

**National Science Foundation
Outsourced Product Design &
Process Development Field Study:
Preliminary Results**

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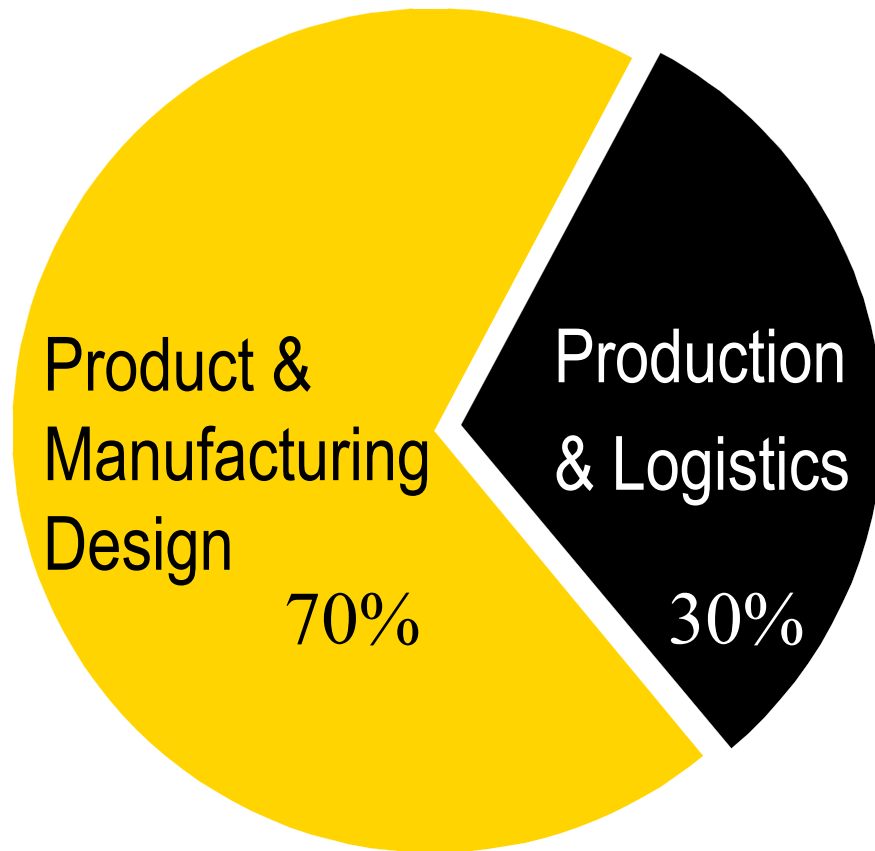
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Motivation

- Large vertically integrated firms are disintegrating in favor of supply chains of specialists
 - But: widespread cost and quality disappointments (anecdotal)
- Case study at Hewlett-Packard, published in *Production and Operations Management* in 2002
- Studies on how to manage these networks are still immature, particularly w.r.t. engineering/technical projects
- Many have focused on the *decision* to outsource or not; less on how to make outsourcing work.
- National Science Foundation-sponsored field study begun in 2004

Role of Design in the Supply Chain

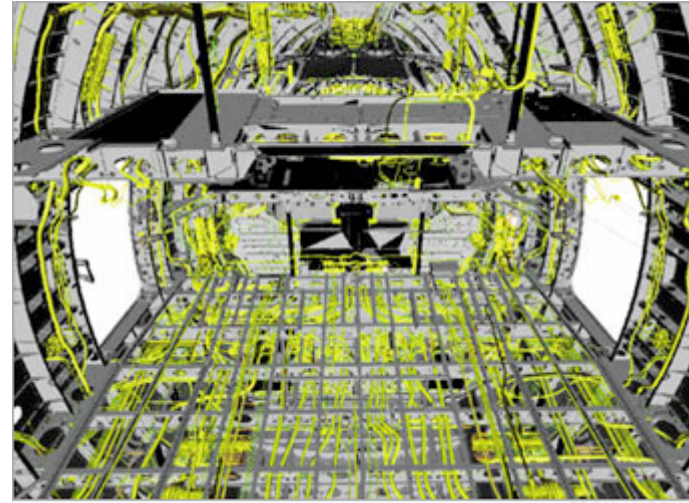


Point in time when total
Lifecycle cost is determined

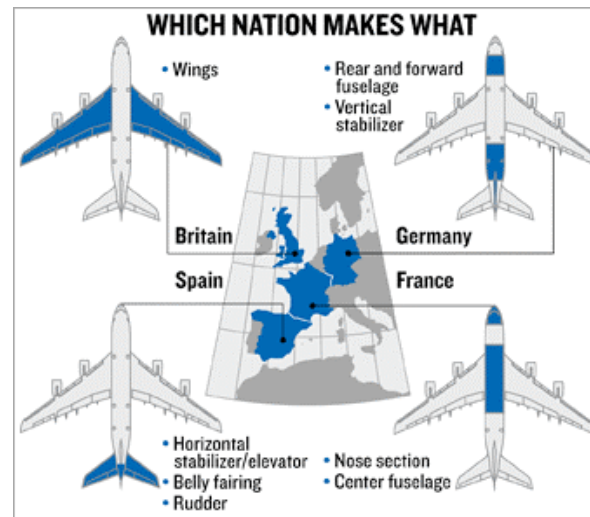
- 70% of total product lifecycle cost is determined during design and development (including process design) (Nevins & Whitney 1989)
- Overwhelming majority of supply chain programs concentrate on post-development activities (Closs & Stank 1999)

June 2006: The A380's wiring literally comes up "short."

- Fuselage sections designed in Hamburg were designed with a 2D CAD system
- Sections designed in Toulouse used a 3D system



FROM: AIRBUS



SOURCE: AIRBUS

FORTUNE GRAPHICS: JOHN TOMANIO

Airbus (EADS) vs. Boeing Stock April 2005 – April 2007



June 14, 2006: Airbus announces delays due to Airbus 380 wiring harness redesign. 1/3 of EADS stock value is lost.

Other Recent News

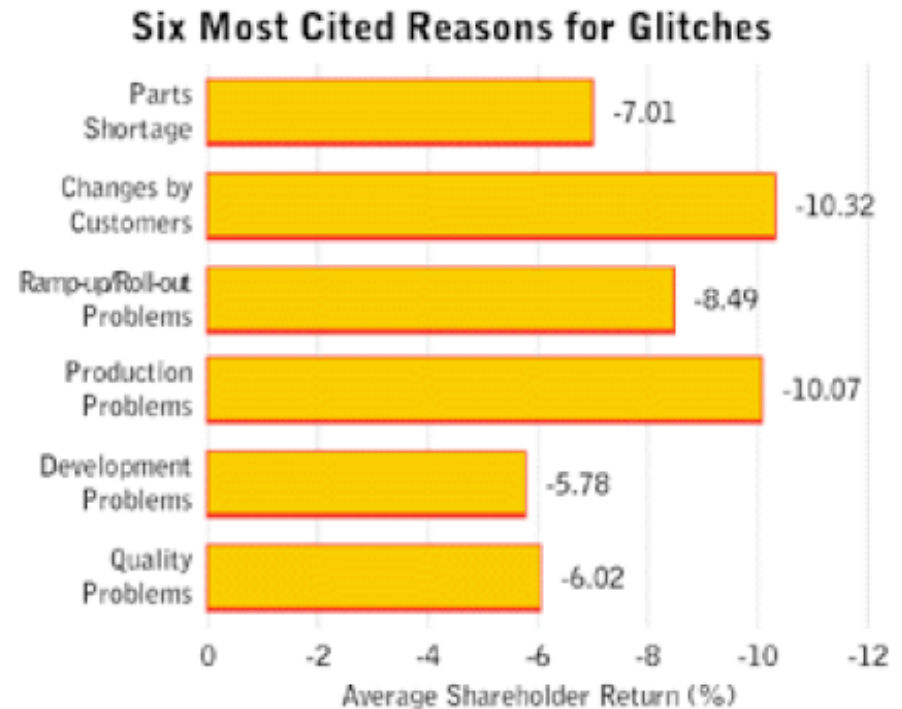
Playstation 3, November 30, 2006
(Boomborg) Sony chief developer of PS3
replaced after delays announced because
of parts shortages.

Increasing Exposure: Supply Chain Glitches Affect Value

EXHIBIT 8



EXHIBIT 7



Source: V. Singhal and K. Hendricks, "How Supply Chain Glitches Torpedo Shareholder Value," *Supply Chain Management Review*, 2002.

NSF Field Study: Research Questions

1. What special challenges do firms face with outsourced product & process development?
2. What practices are used to cope with these challenges and how do these practices affect eventual outcomes (Benchmarking)?
3. What skills help project managers in managing outsourced development projects?

Note: “Outsourcing” for our purposes includes all supplier-lead development projects, not just those that were once done in-house

Partial Literature Review

- Organizational Theory
 - **Org. Design:** Galbraith (1973), Carley & Lin (1997), Zellmer-Bruhn (2003), Siggelkow & Levinthal (2003)
 - **Communication:** Allen (1977), Daft & Lengel (1986), Kogut & Zander (1992), Kusunoki et al. (1998), Sosa et al. (2002)
 - **Org. Culture:** Hofstede (1980), Hannan & Freeman (1984), Cyert & March (1992), Gordon (1991), Beyer & Trice (1993), Modularity
- Supplier Selection
 - Handfield et al. (1999), McIvor & McHugh (2000), Novak & Eppinger (2001), Gilbert & Csva (2003)
- Product Development
 - **Modularity:** Sanchez & Mahoney (1996), Krishnan & co-authors (1997, 2001, 2006), Baldwin & Clark (2000, forthcoming), Schilling & Steensma (2001), Ethiraj & Levinthal (2004)
 - **Product Integration:** Henderson & Clark (1990), Clark & Fujimoto (1991), Giffin & Hauser (1993), Liker (1995), Iansiti (many), Griffin (1997), Fine (1998), Fine & Whitney (1999), Loch & Terwiesch (1998), Ulrich & Eppinger (2000), Boone & Ganeshan (2001), Joglekar & co-authors (many), Browning (2001, forthcoming), Thomke & co-authors (1998, 2001, and others), MacCormack et al. (2001), Ramdas (2003), Sosa et al. (2004), Gomes et al. (2005), von Krogh and von Hippel (2006), Ford & Serman (1998), Anderson et al. (2007), Loch & Kavadias (forthcoming)
 - **Integrators:** Jaikumar (1986), Ancona & Caldwell (1992), Fung & Magretta (1998), Häcki & Lighton (2001), Parker & Anderson (2002)

Relationships Examined

Controls

Duration of Focal Firm Supplier Relationship,
Project Duration, No. of Employees, Project
Engineer experience, Etc.

Coordination Tools

Formal Project Mgt. Methodologies
Formal Quality Control Programs
Etc.

Cultural Similarity Between Firms

Shared First Language
Geographic Distance
Same Industry
Etc.

Project Engineer Training

Technical Skills (e.g. Product Integration)
Soft Skills (e.g. Communication, Negotiation)
Business Skills (e.g. Project Mgt., Case Analysis)
Etc.

Organizational Mechanisms

Unify Purchasing & Engineering
Dedicated Personnel, Co-location
Information Systems
Media Richness & Frequency of Use
Modular Task Design
Etc.

Project Outcomes at Launch/Completion

Working Relationship
Quality (Good Parts, Reliability)
Functionality
Cost
Timing

Methodology

Field study interviewed managers of identified projects at each participant firm (structured interviews)

- Project managers answer questions like:
 - What issues were encountered (language, geography, industrial differences, differing goals, etc.)?
 - What methods were used to coordinate the project?
 - E.g. co-location, project mgt. tools like PERT, modular design, structured design tools like QFD etc.
 - Frequency and types of communications with the supplier
 - Education, background, and training (such as systems engineering, costing, or negotiations skills)
 - Various controls such as number of employees on project, length of project, etc.
- Pencil & paper instruments with standardized questions administered prior to interview
 - Their supervisors rate the success of each project vs. initial expectations on quality, performance/functionality, cost, timing, and overall working relationship

Data Collection timeline

- Initiate contact with a firm
 - Explain project and requirements
- Identify projects and respondents
- Sign non-disclosure agreements if necessary
- Schedule participants
- Collect data
- Stay in touch with newsletters

48 Projects in 18 Organizations Studied (data collection in progress)

Applied Materials, Blade Logic, Fiskar's, Heraeus, Innovative Emergency Mgmt., Motorola (Freescale), Cardinal Health, Frito-Lay, Fujitsu-Siemens, GM, IBM, Lockheed Martin 1, Lockheed Martin 2, Network Appliances, Sensortran, Sigmatel, Stork-Fokker, and Zombie Studios



Study Respondents (nerds like us)

Bachelor's Degree	Frequency
Electrical Engineering	20.8%
Mechanical Engineering	18.8%
General/Other Engineering	14.6%
Computer Science	10.4%
BBA	8.3%
Other Bachelor's Degree	16.7%
None	10.4%

N = 48 Project Engineers/Administrators

Master's Degree	Frequency
MBA	12.5%
Engineering	16.7%
Other	4.2%
None	66.7%

N = 48 Project Engineers/Administrators

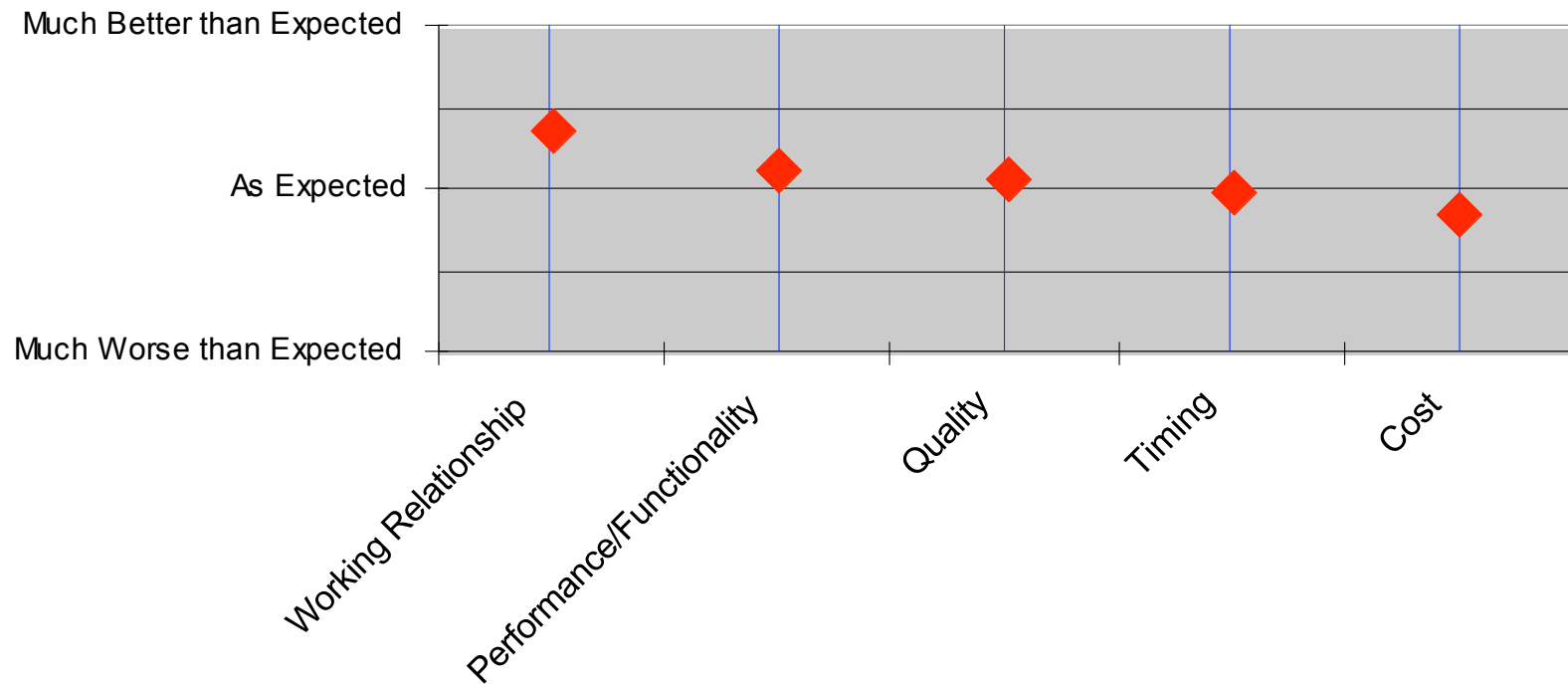
3 B.S. Engineers have MBAs

Preliminary Results

Outcomes, Coordination Tools,
Organization, and Skills

Benchmarking: Outcomes

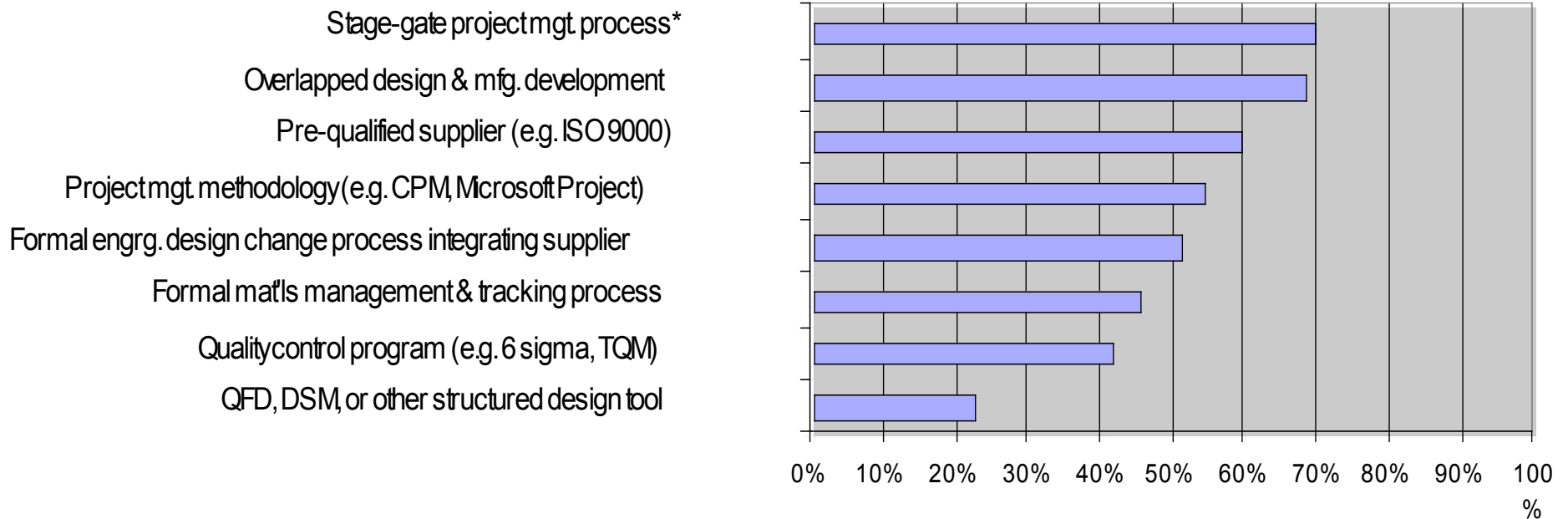
Outcomes (Mean & Range) vs. Expectations



- Projects show a wide variety of success levels
- Relatively low correlation between outcomes

Benchmarking: Tools

Coordination Tools vs. Frequency of Usage



N=48

*Question asked of only of most recent 23 projects surveyed

Regression results deleted

Please contact authors for up-to-date figures

Comments on Statistical Results: Tools

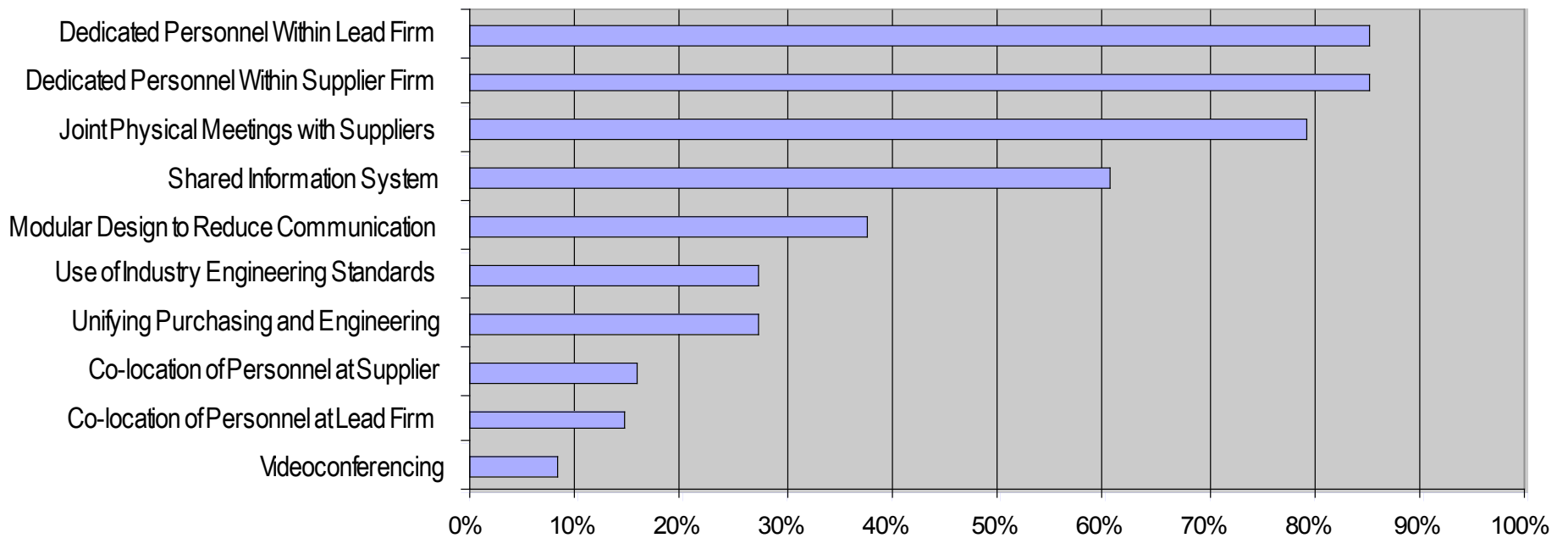
- Project management tools associated with more complex projects??
 - Conjecture: complex project management tools brought in when cost and time are of concern
- Tools' effectiveness increases with more salient outcomes
 - Relationship is intangible
 - Quality often hard to measure until after project is launched
 - Quality programs and timing
- Tools have differential effects on outcomes
 - Quality programs, pre-qualified vendors, and QFD/DSM associated with different favorable outcomes

Interview Results: Organization

- More people needed for outsourced projects
 - Steep learning curve for organization and individuals
 - Burnout from travel & odd hours is a huge issue
 - Virtual integration vulnerable to personnel turnover
- Co-location seems to be a last ditch measure when project is at risk
 - But once established, it tends to be permanent
 - Staggers communication barriers ... “Ugly American with an Asian face...”
- There are no high-tech “silver bullets” for outsourcing
 - Webex seems to be growing in popularity
 - Information systems are still usually just e-mail & Excel
 - Although shared computer-aided design (CAD) probably helps
 - Fax still used for complex data interchange
- Unifying purchasing and engineering thought to be beneficial from HP Case Study
- Software projects thought to be perhaps different because of better developed methodologies and approaches to modularity.

Benchmarking: Organization

Organizational Structures vs. Frequency of Usage



N=48

Regression results deleted

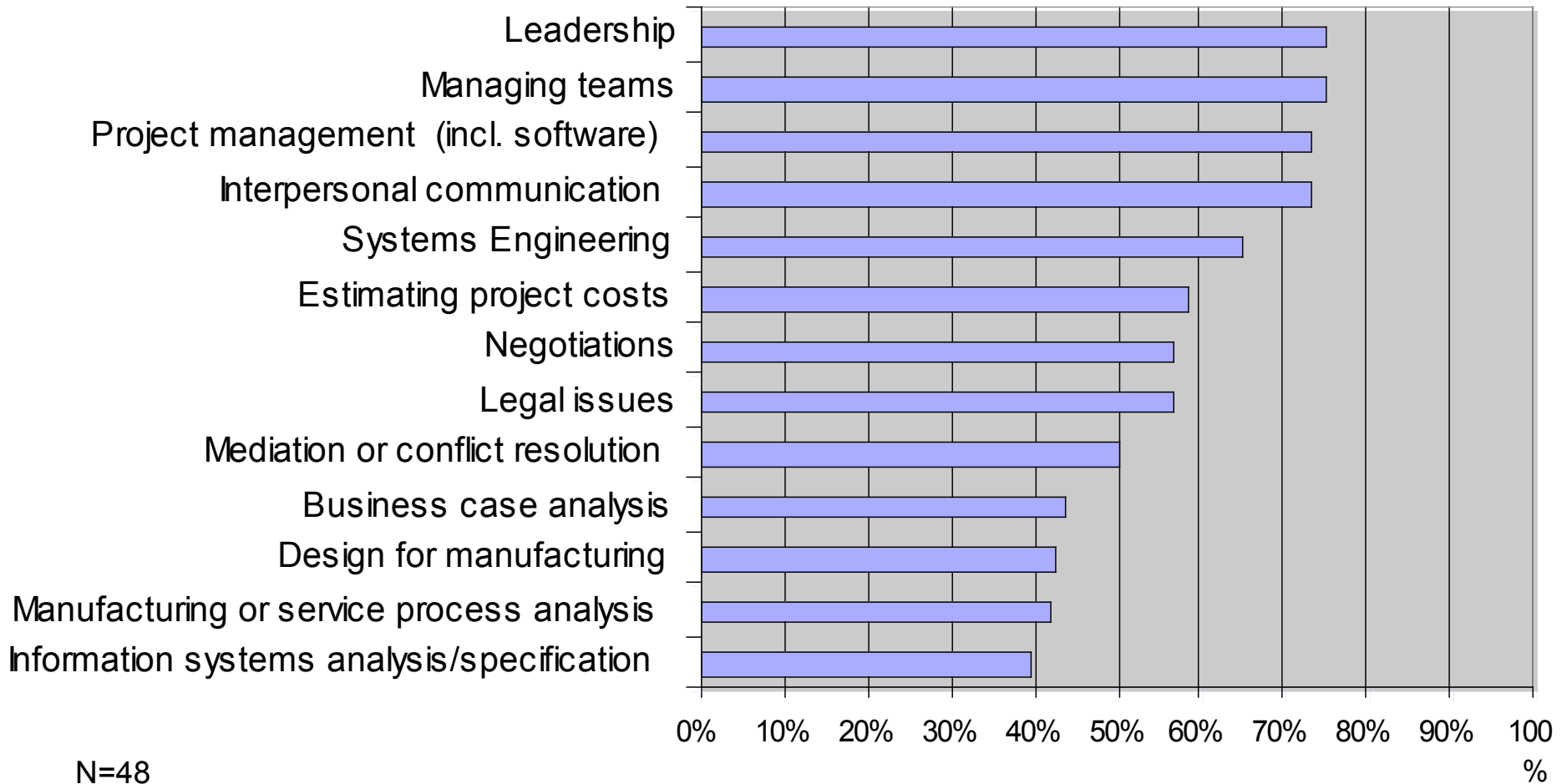
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Interview Results: Skills

- Broad and deep experience in the industry is seen as vital
 - Difficult to get in present-day, fragmented environment
- Most training is either sponsored by company or is “on-the-job”
 - Numerous complaints about cursory nature of company training
- Soft skills (persuasion, leadership, team-building skills) seem key according to most participants:
 - “It’s about getting people on the other side of the line...to like you and to sympathize with you, to do favors for you. I have a guy who’s really good at this. He’s about eight-tenths con-man. He’s got a lot of likeability and is just great at making you feel you have a friendship with him.”
 - “Some of our managers are on the banned list. They are not allowed to visit suppliers.
- Clarity of communication is crucial
 - “Managing by remote-control,” particularly with offshoring and via e-mail
 - Detecting when you’re misunderstood (“Monkey-proofing” ... really)
- Systems engineering at the university level is problematic
 - “I think schools do a horrible job at systems engineering. Product design is pretty good. Integration skills are almost completely lacking. The ability to integrate systems weeds out people who can be promoted versus those who cannot.”

Benchmarking—Skills/Training

Project Engineers with Formal Training in:



Comments on Statistical Results: Skills

- Differential effects between university and company training
 - Project management, negotiation better at university
 - Numerous interview complaints about cursory company training in “soft skills”
 - Case analysis better at company
 - However, DFM & Communications are good at both levels
- Software projects seem to differ in some respects
 - University training in information systems analysis associated with better results in cost and worse results in working relationship, quality, and functionality

Regression results deleted

Please contact authors for up-to-date figures

Applications

- Core OM courses at BU, Georgia Tech, UT Austin, Tulane heavily influenced
- Opportunities for specialized courses
 - Designing and Managing Global Design
 - Entrepreneurial supply chain and product/process design
- Corporate training, selection, & career paths

Summary

- Outsourcing design, development, and manufacturing often has hidden challenges & costs
 - Software projects may present different challenges
- Successful outsourcing requires a number of organization structures, tools, and skills beyond what's needed in house.
 - Different coordination mechanisms and tools help in different ways.
 - The promise of high-tech fixes is mostly as yet unfulfilled
 - There are no silver bullets.
- Training programs may need to change
 - Deep experience all around your industry is wonderful, when you can get it
 - Company and university-level courses may be differentially effective
 - University-level product integration training may need to be rethought
- People, and communicating with and relating to people, are the glue that holds your virtual organization together
 - *Retention of effective outsourced project managers may prove to be a competitive advantage*

Next Steps

- We're still recruiting participants
 - To improve robustness of results and detect weaker relationships
- Refine statistical and qualitative findings
 - e.g. Does project management training help more when there is a language barrier?
 - Effect of controls on relationships?

Questions?

More information can be found at:

- pdoutsourcing.org
- EdAnderson.org
- ggparker.net

Keiretsus vs. Alliance Outsourcing

Why Keiretsus are different?

- Shared equity between buyer and supplier
- Suppliers often managed by former executives from buyer firm
- Decades-long relationships