>M$1-100</td>
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<td><strong>Simultaneity</strong> (# concurrent proj)</td>
<td>many</td>
<td>a few</td>
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</table>
The second largest producer of structural steel beams in North America (acquired by Gerdau Ameristeel in 2007).

Classifies projects into three categories: **advanced development**, **platform**, and **incremental**

Typically, Chaparral has 40-50 projects underway:

- 1 or 2 are advanced projects
- 3 to 5 are platform projects
- remainder are small, incremental projects
A leading designer and manufacturer of bowling equipment: pin spotters, ball returns, scoring equipment

AMF chose to organize its PD staff in a matrix structure

The functions involved in PD are: engineering, manufacturing, marketing, sales, purchasing, quality assurance

The AMF matrix organization is closest to the weak project organization

Project managers are not typically the most senior managers in the division; thus, do not have direct control of resources and staffing
With weak project organization the assignment of staff to **smaller projects** and the balancing of workload within a function are more easily accomplished.

AMF is a very **lean company**. The Capital Equipment Division has fewer than 100 salaried employees generating and supporting sales of over $100 million per year.

Everyone works in the same building;

Employees earn substantial financial rewards when the Division is highly profitable;

Members of project teams are motivated to look beyond their own functions, and work together to develop successful products.
The **engineering manager** works daily to ensure that the appropriate coordination occurs, for example, between marketing and engineering.

The **senior management** places emphasis on PD and **encourages effective teamwork**;

The **general manager** devotes several days each month to **monitoring the progress of projects**.
22 PDTs

- Engine Block
- Cylinder Heads
- Camshaft/Valve Train
- Pistons
- Connecting Rods
- Crankshaft
- Flywheel
- Accessory Drive
- Lubrication
- Water Pump/Cooling
- Intake Manifold
- Exhaust
- E.G.R.
- Air Cleaner
- A.I.R.
- Fuel System
- Throttle Body
- EVAP
- Ignition System
- Electronic Control Module
- Electrical System
- Engine Assembly

PDT composition

- 1 product release engineer
- 1 CAD designer
- 3 manufacturing engineers
- 2 purchasing representatives
- 2 casting engineers
- machine tool supplier
- 1 production control analyst
- 1 financial planner
- production personnel

Design small-block V8 engine

General Motors Powertrain Division

Data Collection

How often do you need to share technical information with the other PDTs in order to complete the technical tasks of your PDT?

<table>
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<tr>
<th>PDT</th>
<th>Daily</th>
<th>Weekly</th>
<th>Monthly</th>
<th>Never</th>
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<tr>
<td>Engine Block</td>
<td>✓</td>
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<tr>
<td>Cylinder Heads</td>
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<tr>
<td>Camshaft/Valve Train</td>
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<tr>
<td>Connecting Rods</td>
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PDT Interactions

Team-based DSM

Engine Block A
Cylinder Heads B
Camshaft/Valve Train C
Pistons D
Connecting Rods E
Crankshaft F
Flywheel G
Accessory Drive H
Lubrication I
Water Pump/Cooling J
Intake Manifold K
Exhaust L
E.G.R. M
Air Cleaner N
A.I.R. O
Fuel System P
Throttle Body Q
EVAP R
Ignition S
E.C.M. T
Electrical System U
Engine Assembly V

Frequency of PDT Interactions
- Daily
- Weekly
- Monthly

## Existing System Teams

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<thead>
<tr>
<th>Engine Block</th>
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<th>E.C.M.</th>
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<tr>
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<td>R</td>
<td>S</td>
<td>T</td>
<td>U</td>
<td>V</td>
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### Frequency of PDT Interactions
- **Daily**
- **Weekly**
- **Monthly**

Proposed System Teams

60 design teams clustered into 10 groups.

Reported interactions took place during the detailed design period of the product development process.

Design executed concurrently.

**Six system integration teams**

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<th><strong>Product Development Principles</strong></th>
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<tr>
<td><strong>‘Iteration’</strong></td>
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<tr>
<td>Changes and rework propagate</td>
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<tr>
<td>through the design network.</td>
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<tr>
<td><strong>‘Parallelism’</strong></td>
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<tr>
<td>Large development efforts require</td>
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<tr>
<td>multiple activities to be performed</td>
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<tr>
<td>in parallel.</td>
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<tr>
<td><strong>‘Decomposition &amp; Integration’</strong></td>
</tr>
<tr>
<td>Splitting a complex system into</td>
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<tr>
<td>sub-systems and combining them</td>
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<tr>
<td><strong>‘Stability’</strong></td>
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<tr>
<td>The total number of design problems</td>
</tr>
<tr>
<td>eventually falls below an acceptable</td>
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<tr>
<td>threshold within a specified time frame</td>
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</table>
The oscillatory nature of PD: development tasks (thought to be finished) reappear or repeat

**Design Churn:**

“a scenario where the total number of problems being solved does not reduce monotonically as the project evolves over time”
Examples of Churn

Bug Data and Daily Builds from Excel 5.0. Milestone 2


Engineering Changes in a Stereo Integrated Amplifier Project


Appearance Vehicle Design

Potential Sources of Churn

**Exogenous**

Changes in design objectives (management directives, requirement changes)

Performance variability/uncertainty

Oscillatory resource allocation (firefighting)

**Endogenous**

Product architecture – interdependencies

System/local decomposition

Feedback delays – information hiding
Why is Churn Bad?

Myopic resource allocation decisions

Elongated PD time

Organizational memory lapses

Frustration and deteriorated morale
Decomposition of development into local and system tasks leads to information hiding which results in churn.
Numerical DSMs

Numbers along the diagonal are the rate of problem solving per unit time: 0 → 100%

Off-diagonal numbers are dependency strengths between tasks: 0 → 100%
System/Local DSMs

Several DSMs (Local & System) with at least one unit of time of delay for information exchange
m local DSMs & a single System DSM

L₁: DSM₁

L₂: DSM₂

Lₘ: DSMₘ

S: DSMₚₛₛ

T₁

T₂

Tₘ

t₁,m

t₂,m

t₁,₁

t₂,₁

tₘ,₁

tₘ,m

t₁,S

t₂,S

tₘ,S
How Does Decomposition/Integration Affect Performance Dynamics?

Given a local DSM, system DSM, and a choice of information update frequency, what are the conditions under which:

Design churn occurs?

Convergence of development is guaranteed?
The process of designing all interior and exterior automobile surfaces for which appearance, surface quality and operational interface is important to the customer.

**Examples**

Exterior sheet metal design

Visible interior panels
Case Study: Automotive Appearance Design Process

Case Study Scope: Appearance Design

- Market Study
- 52 weeks
- Industrial Design
- Engineering Design
- Tooling Development
- Prototyping
- Production

Weekly feasibility meetings

Internal information exchanges

Periodic (6 weeks) scan transmittals
Case Study: Automotive Appearance Design
Process Input DSMs

### Local DSM

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### System DSM

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### Local to system transformation matrix

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### System to local transformation matrix

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Local to system transformation matrix

- Low = 0.1
- Med = 0.2
- Hi = 0.3
Base Case Analysis

System is stable, but converges very slowly

‘Instrument Panel’ has the most destabilizing effect on total system performance
Effect of Mitigation Strategies

Base Scenario

Scenario 1: Adding Resources

Scenario 2: Reduced Coupling

Total Open Issues: Scenarios 1 & 2 Combined
Effect of Delay on Churning Behavior

T=1

T=2

T=3

T=4

T=5

T=6
Effect of Differential Delay Policy

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<th>Differential Policy</th>
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**Slow convergence**

**Fast convergence**

Uniform Policy

Differential Policy
Identifying “Bottleneck” Tasks

An image of automobile center console has been removed due to copyright restrictions.

An image of automobile overhead system has been removed due to copyright restrictions.
Summary

Decomposition/Integration

Large development efforts require multiple activities to be performed in parallel
The many subsystems must be integrated to achieve an overall system solution
Organizations can be “designed” based upon this structure

Decomposition/Integration and Dynamics

Design Churn is a fundamental property of a decomposed development process
Summary

Intrinsic Sources of Churn

Interdependency
Concurrency
Feedback delays and information hiding

Strategies to mitigate churn

Resource-based strategies
Rework-based strategies
Time-based strategies
Further Reading

Complex concurrent engineering

The design churn effect
ESD.36 System Project Management
Fall 2012

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