Organizations and Projects

Lecture 15

November 13, 2012

Prof. Dan Braha

http://necsi.edu/affiliates/braha/dan_braha-description.htm

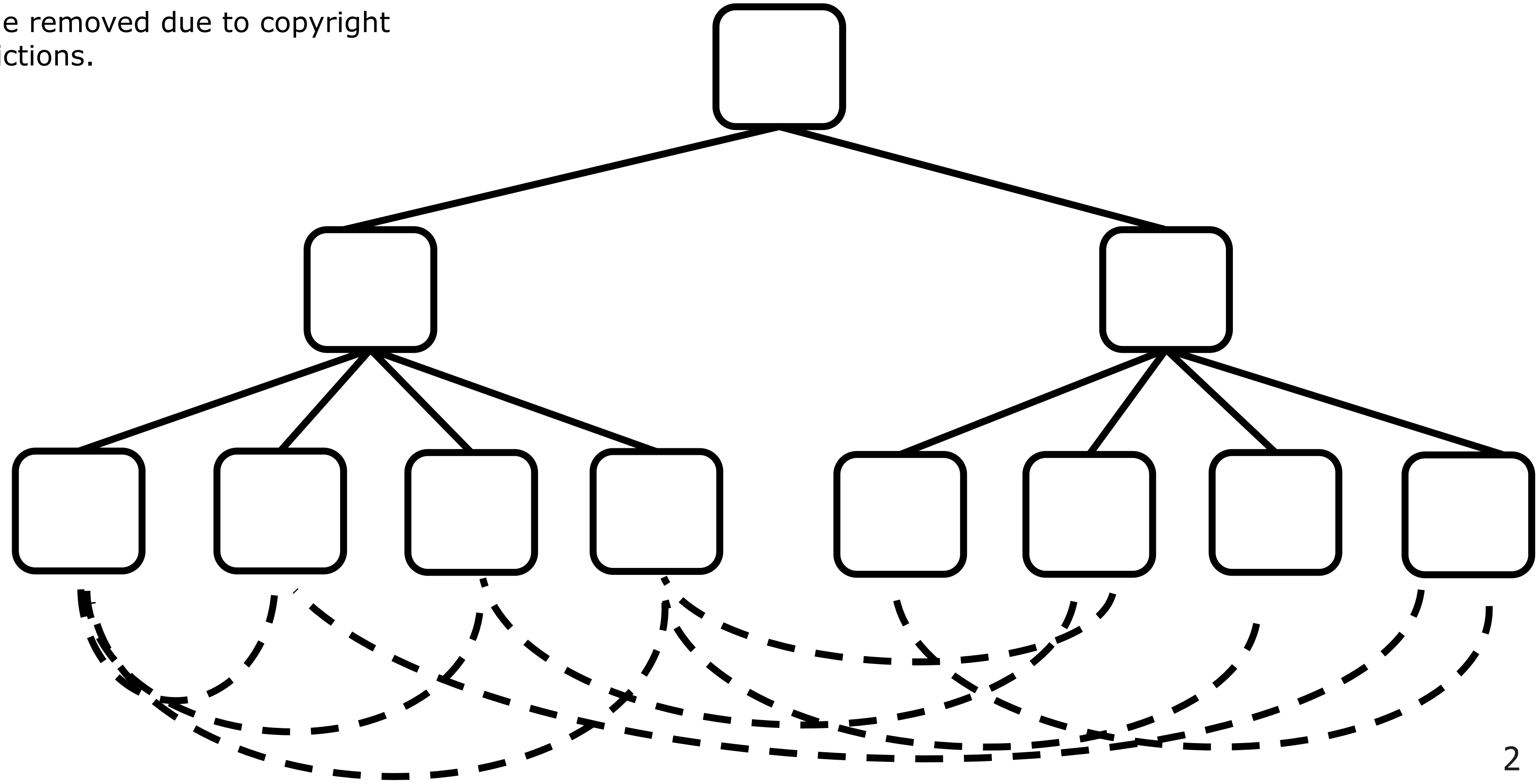
Organization Architecture

People

Relationships

Guiding principles of design and evolution

Image removed due to copyright restrictions.

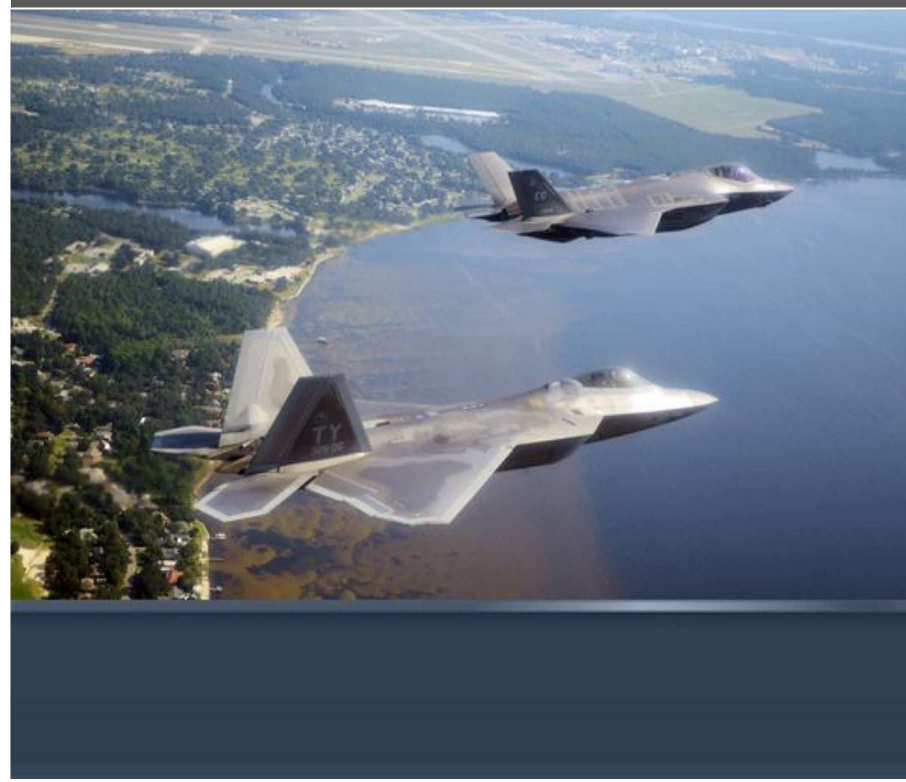


Organization Architecture

AMF Bowling – a leading designer and manufacturer of bowling equipment: pin spotters, ball returns, scoring equipment

Image by Biso.

Pratt & Whitney – a world leader in the design, manufacture and service of aircraft engines, industrial gas turbines and space propulsion systems.

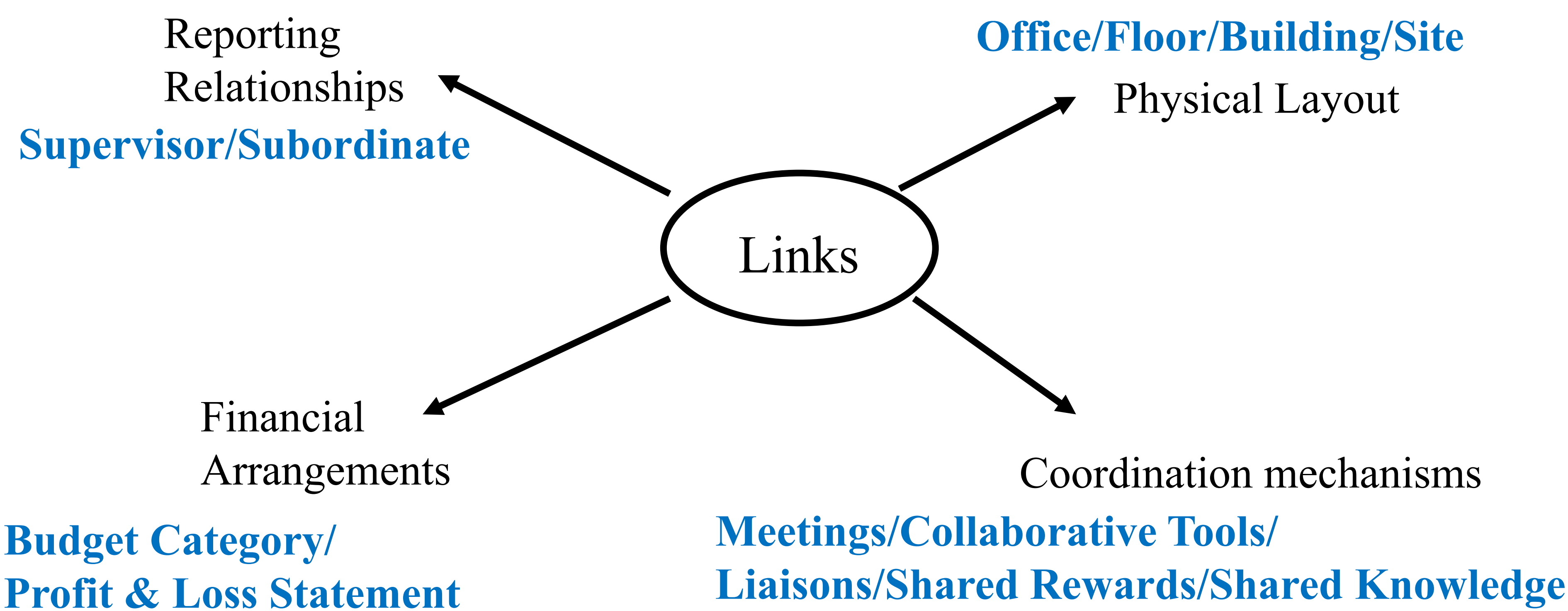


Source: Public domain.

Project Organizations

Project organization is the **scheme** by which individuals designers and developers are **linked** together into **groups**

Organizations are formed by establishing **links** among individuals



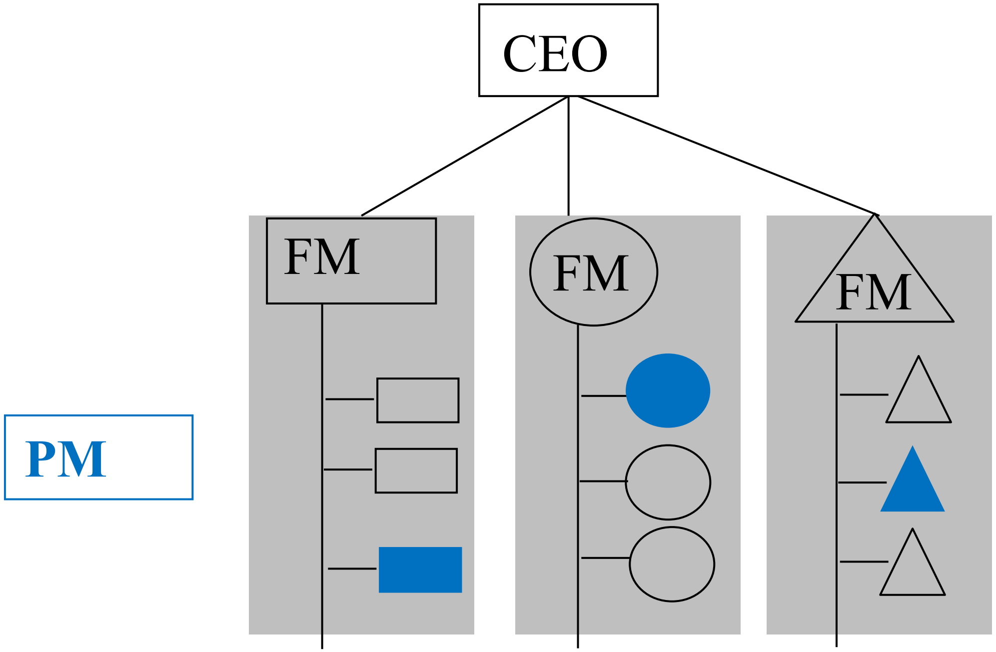
Classical Project Organizations

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



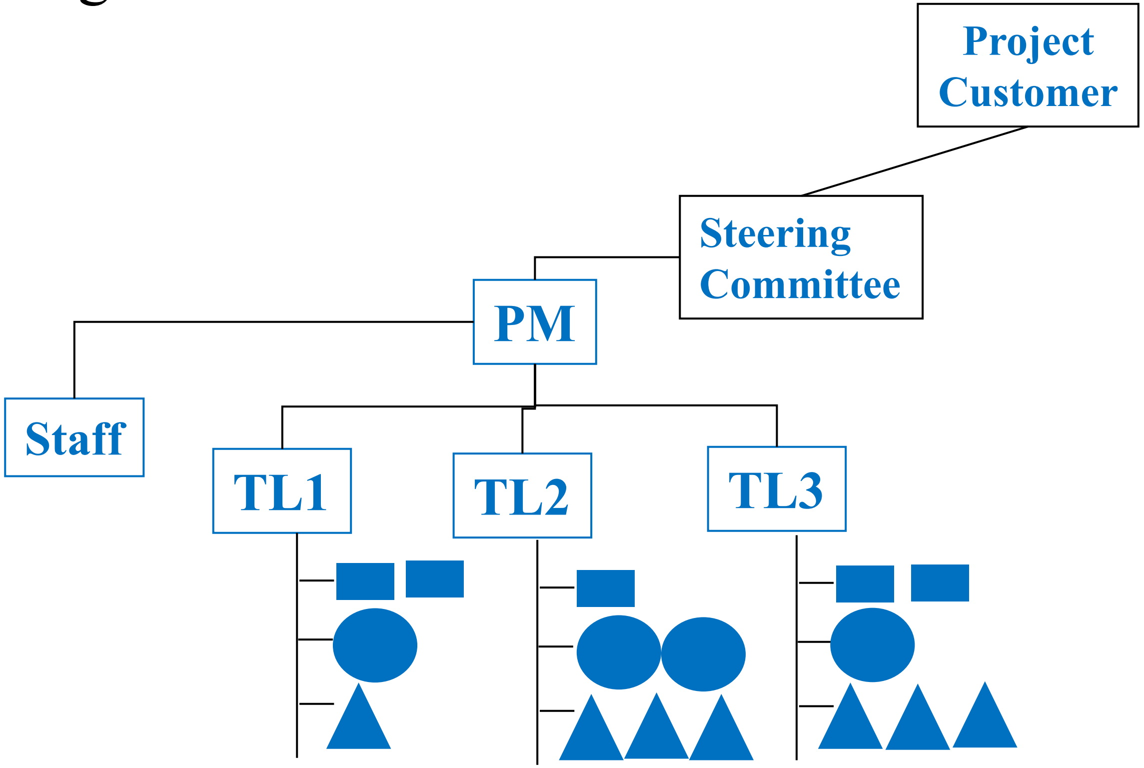
Classical Project Organizations

Dedicated Project Organization

Team members work 100% for the project

Empowered project manager

Organizationally recognized unit for a certain time



Classical Project Organizations

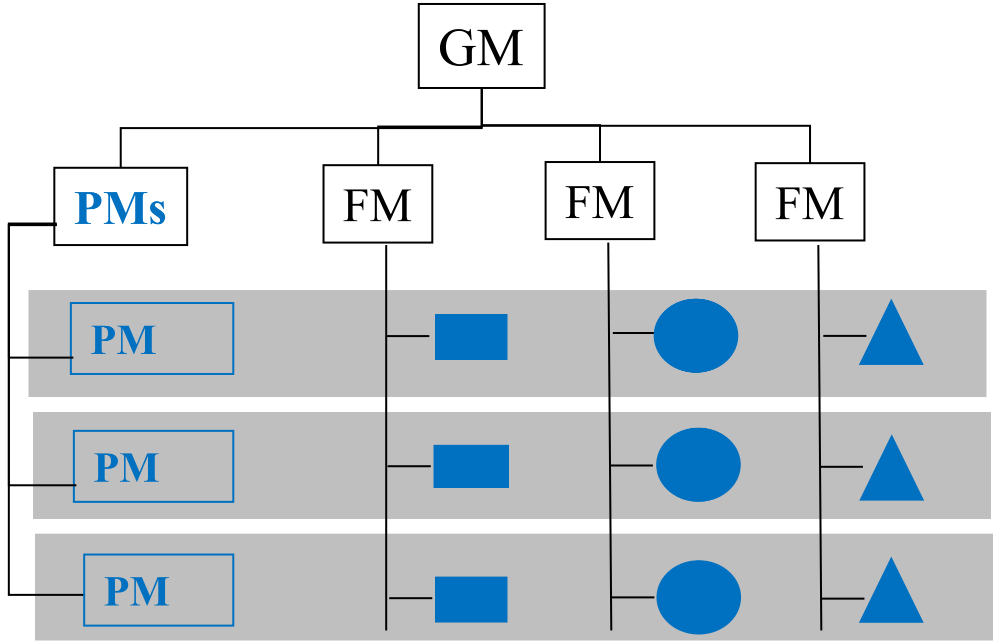
Matrix Organization

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

	Influence PO	Matrix PO	Dedicated PO
Scope *(# tasks)*	small	medium	large
Duration *(# years)*	short (<<1y)	medium	large (>2y)
Uniqueness *(# similar proj.)*	small	neutral	one-of-a-kind
Complexity *(#dependencies)*	low	medium-high	very complex
Ambitiousness *(prob. of success)*	easy success	achievable	challenging
Significance *(for company)*	low priority	important	live-or-die
Risk *(impact of failure)*	small	depends	large
Cost *(total budget)*	<M$1	M$1-100	>>M$100
Simultaneity *(# concurrent proj)*	many	a few	very few

Project Organization Selection

An image of CHAPARRAL STEEL CO. Logo has been removed due to copyright restrictions.

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

Project Organization Selection

An image of AMF Logo has been removed
due to copyright restrictions.

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

Project Organization Selection

An image of AMF Logo has been removed
due to copyright restrictions.

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

Project Organization Selection

An image of AMF Logo has been removed due to copyright restrictions.

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**

Project Organization Selection

General Motors Powertrain Division

Design small-block V8 engine

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

Image of V8 engine animation removed due to copyright restrictions.

Image of Corvette engine removed due to copyright restrictions.

Source: McCord, KR. MIT Sloan School of Management. WP 3594. 1993.

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?

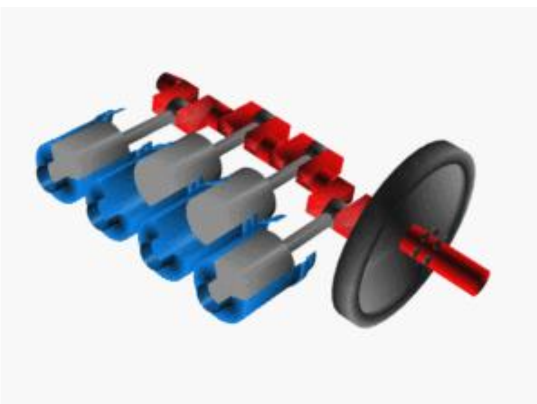
PDT	Daily	Weekly	Monthly	Never
Engine Block	√	___	___	___
Cylinder Heads	___	√	___	___
Camshaft/Valve Train	___	___	√	___
Connecting Rods	___	√	___	___

-
-
-

Source: McCord, KR. MIT Sloan School of Management. WP 3594. 1993.

PDT Interactions

Team-based DSM



Source: Public domain <http://en.wikipedia.org/wiki/File:Cshaft.gif>.

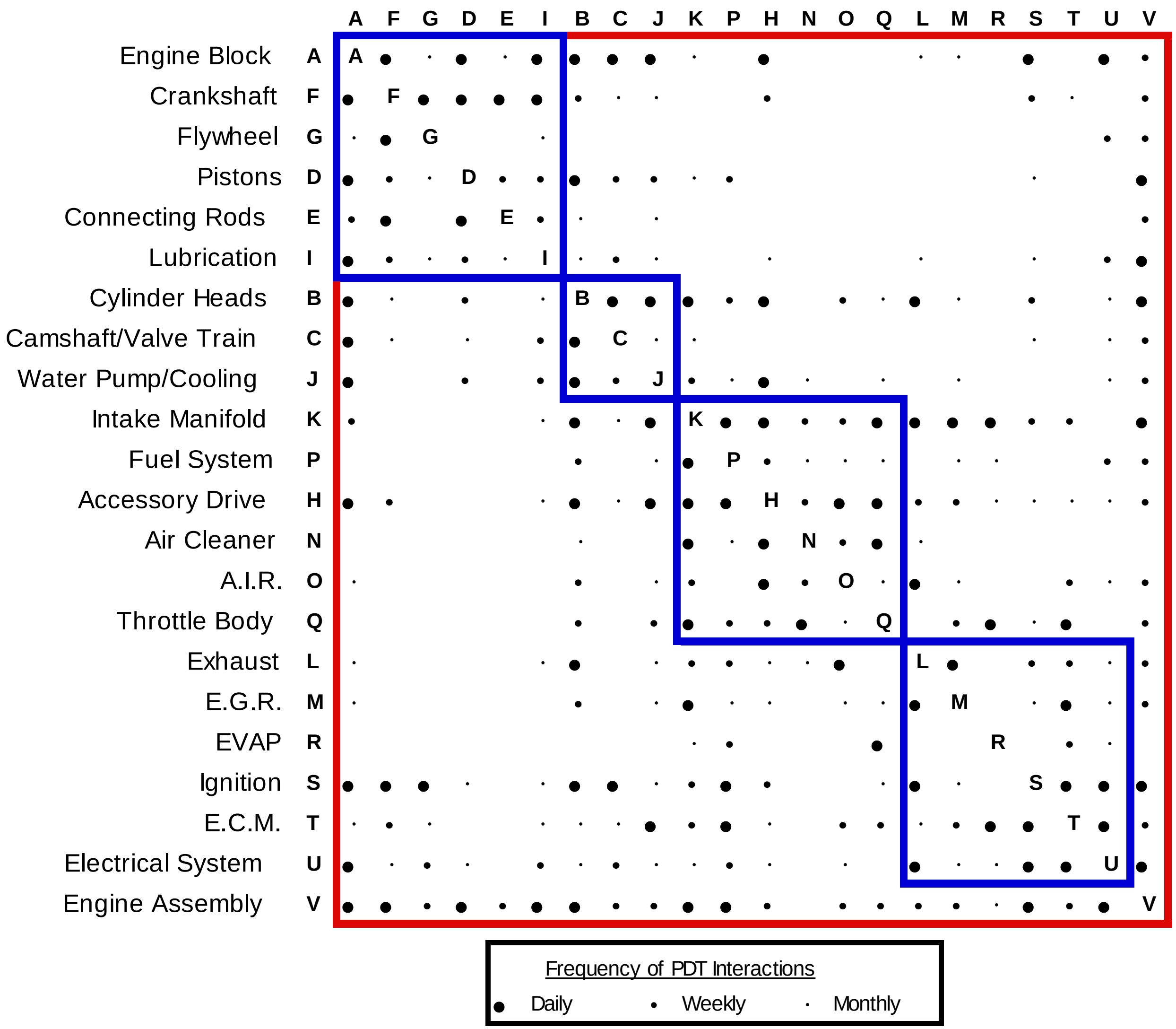
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Engine Block	A	A	●	●	●	·	●	·	●	●	●	·	·	·						●		●	•
Cylinder Heads	B	●	B	●	•		·		●	·	●	●	●	·		•	•	·		•		·	●
Camshaft/Valve Train	C	●	●	C	·		·			•	·	·								·		·	•
Pistons	D	●	●	•	D	•	•	·		•	•	·					•			·			●
Connecting Rods	E	•	·		●	E	●			•	·												•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

Frequency of PDT Interactions

● Daily • Weekly · Monthly

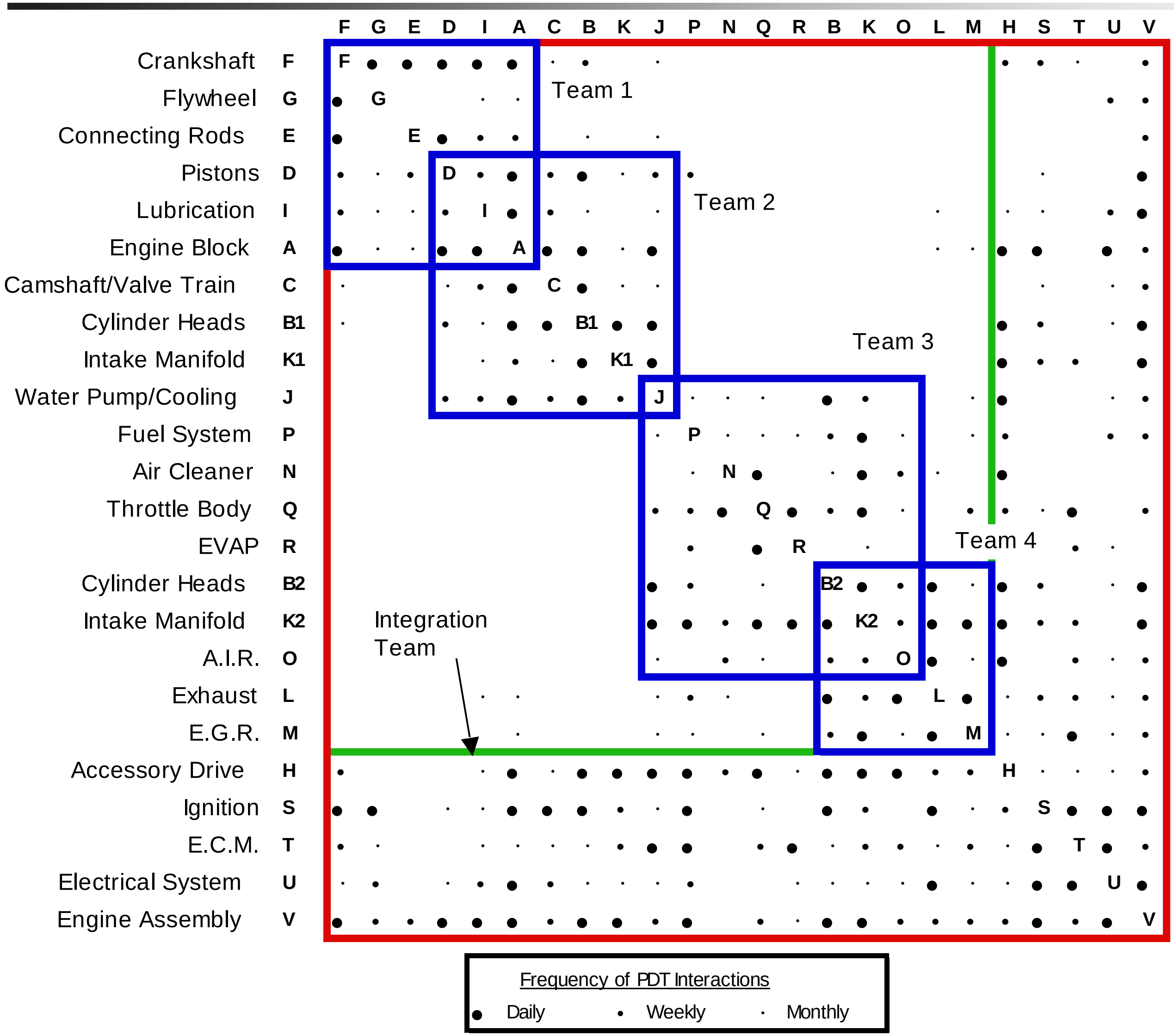
Source: McCord, KR. MIT Sloan School of Management. WP 3594. 1993.

Existing System Teams

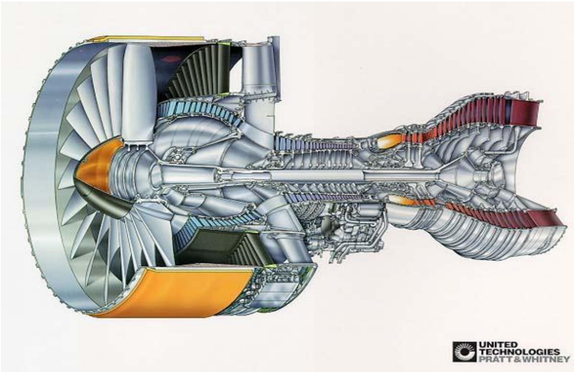


Source: McCord, KR. MIT Sloan School of Management. WP 3594. 1993.

Proposed System Teams



Source: McCord, KR. MIT Sloan School of Management. WP 3594. 1993.



Courtesy of United Technologies.
Used with permission.

Development Organization: P&W 4098 Jet Engine

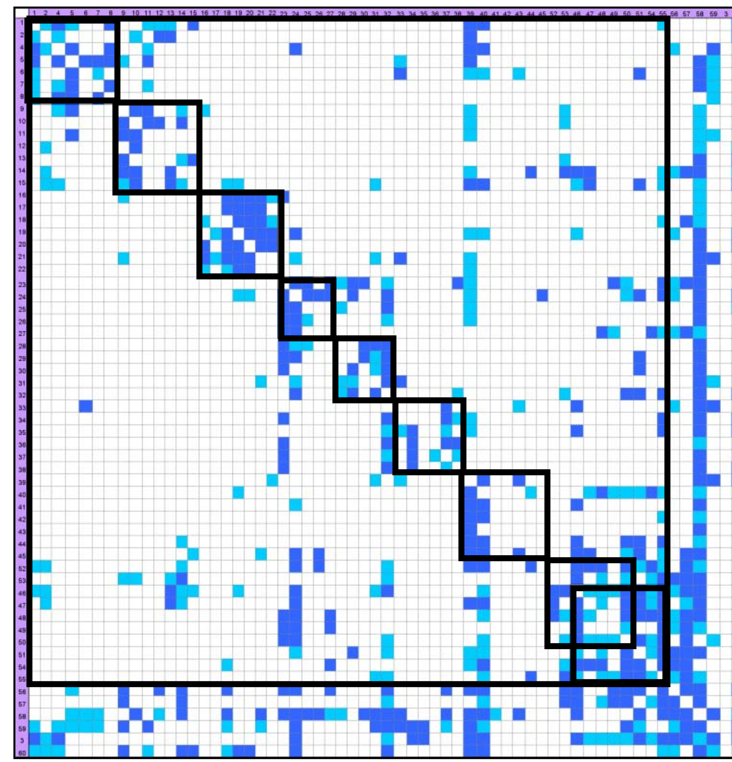
60 design teams clustered into 10 groups.

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

Design executed concurrently.

Low intensity interaction (0 to 5 scale)

High intensity interaction (0 to 5 scale)



Six system integration teams {

Team Interactions

Source: Sosa ME, Eppinger SD, Rowles CM, Management Science. Vol. 50. 2004. pp.1674-1689.

Product Development Principles

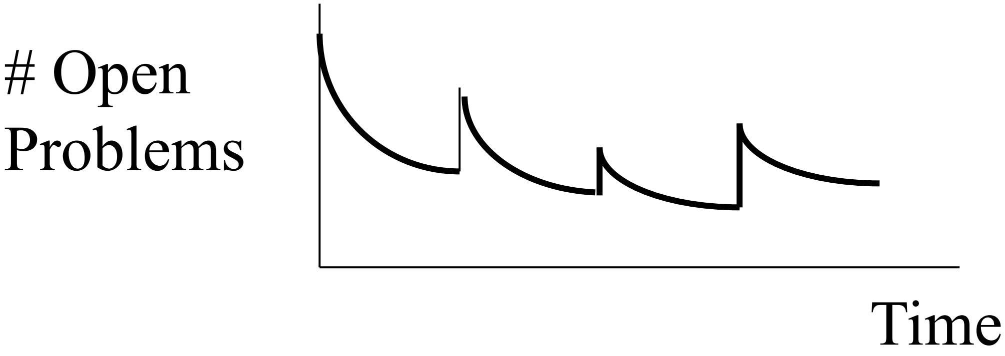
‘Iteration’	Changes and rework propagate through the design network.
‘Parallelism’	Large development efforts require multiple activities to be performed in parallel.
‘Decomposition & Integration’	Splitting a complex system into sub-systems and combining them
‘Stability’	The total number of design problems eventually falls below an acceptable threshold within a specified time frame

The Design Churn Phenomenon

The oscillatory nature of PD: development tasks (thought to be finished) reappear or repeat

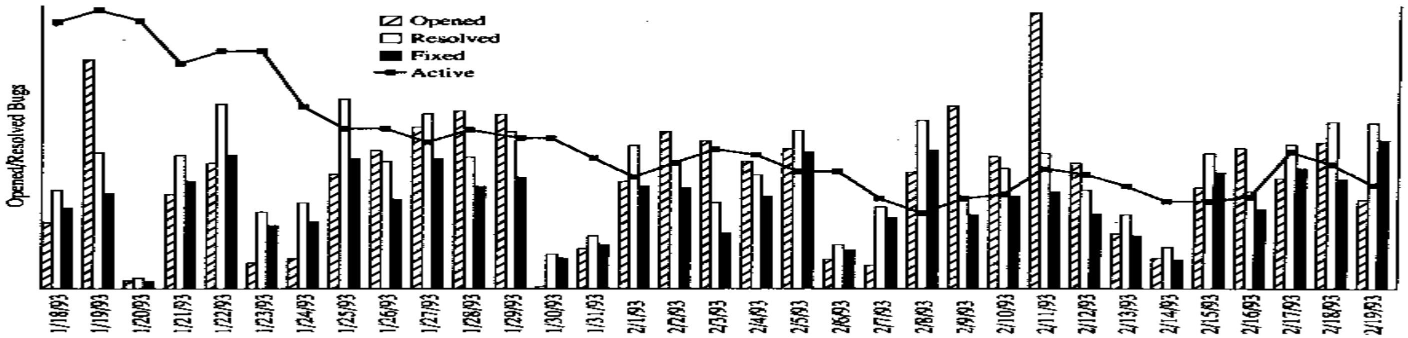
Design Churn:

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



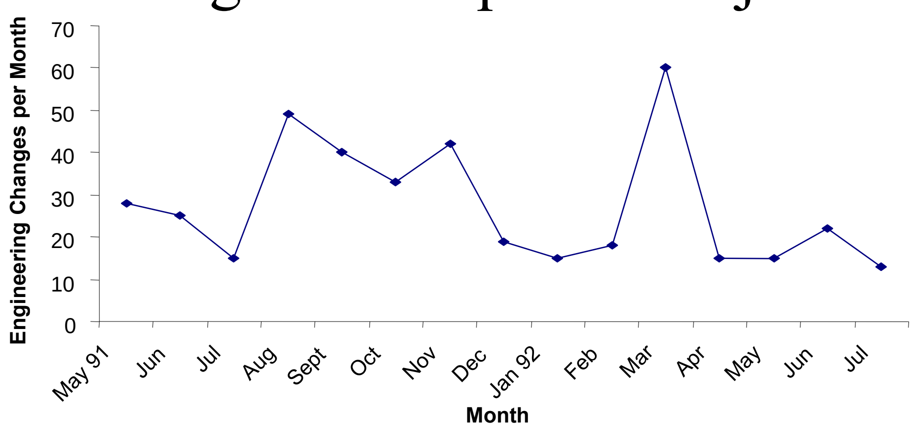
Examples of Churn

Bug Data and Daily Builds from Excel 5.0. Milestone 2



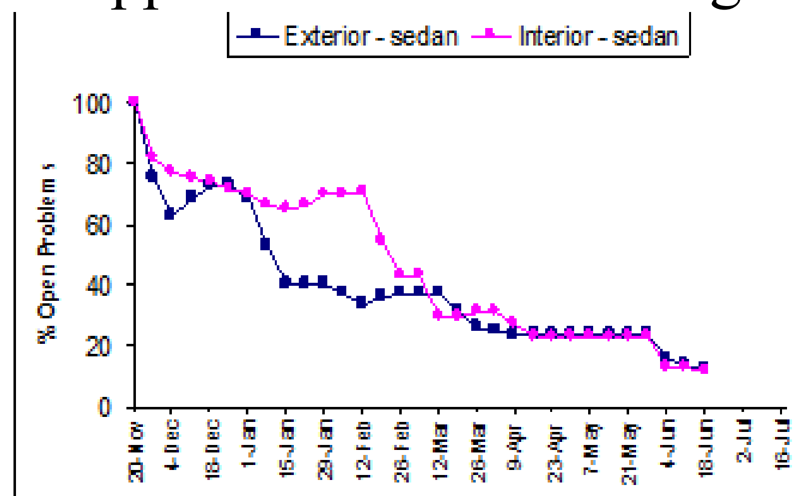
Source: Cusumano & Selby. Microsoft Secrets. Free Press, 1995

Engineering Changes in a Stereo Integrated Amplifier Project



Source: Weelwright & Clark. Revolutionizing Product Development. Free Press, 1992.

Appearance Vehicle Design



Source: Yassine, Joglekar, Braha, Eppinger & Whitney. Research in Engineering Design. Vol. 14. 2003. pp. 145-161.

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

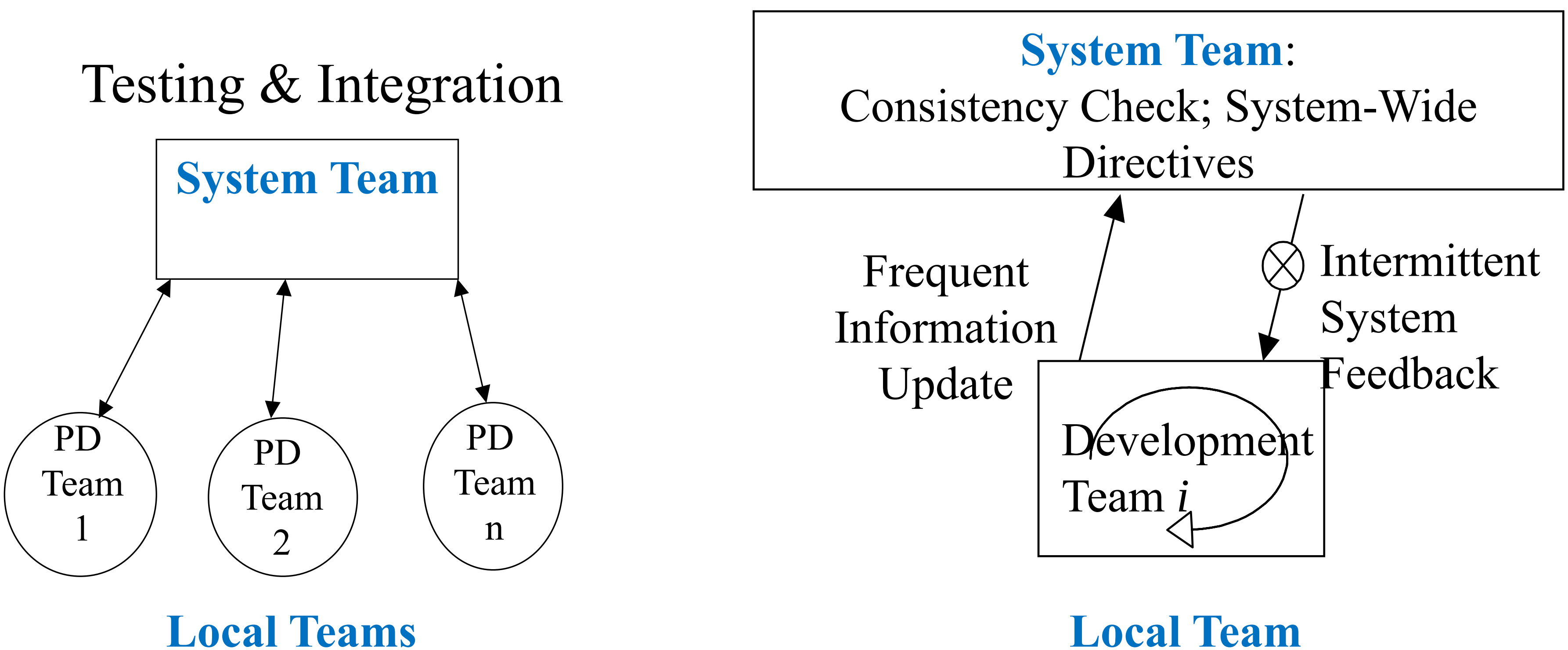
Elongated PD time

Organizational memory lapses

Frustration and deteriorated morale

System/Local Decomposition & Information Hiding

Decomposition of development into local and system tasks leads to information hiding which results in churn



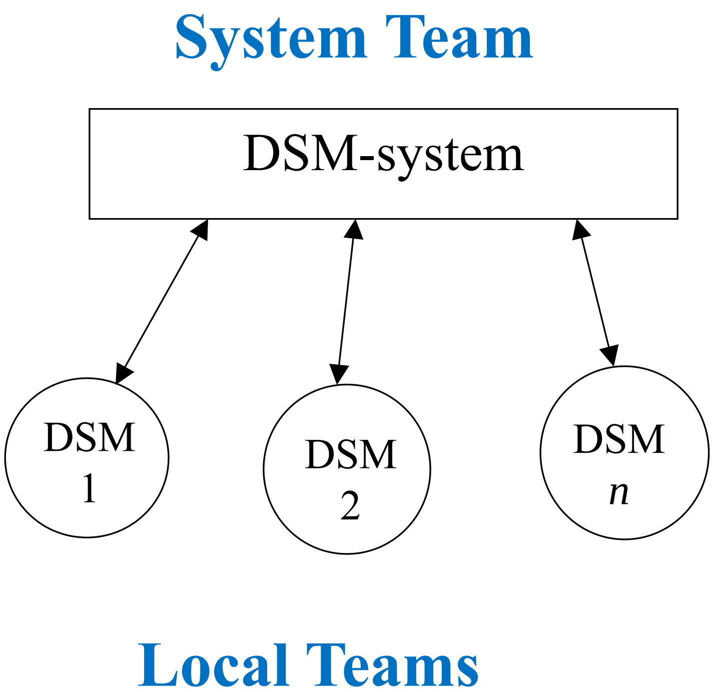
Numerical DSMs

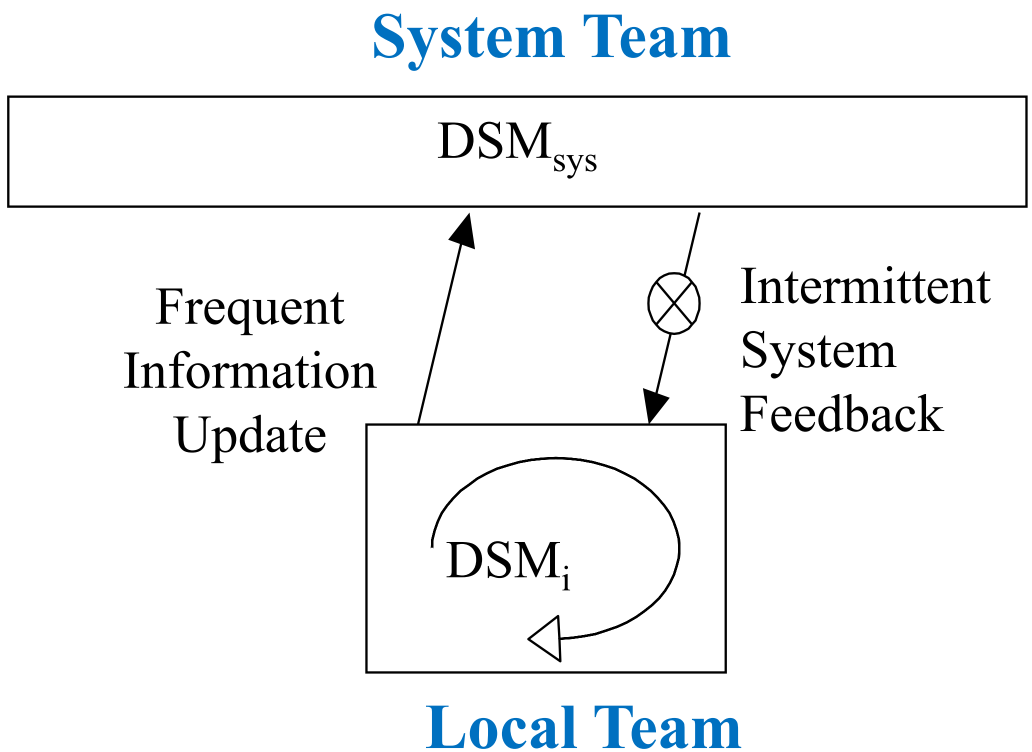
	Task A	Task B	Task C
Task A	0.6		0.4
Task B	0.2	0.7	
Task C		0.7	0.2

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

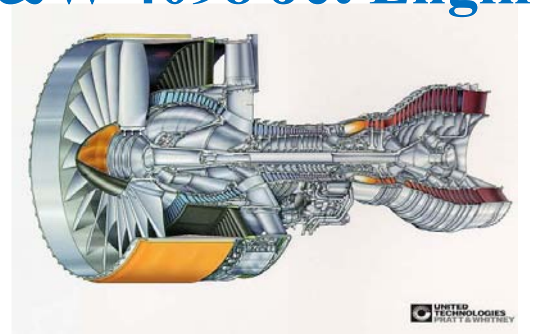




Several DSMs (Local & System) with at least one unit of time of delay for information exchange

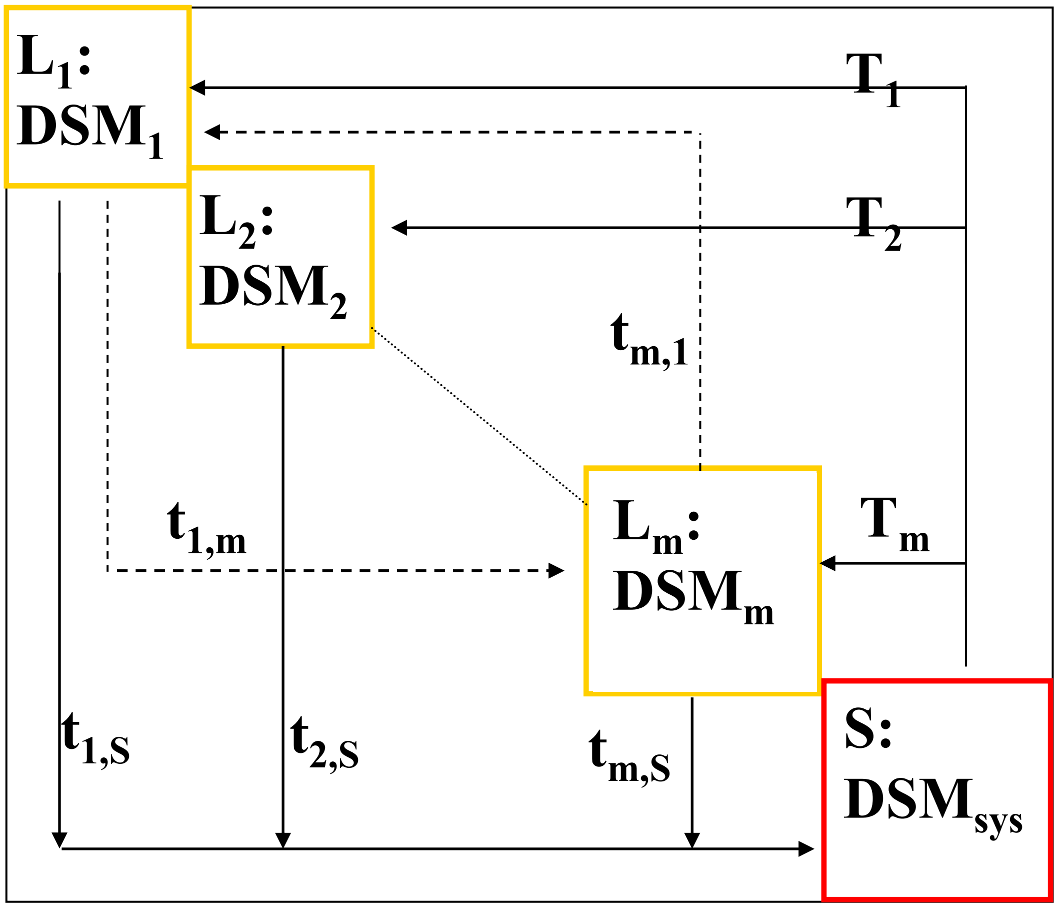
DSM Representation

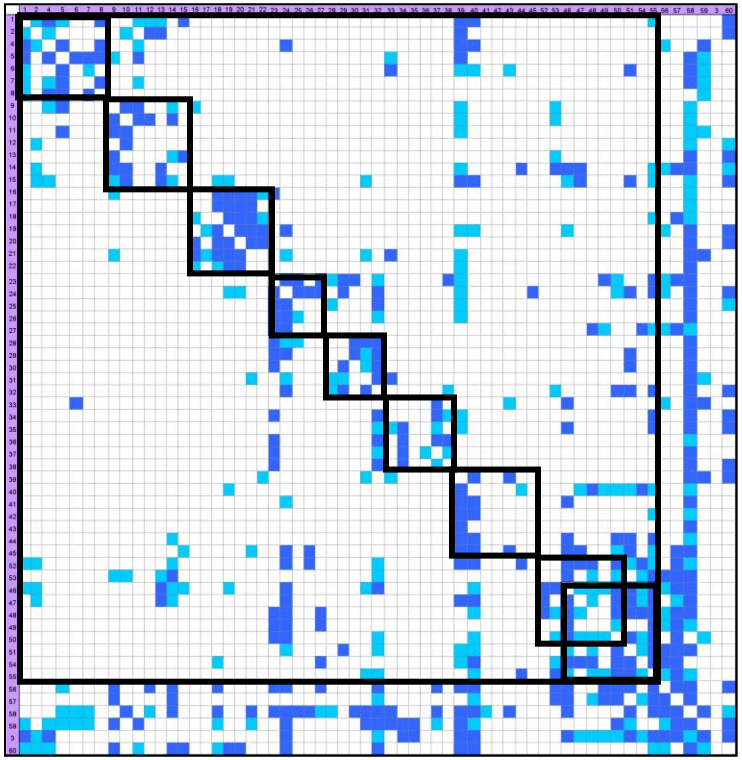
P&W 4098 Jet Engine



Courtesy of United Technologies. Used with permission.

m local DSMs & a single System DSM





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?

Case Study: Automotive Appearance Design Process

The process of designing all **interior** and **exterior** automobile surfaces for which appearance, surface quality and operational interface is important to the customer

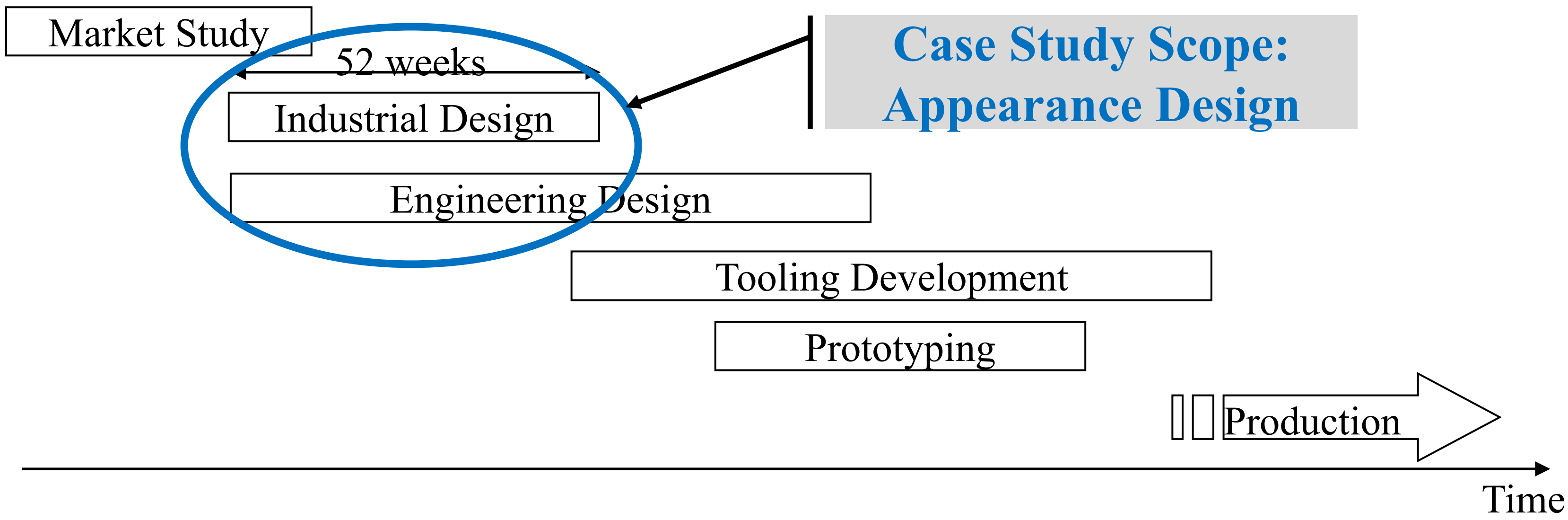
Image removed due to copyright restrictions.

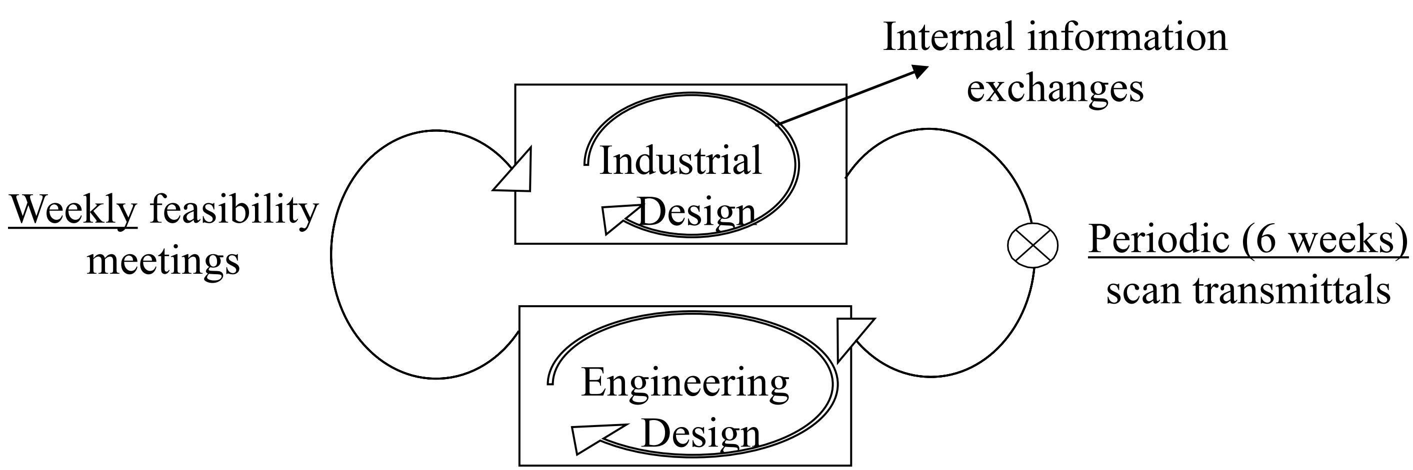
Examples

Exterior sheet metal design

Visible interior panels

Case Study: Automotive Appearance Design Process





Case Study: Automotive Appearance Design Process Input DSMs

Local DSM

			1	2	3	4	5	6	7	8	9	10
1	L_1	Carpet	0.85	0.12	0.02	0.06	0.06				0.06	
2	L_2	Center Console	0.1	0.53	0.04			0.3	0.02		0.24	0.02
3	L_3	Door Trim Panel	0.02	0.04	0.47	0.08		0.24	0.02		0.18	0.02
4	L_4	Garnish Trim	0.06		0.18	0.68		0.14	0.1	0.02	0.08	
5	L_5	Overhead System	0.04				0.83					
6	L_6	Instrument Panel		0.3	0.26	0.16		0.28	0.06		0.02	0.2
7	L_7	Luggage Trim		0.02	0.02	0.1		0.06	0.76	0.06	0.04	
8	L_8	Package Tray				0.1			0.06	0.83	0.16	
9	L_9	Seats	0.08	0.24	0.18	0.08		0.04	0.04	0.16	0.63	0.2
10	L_{10}	Steering Wheel		0.02	0.02			0.26			0.2	0.7

System DSM

			1	2	3	4	5	6	7	8	9	10
1	S_1	Carpet	0.2									
2	S_2	Center Console		0.2								
3	S_3	Door Trim Panel			0.2							
4	S_4	Garnish Trim				0.2						
5	S_5	Overhead System					0.2					
6	S_6	Instrument Panel						0.2				
7	S_7	Luggage Trim							0.2			
8	S_8	Package Tray								0.2		
9	S_9	Seats									0.2	
10	S_{10}	Steering Wheel										0.2

Local to system transformation matrix

		1	2	3	4	5	6	7	8	9	10
1	Carpet										
2	Center Console			0.09	0.17	0.21	0.09	0.14	0.42	0.29	0.38
3	Door Trim Panel		0.12		0.6	0.24	0.1	0.16	0.49	0.34	0.44
4	Garnish Trim		0.06	0.15		0.12		0.16	0.49	0.08	0.22
5	Overhead System		0.05		0.08						
6	Instrument Panel		1	0.87	0.58			0.94	1.41	0.49	3.81
7	Luggage Trim		0.07	0.06	0.25						
8	Package Tray				0.08					0.07	
9	Seats		0.14	0.12	0.12				0.58		
10	Steering Wheel				0.05						

System to local transformation matrix

		1	2	3	4	5	6	7	8	9	10
1	Carpet	0.15									
2	Center Console		0.15								
3	Door Trim Panel			0.15							
4	Garnish Trim				0.15						
5	Overhead System					0.15					
6	Instrument Panel						0.15				
7	Luggage Trim							0.15			
8	Package Tray								0.15		
9	Seats									0.15	
10	Steering Wheel										0.15

Low = 0.1

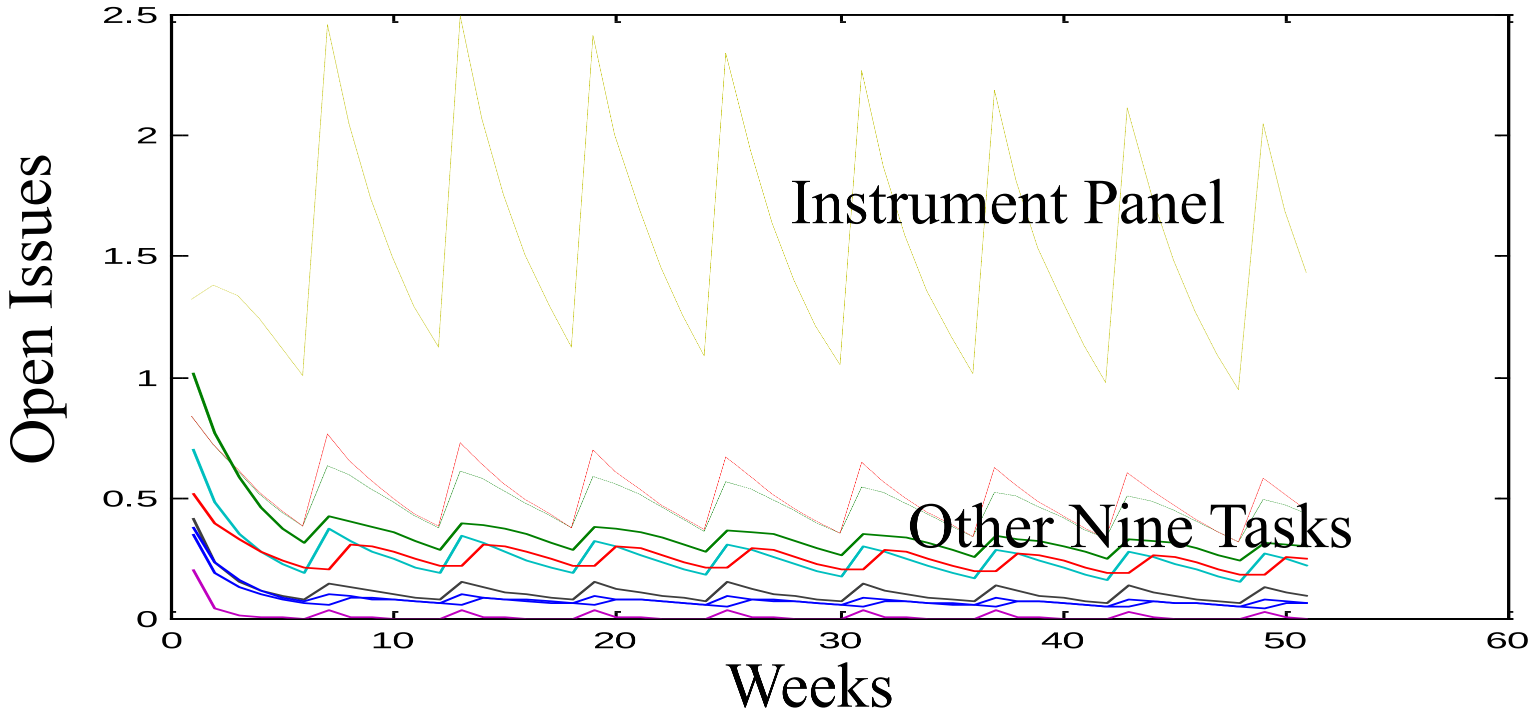
Med =0.2

Hi = 0.3

Base Case Analysis

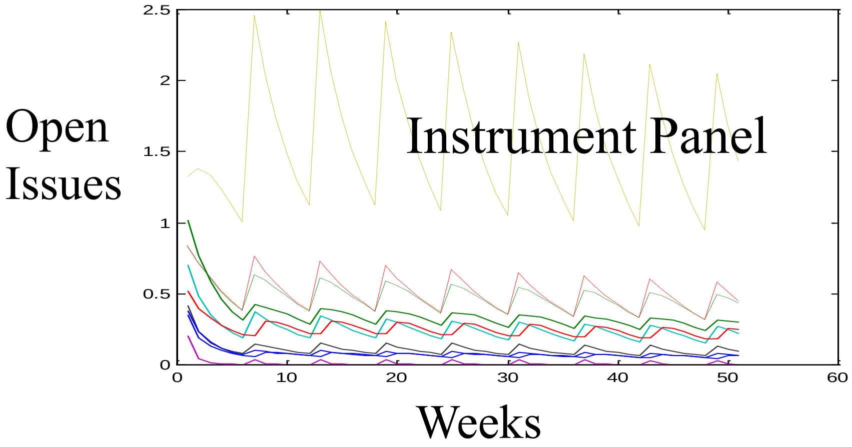
System is stable, but converges very slowly

'Instrument Panel' has the most destabilizing effect on total system performance

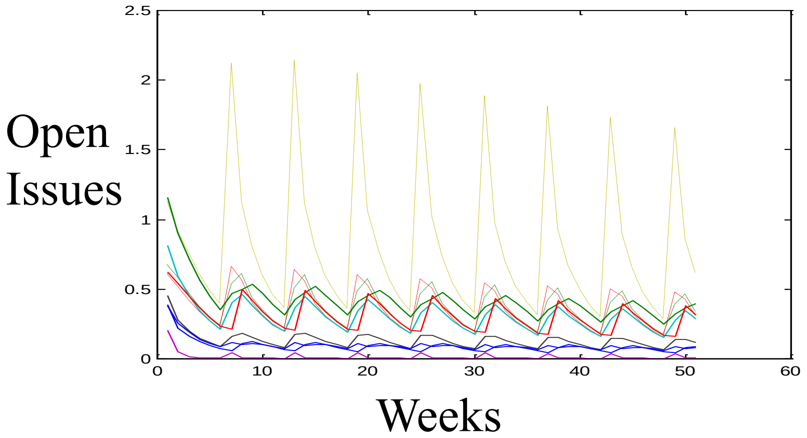


Effect of Mitigation Strategies

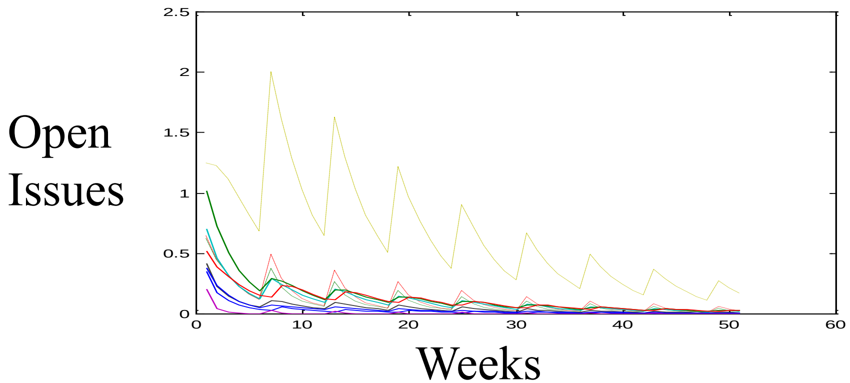
Base Scenario



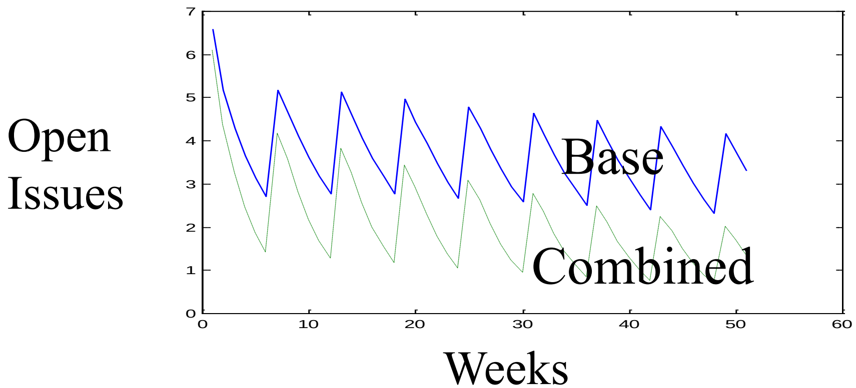
Scenario 1: Adding Resources



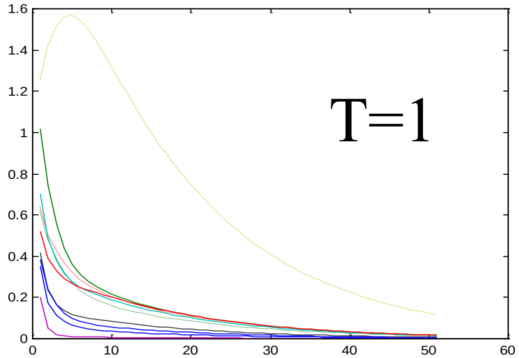
Scenario 2: Reduced Coupling

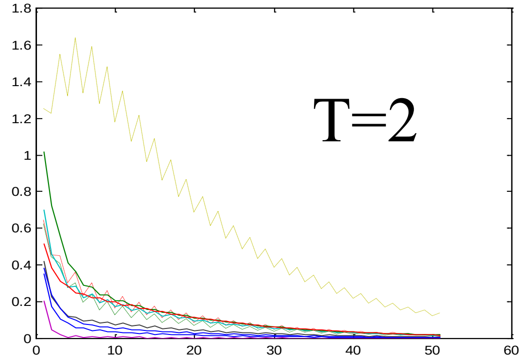


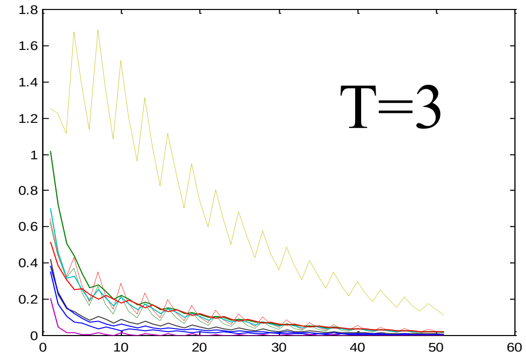
Total Open Issues: Scenarios 1 & 2 Combined

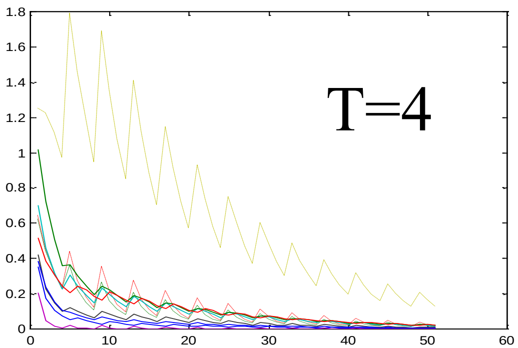


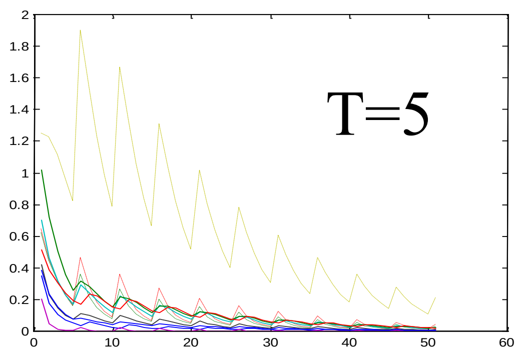
Effect of Delay on Churning Behavior

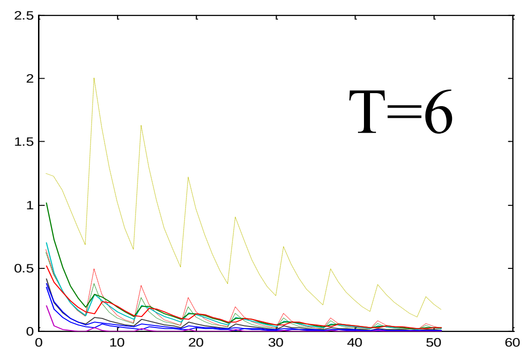








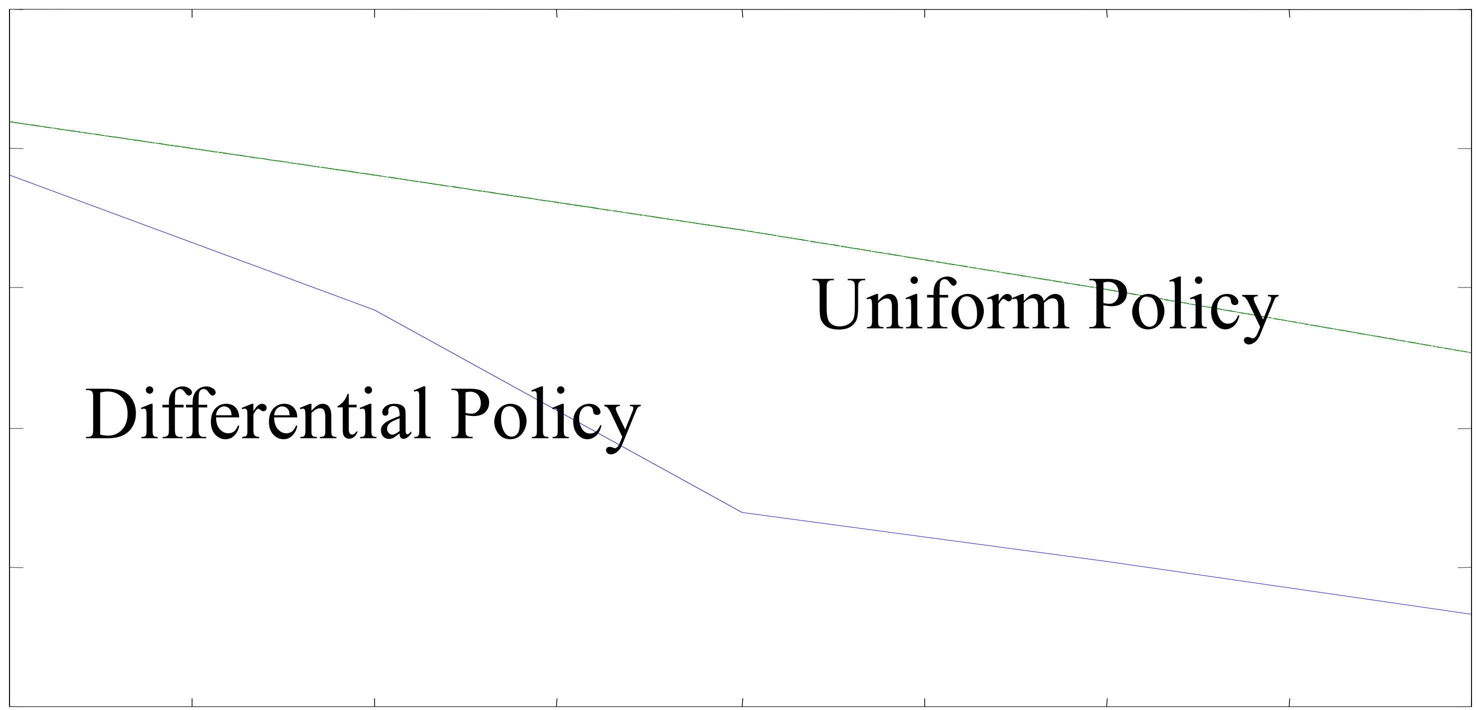




Effect of Differential Delay Policy

Slow convergence

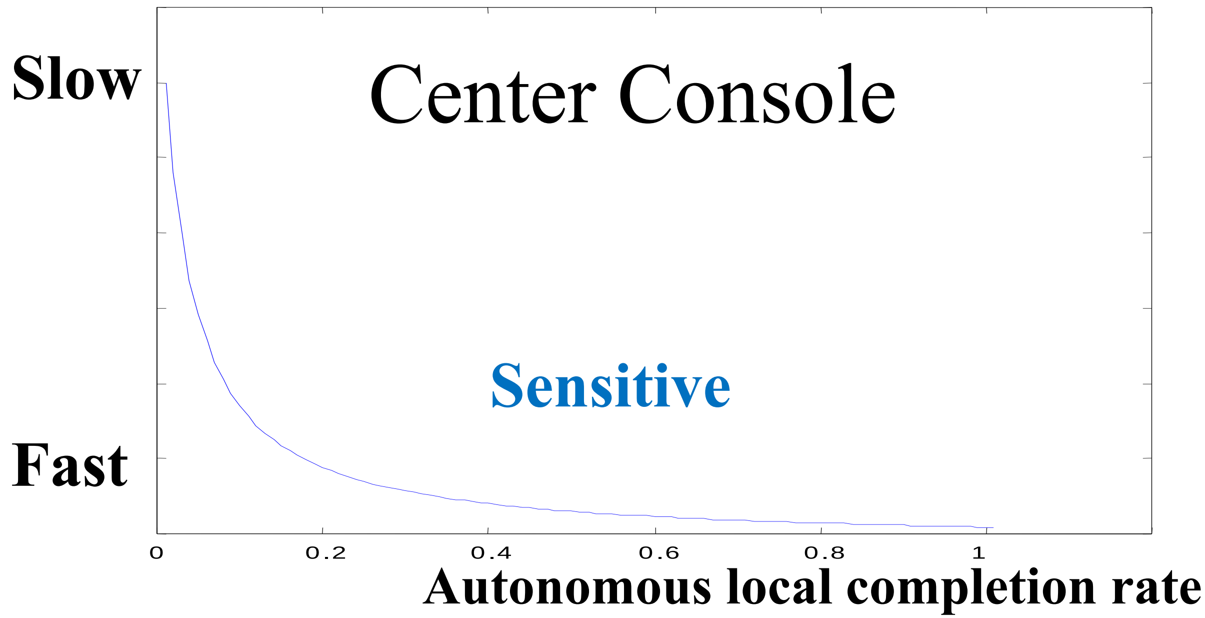
Fast convergence

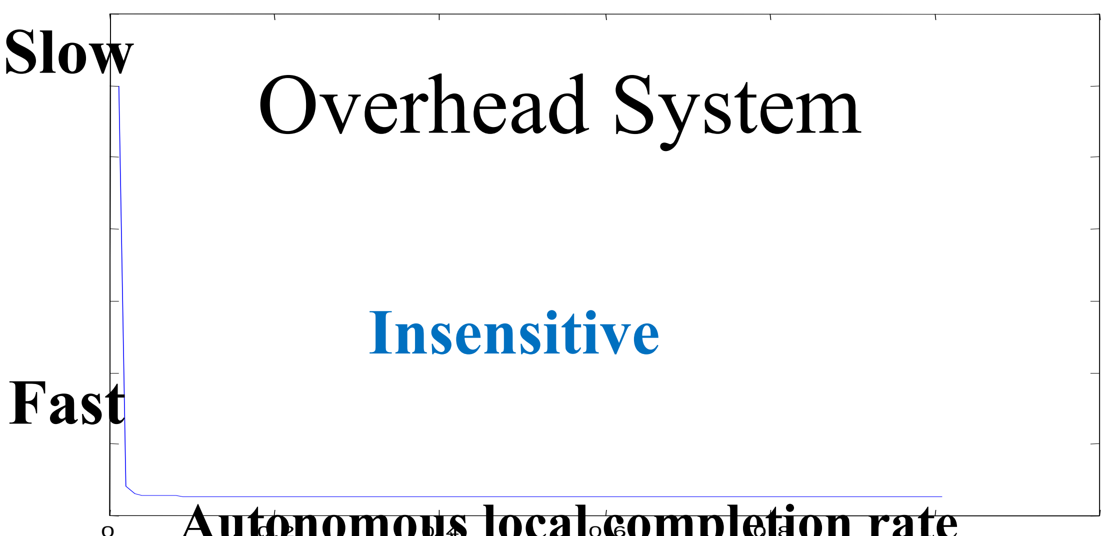


Uniform	T=5	T=4	T=3	T=2	T=1
Differential	$\begin{Bmatrix} T_1=5 \\ T_2=6 \end{Bmatrix}$	$\begin{Bmatrix} T_1=4 \\ T_2=6 \end{Bmatrix}$	$\begin{Bmatrix} T_1=3 \\ T_2=6 \end{Bmatrix}$	$\begin{Bmatrix} T_1=2 \\ T_2=6 \end{Bmatrix}$	$\begin{Bmatrix} T_1=1 \\ T_2=6 \end{Bmatrix}$

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

Dan Braha and Ali Yassine. "Complex Concurrent Engineering and the Design Structure Matrix Approach." Concurrent Engineering: Research and Applications. Vol. 11 (3). pp. 165-177. 2003. Read paper at http://necsi.edu/affiliates/braha/CERA.pdf

The design churn effect

Ali Yassine, Nitin Joglekar, Dan Braha, Steven Eppinger, and Dan Whitney. "Information Hiding in Product Development: The Design Churn Effect." Research in Engineering Design. Vol. 14 (3). pp. 131-144. 2003. Read paper at http://necsi.edu/affiliates/braha/RED03_Info.pdf

ESD.36 System Project Management
Fall 2012