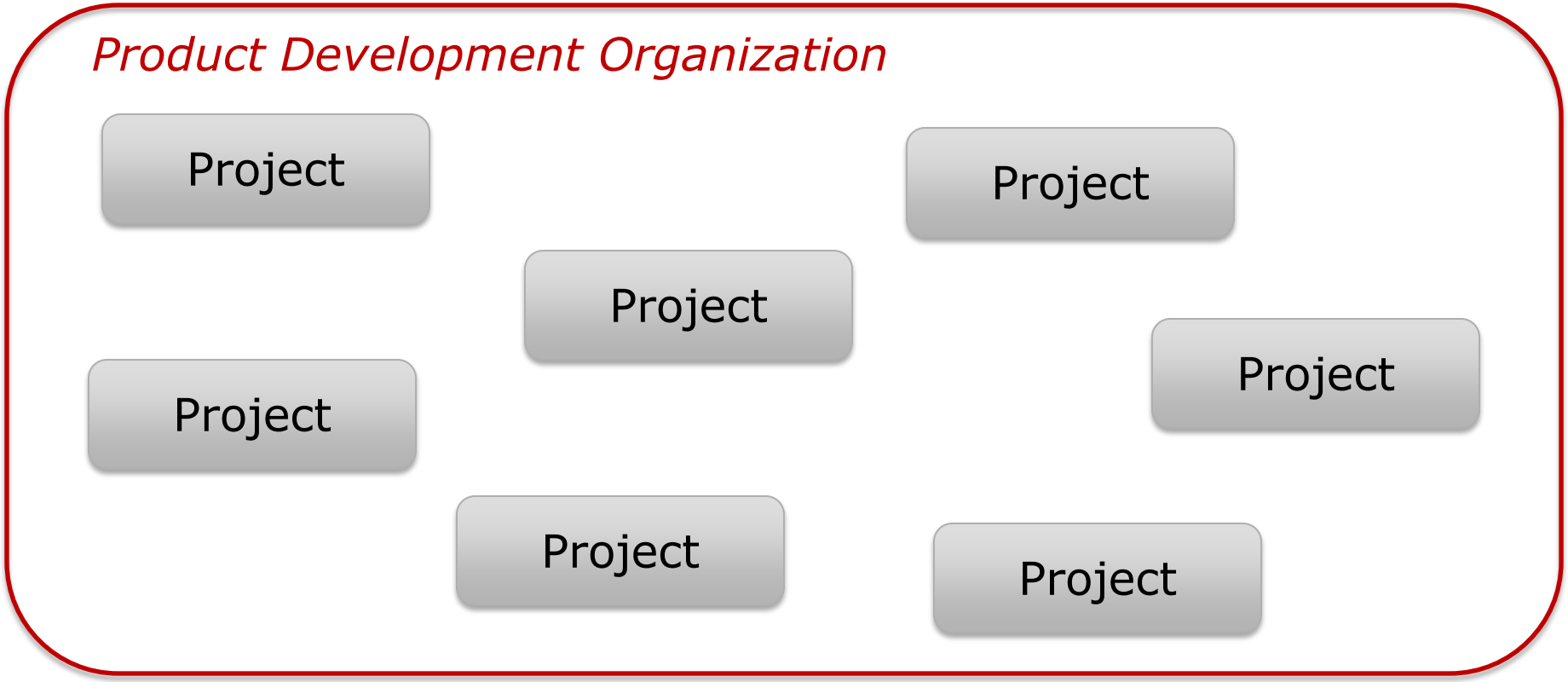
Standardization of Product Development Processes in Multi-Project Organizations

Sid Rupani
sidrup@mit.edu
PhD Candidate
Engineering Systems Division, MIT

Advisor: Warren Seering

LAI MIT LEAN ADVANCEMENT INITIATIVE

MIT ESD



How does process standardization influence organizational performance?

What is the impact of process standardization on organizational performance?

Process Standardization

+

Organizational Performance

- Efficiency
- Knowledge Transfer
- Decision making / Resource Allocation

Adler et. al 1999; Morgan, Liker 2006

Argote 1999; Adler and Cole 1993

Hammer and Stanton 1999; Garvin 1998; Sobek, Liker, Ward 1998

-

- Project performance
- Innovation
- Adaptation/ Learning over time
- Employee Satisfaction

Krubasik 1988; Shenhar 2001

Benner & Tushman 2002; Tilcsik 2008

March 1991; Levinthal and March 1993

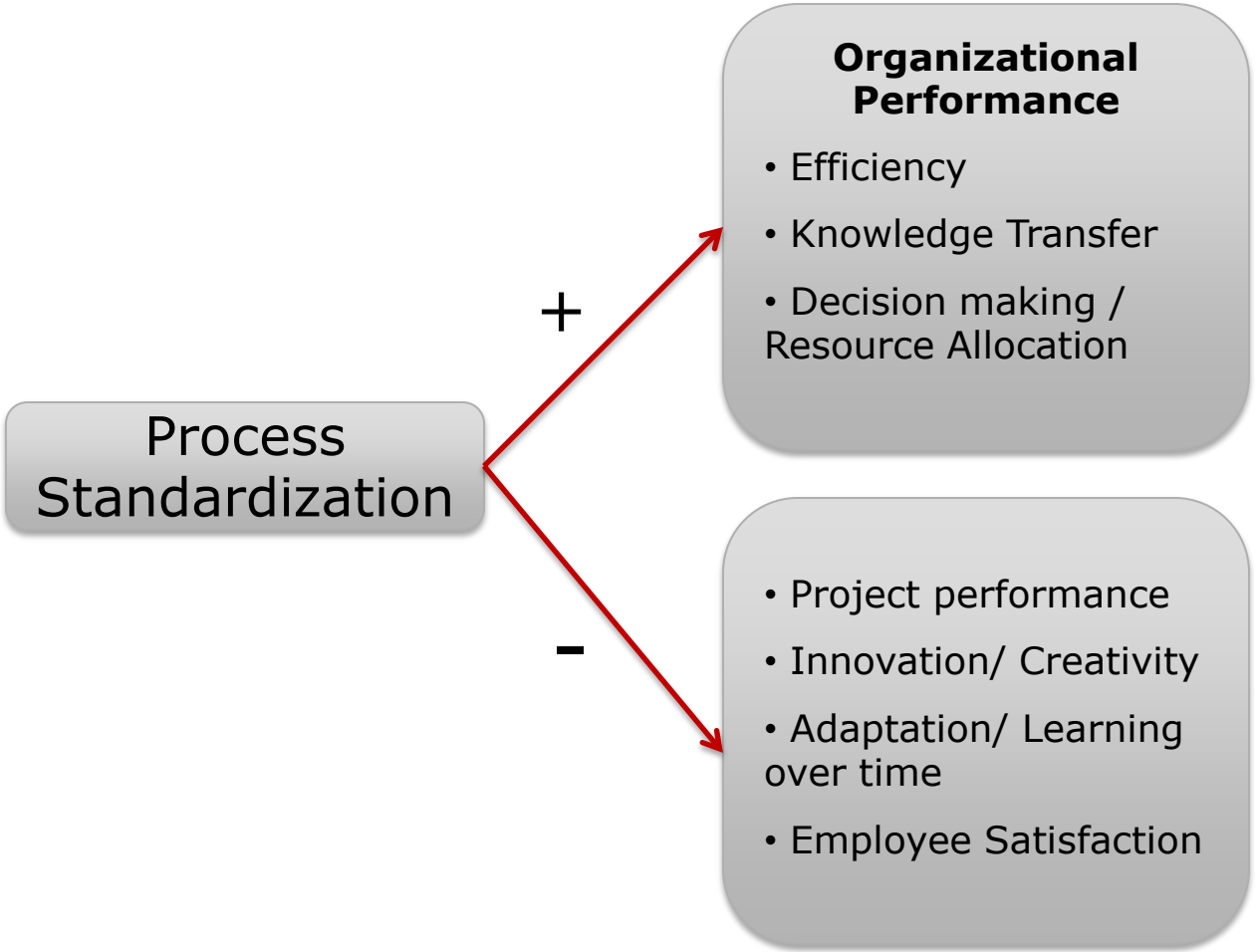
Adler et al. 1999

Field Research

- 5 large companies ($5B+ annual sales)
- Develop electromechanical assembled products
- Different industries
- Different approaches to process standardization
- Data: Interviews, Project Documents, Central Process Documents

- Theory-building from case studies (*Eisenhardt and Graebner 2007*). Selected Cases form theoretical Sample

Lessons from Case Studies - 1



"The biggest benefit is that because of the standard deliverables at the reviews, we all talk the same language and expect to see the same things in the same format. It's easy for the Senior Management Team to know when a red flag comes up or when a project is moving into exception."

Process Manager at Company E

"One good thing was that since we started using the same tools, it allows us to easily move between projects. We didn't have to retrain every time we switched."

Engineer at Company E

"Because of the tools, we can get engineers from other projects in crunch time and they don't spend too much time ramping up. They can be integrated relatively seamlessly."

Project Manager at Company E

Process Design

- Activities/Tasks
- Order, Flow, and Dependencies
- Timing
- Roles/Agents
- Tools/Methods
- Deliverables/ Outputs

Project Performance

- Product Cost
- Product Quality
- Development Time
- Development Cost

Process Standardization

- Activities/Tasks
- Order, Flow, and Dependencies
- Timing
- Roles/Agents
- Tools/Methods
- Deliverables/ Outputs

Organizational Performance

- Efficiency
- Knowledge Transfer
- Creativity/ Innovation
- Decision making / Resource Allocation
- Adaptation/ Learning over time
- Employee Satisfaction

Lessons from Case Studies - 2

- All companies
  - Acknowledged and controlled some amount of process variation, left some free to the discretion of project team

- Companies differed on:
  - What project characteristics they took into consideration to customize their process
  - Process Dimensions that are centrally specified and others left to vary

Company A

Inputs	Algorithm	Outputs
• Hardware/Software • Extent of In-House Development 8 Product 'Archetypes'	Table - each product archetype column, activities as rows. yes/no indicated.	• Activities

Company A - Project Archetypes

	Product Type							
	Hardware	**Software (not MNL, not ABC)**	**Hardware & Software**	**Software OEM-in**	**Hardware OEM-in**	**Hardware Reseller**	**ABC Software**	**ABC XYZ Software**
Examples:	AB4000, AB5000, some Tape	none, except RST going to PQR	SVC		AB3000, Brokeman 20	Sysco PQR	Note: These are special in that are closely tied to system software of which ABC is a part	
Development								
Accessibility Checklist(s)							NA - handled by pDA	NA - done at major release. Not required for SPE maint
Anti-Smike - HW only		NA - not HW		NA - not HW			NA - not HW	NA - not HW
Cost of Originality (COO & VOO)						NA - not required for reseller	NA - handled by pDA	NA - done at release level
Chemical Emissions Data								
Finance								

Company B

Inputs	Algorithm	Outputs
• Complexity • Newness • Cost • Certifications • Technology Readiness • Business Unit • Testing Requirements • Support Requirements • Hardware/Software • Extent of Outsourcing • Supplier Quality • Production Needs 32 questions	Logic Table – each activity decision made by referring to answers for pertinent questions	• Activities (required and suggested) • *Deliverables* • *Templates* ~80 technical activities ~50 management activities

Company B

A	B	C	D	E
	Q1		What is the projected cost of this project?	Select one.
☐	a		At or Above $ABC	
☒	b		Below $ABC	
	Q2		Please indicate maturity of technology on the project	Select one.
☐	a		Risky technology - unproven or limited application; emerging within market	
☒	b		Mature technology - proven and applied in similar applications; established within market	

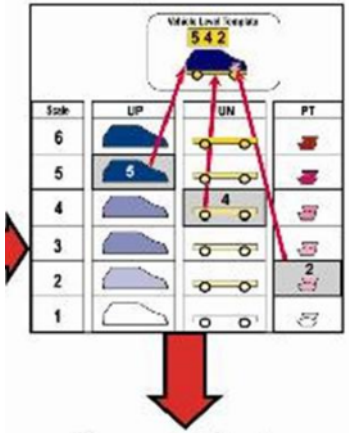
A	B	C	D	E
"x"=YES	Req/ Audit	Cust Reqd	ACTIVITIES AND TASKS	DELIVERABLE
☒			**Capture Originating Requirements**	
☒		☐	1. Capture stakeholders needs	stakeholder needs
☒		☐	2. Capture source requirements.	source requirements
☒		☐	~~3. Capture architectural context.~~	~~architectural context(s)~~
☒		☐	4. Define most important	most important requirements
☒		☐	5. Define technical performance	technical performance measures (TPMs)
☐			**Define Concepts**	
☐		☐	~~1. Define concept.~~	~~concept~~
☐		☐	~~2. Perform conceptual analysis.~~	~~conceptual analysis document~~
☒	☑		**Define Requirements**	
☐		☐	1. Perform requirements trade	trade studies
☒	☑	☐	~~2. Define product requirements.~~	~~product requirements~~
☒	☑	☐	~~3. Conduct traceability analysis from~~	~~requirements trace/ analysis~~
☒		☐	4. Perform functional hazard	functional hazard assessment

Company C

Inputs	Algorithm	Outputs
"Degree of Product Change" in three key subsystems Rated from 1-6	Three digit code maps to a "timing template"	• Activities • Sequence • Timing • (Reviews) • Deliverables • Templates • Roles

Company C

Program Scale

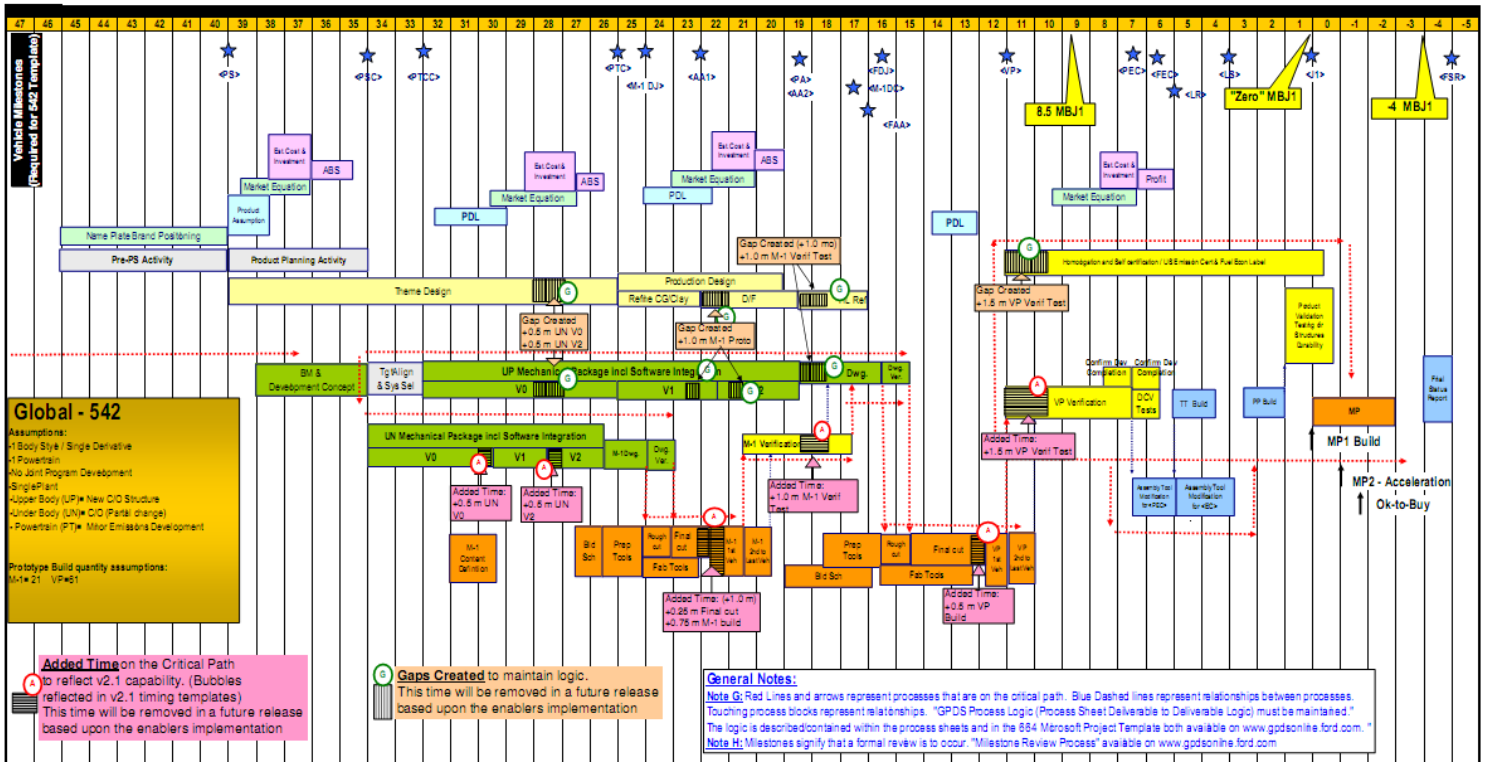


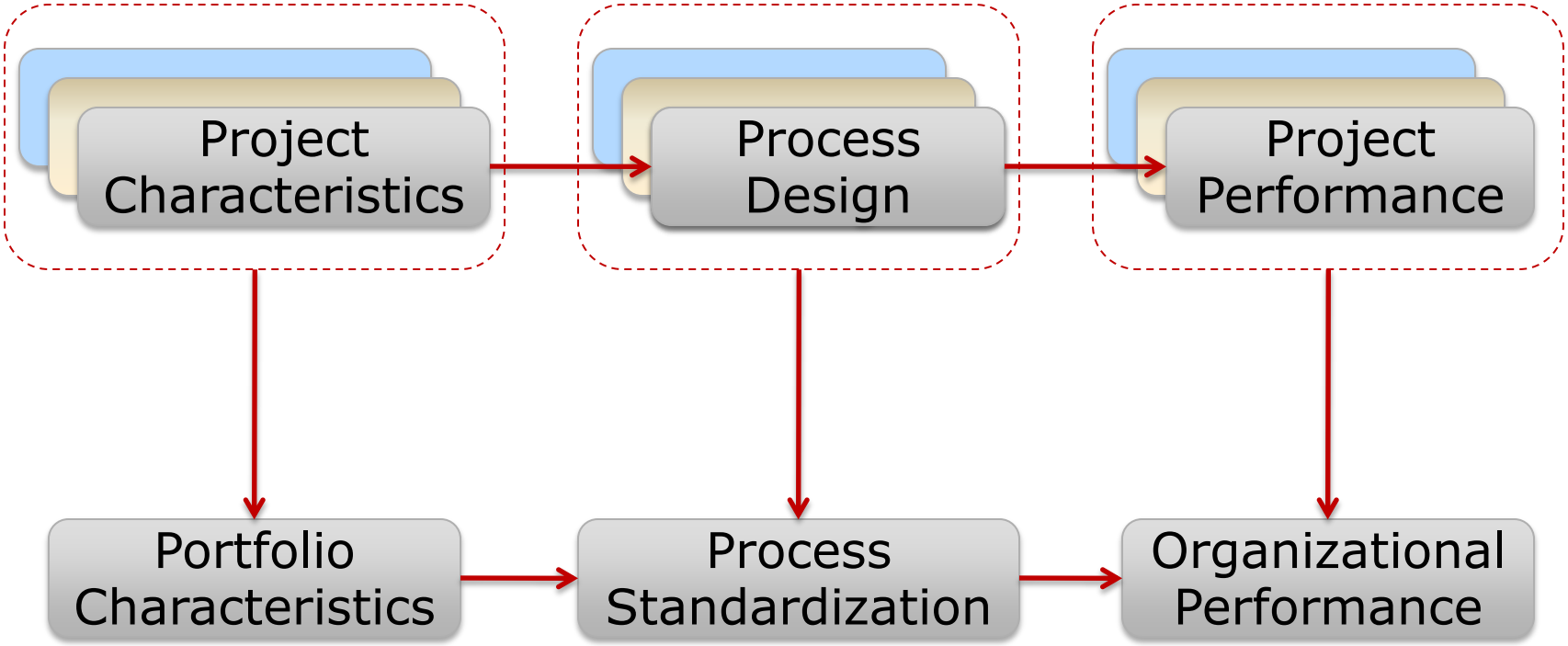
Program Timing Template

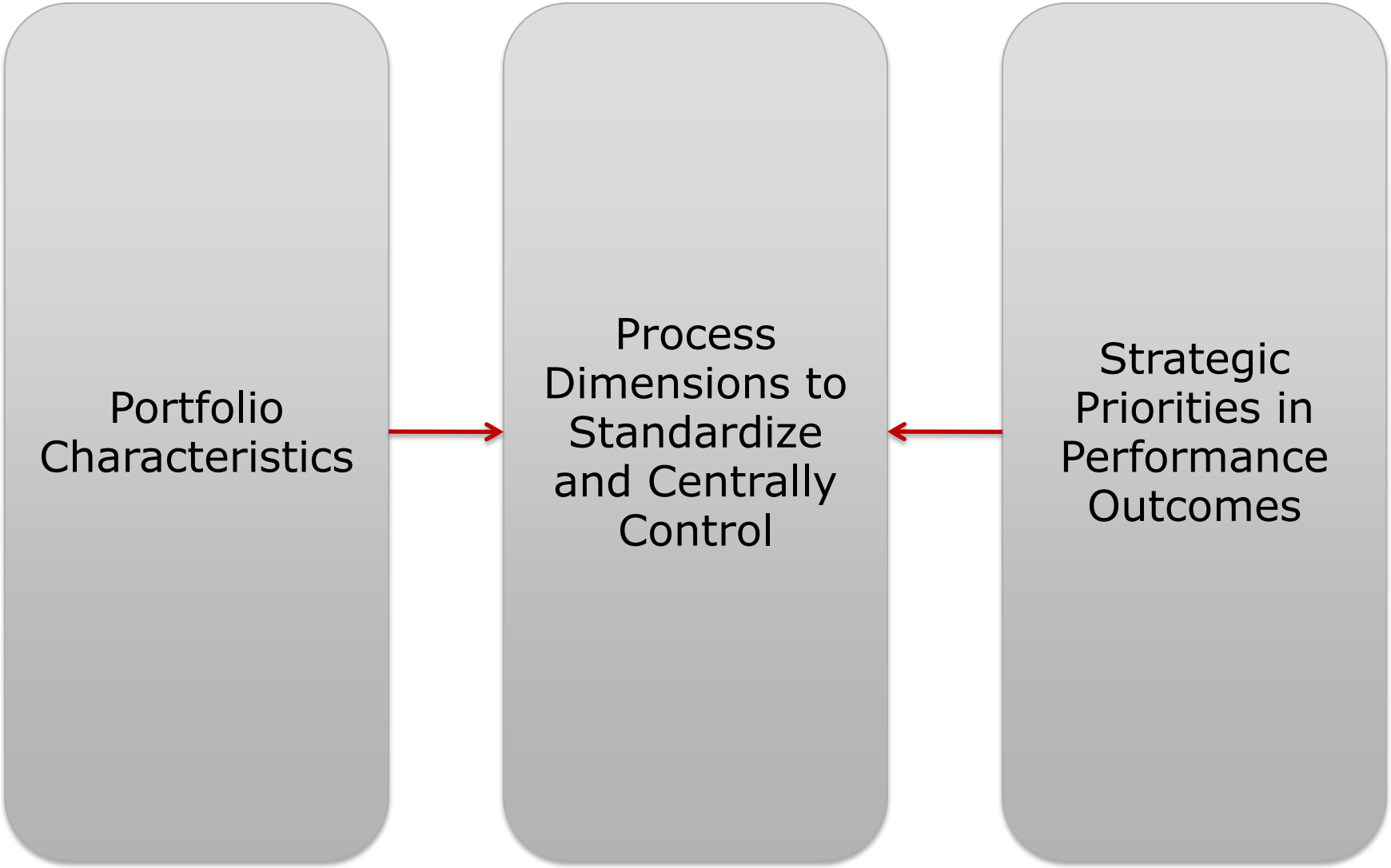
Timing Templates – MBJ1				
Scale	<PS>	<M-1DJ>	<FDJ>	<VP>
654	42.0	27.0	17.5	13.0
542	39.0	24.0	15.5	11.0
322	28.0	-	14.0	9.5

Global - 542 Timing Template

1) All Timing Templates <PS> to <J1> timing is based on current Global Capability.
2) All Process Documents (Process Sheets, Process Flow Chart and Workplanning Template) are based on 664 Scale and desired state <PS> to <J1> timing (e.g. Process Documents <PS> to <J1> timing 40 months vs. 664 Timing Template <PS> to <J1> timing 44 months)
Note: Not all GPDS Deliverables are accounted for on the timing templates.




Project Characteristics
Process Design
Project Performance
Portfolio Characteristics
Process Standardization
Organizational Performance

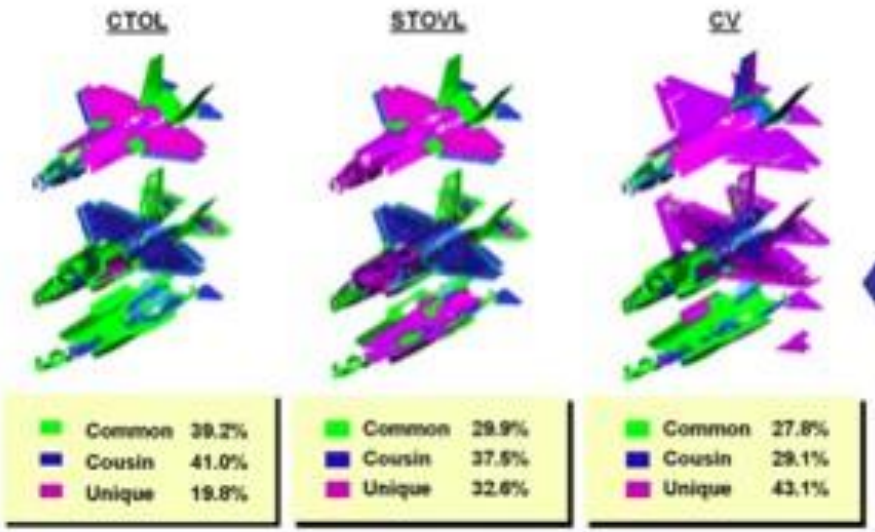

Portfolio Characteristics
Process Dimensions to Standardize and Centrally Control
Strategic Priorities in Performance Outcomes

Summary

- Individual Process Dimensions

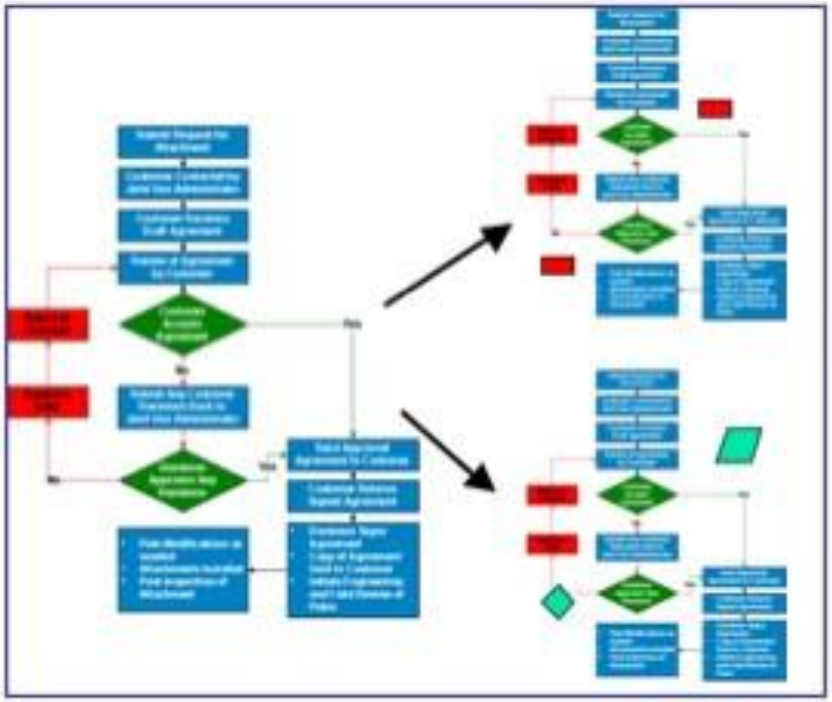
- Which process dimensions should your company be controlling centrally? Consider:
  - Variation in Project Characteristics across portfolio
  - Strategic Priorities across Performance Outcomes

Thank You!



Source: http://www.jsf.mil/, accessed July 6, 2006

?



Questions? Comments?

Supplementary Slides

Data Collection

- Visits to companies – each visit 3 days to a week.
- Interviews (40+) with project managers, process managers, engineers, business-unit managers, functional managers
- Process documentation (corporate and project level), Project information
- Examples of Project-level process data
  - Documentation from Gates/Reviews
  - "Engineering Plan", Project Information Repositories and Checklists
  - Process Customization Declarations (PCD) and Rationales for Deviation (RfD)
- Questions Driving Data Collection and Analysis
  - How do product development processes for different projects in an organization differ?
  - What factors drive these differences?
  - How do differences or standardization across processes impact performance on project-level and organization level outcomes?

Benefits of Standardization

- Process standardization enables true concurrent engineering and provides a structure for synchronizing cross-functional processes that enables unmatched vehicle development speed…

- standard development processes are the only conceivable way to run a multi-project development factory and gauge the performance and progress of any individual program."

Morgan and Liker, Toyota Product Development System, 2006

- The standardization increased the relevance of knowledge acquired in one part of the establishment for another and the documentation served as a conduit for knowledge to flow from one part of the organization to the other.

Adler and Cole (1993), Argote (1999)

However…

- Projects are different!

  PD projects differ in factors like scale, complexity, technology uncertainty, schedule, environments, goals, domain, available resources, and project team capability.

  MacCormack and Vergnanti, 2003; Dvir, Shenhar, and Alkaher, 2003; Cockburn, 2000; Glass, 2000; Lindvall and Rus, 2000.

- A 'one-size-fits-all' approach is difficult to work in product development.

  MacCormack and Vergnanti, 2003; Glass, 2000; Lindvall and Rus, 2000.

- "…process diversity offers one big advantage: it allows different kinds of [projects] to be managed in different ways"

  Hammer and Stanton, 1999

The standardization extreme

- "…many organizations' standard processes tend to be detached from the way work is actually done. Many of those doing so-called 'real work' may see the standard process as irrelevant, too generic to be helpful"

  Browning, Fricke, and Negele 2006

- Standard process is often bureaucratic and cumbersome, lacks buy-in from employees, and project teams often circumvent the process or only pay lip-service to it.

  Cooper 2005

- GM example: "the more they attempt to define the process of product development, the less the organization is able to carry out that process properly."

  Sobek, Liker, and Ward 1998

Standardization and Innovation

- Routinization creates a risk: when organizations are guided by old knowledge, they do not create new knowledge.

  Brunner, Staats, Tushman 2009

- In a 20-year longitudinal study of patenting activity and ISO 9000 quality program certifications in the paint and photography industries, we found that increased routinization associated with process management activities increases the salience of short term measures and triggers selection effects that lead to increases in exploitative technological innovation, at the expense of exploratory innovation.

  Benner and Tushman, 2002, 2003