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Improving outcomes in outsourced product development: a joint consultant-client perspective

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Abstract

Although firms increasingly outsource front end product development activities to production suppliers or design consultants, this practice has received little scholarly attention. The few existing academic studies report high failure rates but generally present only the client firms' view of the causes. Our first results from in-depth interviews of both clients and consultants give a richer picture of enablers of success and causes of failure. We confirm some previous findings (internal divisions within the client, "poor communication" between parties), identify new ones (inadequate client capabilities, failure to transfer design intent), and combine them into a comprehensive model of outsourced product development that includes negotiating project scope, continuously managing expectations, and carefully re-integrating the design output into the client's operations. Finally, we classify several types of client dependency (need for new ideas, extra capacity, or specific technical expertise) and highlight the particular hazards associated with each.

Key words: design outsourcing; design consulting; new product development; innovation; make or buy

1. Introduction

Firms that develop, brand, and sell products have long used selective outsourcing of production activities to achieve competitive advantage. Increasingly, these firms are outsourcing front end product development activities such as industrial design and design engineering as well. Two modes of *design outsourcing*, distinguished by the nature of the *design provider*, are common. In black box outsourcing, a single supplier designs and produces the product to meet the client firm's general specifications (Clark and Fujimoto 1991). In *design consulting* (Walsh 1996),

design is performed by a consultant while production is retained within the client firm or outsourced to a contract manufacturer.

Although excellent outcomes do occur, many firms struggle when outsourcing design. Outsourcing-related problems on Boeing's 787 cost the company $2.5 billion dollars in the third quarter of 2009 alone and have delayed the project by two and a half years overall (Quinn 2009). A nationwide survey of electronics design outsourcing managers found that 65% had experienced a project that took longer than expected, 46% had experienced cost overruns, and 21% had received a project that failed to meet requirements (Mokhoff and Wallace 2005). Nearly one third of managers at large companies view design outsourcing as a "net liability" to their companies (Rayner 2005), and nearly two-thirds of outsourced platform design projects studied at *Fortune* 1,000 companies "struggled or failed" (Amaral and Parker 2008). Collectively, these cost overruns, schedule delays, and lost opportunities cost firms dearly. By contrast, successful outsourcing projects can create enormous value. Reebok's Pump sneaker, developed collaboratively with the design consultancy Continuum, is said to have generated $1 billion in new sales for Reebok (Design Continuum 2010). A better understanding of the causes of failure and sources of success could turn more projects from liabilities into assets.

Perhaps surprisingly, little scholarly research has attempted to explain observed variation in project outcomes. We know of just two empirical academic studies that assign causes to the outcomes of specific projects. Roy and Potter (1990, 1993), in a study of small and medium-sized U.K. manufacturers receiving a government grant to hire a design consultant, found that "the problems most associated with project failure were inadequate briefing of the consultant and internal disagreements [within the client firm] about the aims or value of the projects." Amaral and Parker (2008), in their study of outsourced platform design projects, found that the three

most common reasons for project failure were misaligned objectives between the client firm and its design provider or within the client firm itself, unanticipated rivalries between multiple vendors, and poor version control.

Unfortunately, the strength of these findings is tempered by a key methodological choice in the study designs: both obtained their data by surveying client personnel exclusively. While the client perspective is critical to understanding the problem, the other side of the story – the design provider perspective – was not represented. This is significant for several reasons. First, client personnel have a limited view of the outsourcing engagement. From their vantage point they can observe the effects of variation in project and provider characteristics, but they are not in a position to observe the effects of variation between client firms. Second, they may base their judgments on a small number of observations. Most client personnel have experienced only a handful of outsourcing projects in their careers, whereas design providers experience that number every few months. Third, client personnel may be unduly critical of "outsourcing" if they fear it threatens their jobs. Thus, the results of these studies may suffer from bias.

Client-side bias is also evident in reader surveys conducted by the trade press (e.g., Rayner 2005). Not surprisingly, such surveys typically blame poor outsourcing outcomes on failings by the design provider, such as poor communication or lack of project management ability (Mokhoff and Wallace 2005). Certainly these do occur, but they may be symptoms of more systemic, structural phenomena such as geographic or cultural barriers. The assignment of blame to actors rather than structure is likely an artifact of the mass questionnaire format, which is unlikely to produce complex or nuanced explanations.

While largely absent from the trade surveys, the provider perspective is voiced via journalistic interviews (Rassam 1995, Goering 2006) and self-authored books and articles

(Brown 2008, Brown 2009, Esslinger 2009). These provide richer accounts than the client surveys but are no less biased. The interviewees or authors are typically founders and spokesmen of major design consultancies. They naturally want to represent the outsourcing model in the best possible light.

Thus, research to date has generally taken either the client or the provider perspective exclusively, but neither can present a complete picture. We believe that by taking a joint perspective we can elucidate a richer understanding of the challenges inherent in outsourced product development. As part of a larger effort to document and explain variation in project outcomes, this paper uses in-depth interviews with experienced consultant and client personnel to: 1) identify the most significant factors influencing project success and failure, 2) compare and contrast the client and consultant perspectives, and 3) develop frameworks useful to practitioners for improving project outcomes.

The remainder of the paper is organized as follows. We begin by framing the literature in terms of a comprehensive process model of design outsourcing. From there, we describe the research setting – design consulting – in which we gathered novel insights. Our results confirm many previous findings but suggest that existing literature understates several important factors, including characteristics of the client firm, the project negotiations, and the transfer and reintegration of the design at the end of the project. Finally, we classify several types of client dependency (need for new ideas, extra capacity, or specific technical expertise) and highlight the particular hazards associated with each.

2. A Process Model of Outsourced Product Development

We structure our review of the literature, and the presentation of our results, using a prototypical model of the outsourced development process (Figure 1). Variations are possible: in black-box

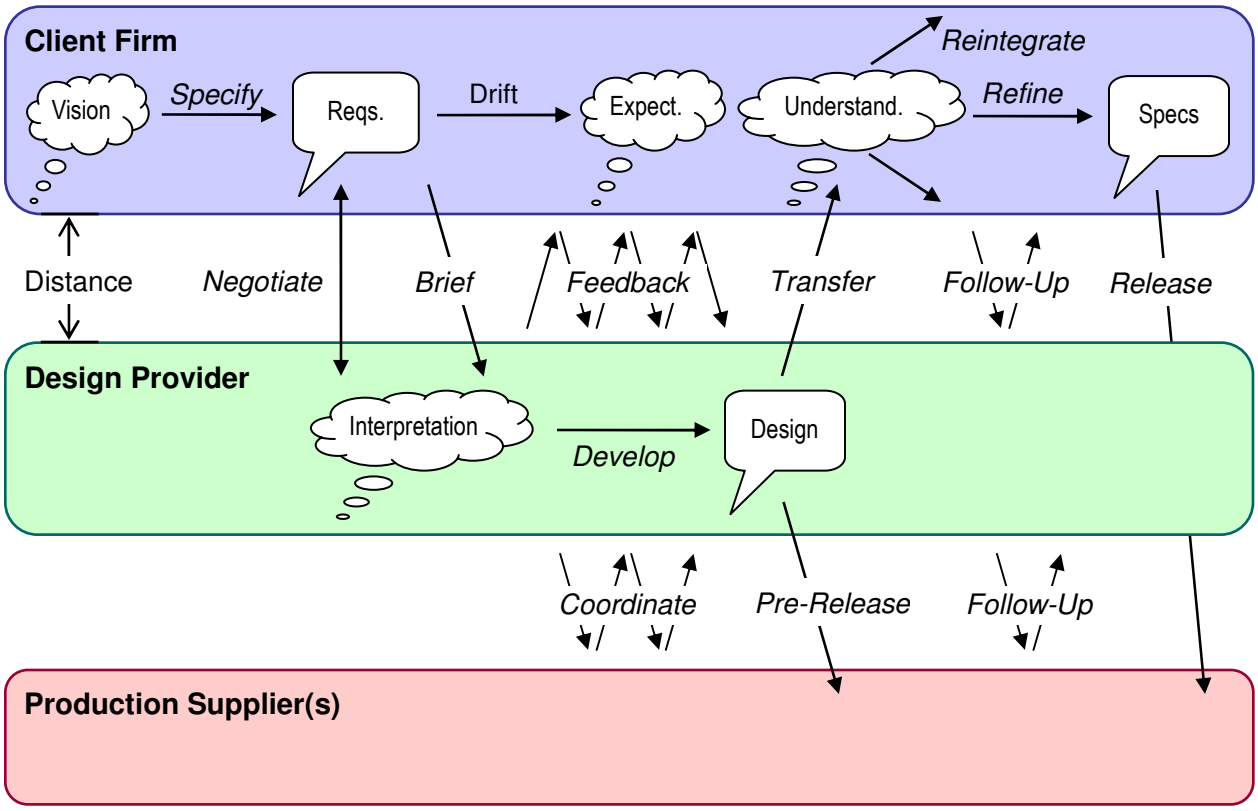

Figure 1 A process model of outsourced product development

outsourcing the *Design Provider* and the *Production Supplier* are the same company. In design consulting the *Production Supplier* could be part of the *Client Firm*. Not every step in the figure occurs in every process, either because the process does not need the step or because the step, for reasons discussed below, should have occurred but did not. In general, the *Client Firm* starts with a Vision for the project and *Specifies* it into a set of Requirements. The client firm identifies a *Design Provider*, *Negotiates* terms of the engagement, and *Briefs* the provider on project requirements and context (in some cases, requirements are specified jointly during negotiation). The design provider *Develops* the Design, *Coordinating* as necessary with the *Production Supplier*. Meanwhile, the client firm's Requirements may *Drift* due to exogenous (e.g., actions by competitors) or endogenous (e.g., a change in management direction) factors. Continuous *Feedback* must be maintained to ensure alignment of Expectations and development, but such

feedback is complicated by several types of *Distance* (geographical, cultural, etc.) between the two parties. After development the design provider *Transfers* the Design back to the client firm, which must *Reintegrate* it into its organization and *Refine* it if necessary prior to production. The client firm then *Releases* completed Specifications to the production supplier. Ideally, *Follow-Up* between all parties occurs throughout this process. The literature suggests that problems can occur in several of these stages, but our research suggests that problems occur in them all.

3. Literature Review

Prior empirical research has focused primarily on factors related to the Specification of Requirements, the capabilities of the Design Provider, the quality of the Briefing, and the extent of Feedback during development. In addition, theoretical literature on product development and systems engineering suggests likely factors related to Distance, Feedback, and Reintegration.

3.1. Factors related to the Client Firm

Client firm size may affect project outcomes, but the nature of the relationship is unclear. Roy and Potter (1990) found that severe problems "were much more likely to occur in the firms with under 50 employees and especially affected the smallest firms with under 10 employees." The authors attributed this to lack of experience and lack of time on the part of the employees. However, the occurrence of these problems did not significantly affect the rates at which projects were later implemented by the firm (Roy and Potter 1993). On the other hand, Rayner (2005) reported that managers at large firms (sales >$500 million) view design outsourcing less favorably than those at mid-sized ($10 million to $500 million) and small companies. He attributed this to the fact that larger firms are more likely to outsource complete systems, partner with original design manufacturers rather than consultants, and outsource to overseas rather than

domestic design providers. Although not stated, the implication is that outsourcing of partial systems, to design consultants and domestic providers, is viewed more favorably.

3.2. Factors related to the Specification of Requirements

Poor specification of requirements often leads to poor project outcomes. The client firm must know what it wants to accomplish (Rassam 1995), develop mature specifications (Fine and Whitney 1996, Goering 2006), and achieve consensus about both the specifications and the objectives of the outsourcing engagement (Roy and Potter 1990, Amaral and Parker 2008).

3.3. Factors related to the Design Provider

The trade literature in particular assigns blame for poor outcomes to inadequate technical, managerial, and communication capabilities on the part of the design provider (Rassam 1995, Mokhoff and Wallace 2005, Goering 2006). Numerous articles advise client firms to "shop around" and choose their provider carefully (Roy and Potter 1990, Bruce and Morris 1994, Rassam 1995, Goering 2006), but we will show that this advice, taken to extremes, creates additional problems.

3.4. Factors related to the Distance between the Client Firm and the Design Provider

Knowledge transfer theory suggests that increasing the distance between the client firm and the design provider will adversely affect project outcomes. Geographic distance hinders communication (Allen 1977), as do language barriers. Cultural distance complicates coordination because each party may be unfamiliar with the other's organizational norms and standard operating procedures, while organizational distance weakens project management by disabling mechanisms such as hierarchy and management by objective (Anderson et al. 2007).

Organizational barriers may also reduce mutual respect and trust between parties, limiting information flow across the boundary (Bruce and Morris 1994).

3.5. Factors related to the Briefing

Related to specification, poor *transfer* of requirements to the design provider compromises development. None of the projects in Roy and Potter's sample that had a "poor" design brief were implemented profitably, a finding echoed anecdotally (Bruce and Morris 1994, Rassam 1995, Goering 2006).

3.6. Factors related to Discontinuities in Development Team Membership

Consistent project team membership is critical for in-house product development (Smith and Reinertsen 1998), and is no less so for outsourced development. Several companies in Roy and Potter's sample expressed concern that they had briefed the project with senior consultant personnel, who then passed the work on to "an inexperienced junior person." Arguing from a theoretical basis, Baldwin and Clark (2000) note the risk that a design provider will reassign its personnel to other clients at the conclusion of development, making follow-up or re-engagement with the original team difficult.

3.7. Factors related to Development

Roy and Potter report that only 20% of projects in which design work was "poor" were implemented profitably by the client firm. Problems with the work included failing to satisfy the brief, being impractical to manufacture, or exceeding the project schedule.

3.8. Factors related to Drift in Requirements

Anecdotal evidence suggests that client firms' requirements often shift during the course of the project. "A common problem is that a company will see a competitor bring out a new product,

which inclines them to bring out a copycat version" (Paul Priestman, quoted in Rassam 1995). Internally, the client firm may undergo a change in senor management or a downturn in financial standing (Roy and Potter 1993).

3.9. Factors related to Feedback

"Poor communication" is an oft-repeated theme that deserves clarification. To manage expectations, the design provider must continuously communicate the status of development, including the inevitable changes that result as initial uncertainty is resolved (Roy and Potter 1990, Rassam 1995, Goering 2006). Simultaneously, the client must continuously communicate the status of its expectations, especially any changes in project requirements (ibid., also Bruce and Morris 1994). The use of boundary spanning objects (Carlile 2002) and personnel (Parker and Anderson 2002), as well as information technology tools (Anderson et al. 2007), have been recommended to improve coordination across organizational barriers. In an ongoing project, Anderson and colleagues (2008) are specifically investigating the effects of various coordination mechanisms on project outcomes.

3.10. Factors related to Reintegration

The reintegration of the design can be hindered by both personal and organizational resistance. "Just bringing in an outside designer without preparing the organization for this, which is what some companies do, can work very badly. The 'not-invented-here' syndrome often means that [outside] designer-inspired ideas are rejected" (Rassam 1995). In addition, the firm may unwittingly reject the design if its architecture does not match that of the organization (Henderson and Clark 1990). Sanchez and Mahoney (1996) noted that "although organizations ostensibly design products, it can be argued that products design organizations, because the coordination tasks implicit in specific product designs largely determine the feasible organization

designs for developing and producing those products." If the product design developed by the consultant does not match the existing organization design, either the organization must adapt to the product – a challenge, given that organizations are slow to change (Hannan and Freeman 1984) – or the product will be altered to match the organization, perhaps losing essential architectural structure or the originality which motivated outsourcing its design in the first place.

3.11. Factors related to Refinement

Lastly, project success is favored by the client firm's commitment to carrying it through. Roy and Potter (1990) observed several examples of projects "which only yielded commercial returns because the firm was willing to persist with the work even when the consultant's proposed design was unsatisfactory."

4. Methods

Our research leverages the collective wisdom of experienced consultant and client professionals, using in-depth interviews to complement the surveys performed to date. The work is ongoing; we present our first results with confidence that more data will enrich but not overturn them.

4.1. The Research Setting: Design Consulting

Although most research to date has focused on black box outsourcing (Fine and Whitney 1996, Handfield et al. 1999, Wasti and Liker 1999, Novak and Eppinger 2001, Amaral and Parker 2008), design consulting may be a better context in which to understand outsourced design outcomes. First, because design activities are performed independently of production activities, it is possible to isolate the effects of outsourced design from those of outsourced production. Second, design consulting is typically applied at a smaller scale than is black box outsourcing. It is generally agreed that project difficulty increases with increasing project size (Ulrich and

Eppinger 2004); studying large projects makes it difficult to untangle the effects of scale from those of design outsourcing. Finally, because design consulting projects are relatively small, they turn over quickly, making design consultancies the "fruit flies" of the design outsourcing world and giving practitioners an extensive number of project experiences to draw from (Grant 2000).

Design consulting is practiced in a range of industries, from software (Joglekar and Rosenthal 2003) to biotechnology (Pisano 1990), but we focus on durable consumer, medical, and industrial goods. Such products are small enough to be studied yet complex enough to be interesting, requiring the coordination of expertise from several functional specialties (e.g., consumer research, industrial design, mechanical and electrical engineering, etc.). The populations of interest were the development staff of consultancies specializing in these domains (Core77 Inc. 2010), and the client personnel with whom they collaborate.

4.2. Sample Selection

To ensure a variety of perspectives, a statistically non-representative stratified sampling technique (Trost 1986) was used to balance variation in employer type, experience level, job title, and current or former employment status. Respondents were recruited through word-of-mouth and targeted solicitation of thought leaders within the study population. Of the 40 individuals approached to date, 30 agreed to participate, representing 25 companies. Respondents had an average of 14 years experience with consulting (range 3 to 29 years).

4.3. Data Collection

Two methods of data collection were used. First the respondent was interviewed using an in-depth, semi-structured approach (McCracken 1988). All interviews were conducted by the first author, and lasted from one to two hours, depending on the enthusiasm of the respondent. To encourage candor, 25 were performed in a private office or away from the respondent's

workplace. After completing the interview, the respondent was surveyed using an 82-item, closed-form questionnaire. The questionnaire addressed the frequency of occurrence of common design outsourcing pitfalls as well as the relative success rates of various types of projects. The questionnaire was typically started during the interview but completed by the respondent afterwards. To date, 27 completed questionnaires have been returned.

4.4. Data Analysis

Audio recordings of the interviews were fully transcribed by the first author. The transcripts and interview notes were then coded using grounded theory (Corbin and Strauss 2007). Both stated and latent opinions were considered. For instance, a respondent might deny the occurrence of a particular problem but elsewhere note the measures taken to prevent it. The second author reviewed the emergent coding schema and resulting theory throughout the process.

The coded interview data and the questionnaire results were then analyzed to identify the most significant factors influencing project success and failure. In the spirit of failure modes and effects analysis, the frequency, severity, and likelihood of detection were all considered in rating factors as Significant, Moderate, or Minor risks.

Direct quotations have been edited slightly for readability and to protect confidentiality.

5. Factors Influencing Project Success and Failure

Table 1 compiles the major factors influencing project outcomes, as reported by the empirical literature and by our consultant and client informants. The relative risk of each factor is presented, allowing comparisons between the three perspectives. The "~" symbol indicates that the factor was not mentioned or was deemed to be negligible risk. Our interviews confirm many of the factors reported in the literature, refine others, and add new ones. For the sake of space, we only discuss those that significantly extend or refine the literature.

Table 1: Risk Factors in Outsourced Product Development

According to the:	Literature	Consultants	Clients
Client Firm			
· Lacks capability, experience, and/or processes for *managing* new product development	~	**Significant**	**Significant**
· Lacks experience with, is not a knowledgeable *buyer* of, design services	~	**Significant**	**Significant**
· Lacks technical capabilities and/or domain experience	~	Moderate	Minor
· Corporate culture is to over-specify, over-schedule innovation; significant risk-aversion	~	Moderate	**Significant**
· Project team does not include or consult all stakeholders	[7]*	Moderate	Moderate
· Project team lacks leadership, authority, and/or influence within client organization	~	Moderate	Minor
· Client firm is very large or very small	[6,7]	~	~
Specification of Requirements			
· Project lacks definition; client cannot specify what it wants	**[3,5,7]**	**Significant**	Moderate
· Divisions within the client firm over project objectives	**[1,5,7]**	**Significant**	Moderate
· Project is about "blue sky" innovation	~	Moderate	Minor
· Project has high technical risk; client expectations unrealistic	~	Moderate	~
Negotiation			
· Client is overly focused on project cost and schedule, neglecting quality	~	**Significant**	**Significant**
· Misunderstandings about project objectives	~	**Significant**	**Significant**
· Mutual under-appreciation of risk; difficult to price project	~	**Significant**	**Significant**
· Consultant oversells their capabilities or the likelihood of project success	[3]	Moderate	Moderate
Consultant			
· Lacks technical capabilities and/or domain experience	[3,4]	Minor	Moderate
· Lacks project management capability	[4,7]	Minor	~
Distance between Client Firm and Consultant			
· Geographic distance	[7]	Minor	**Significant**
· Corporate cultural distance	~	Moderate	Minor
· Organizational distance	[2]	Moderate	Minor
· Misalignment of objectives	[1,7]	Minor	Moderate
· International barriers	[3]	~	Moderate
Briefing			
· Poor briefing, due to difficulty of encapsulating client's tacit knowledge, inherent uncertainty of innovation	~	Moderate	**Significant**
· Poor briefing, due to client ignorance or carelessness	**[3,5,7]**	Moderate	Minor
· Poor briefing, due to client deliberately withholding information to stimulate creativity	~	Moderate	Minor

* Legend: [1] Amaral and Parker 2008, [2] Bruce and Morris 1994, [3] Goering 2006, [4] Mokhoff and Wallace 2005, [5] Rassam 1995, [6] Rayner 2005, [7] Roy and Potter 1990, [8] Roy and Potter 1993

Table 1: Risk Factors in Outsourced Product Development (Continued)

According to the:	Literature	Consultants	Clients
Discontinuities in Team Membership			
· Discontinuities in client team	~	Moderate	Minor
· Discontinuities in consultant team	[7]	Minor	Minor
Development			
· Consultant personnel insufficiently engaged due to lack of time	[2,7]	Moderate	Minor
· Design impractical to manufacture	[2,7]	Minor	Moderate
· Design work poor	[7]	~	Minor
· Consultant ignores the brief, "does own thing"	[2,7]	~	~
· Rivalries between multiple vendors	[1]	~	~
Drift in Requirements			
· Client adds requirements or makes changes, compromising budget; "scope creep"	[5]	Moderate	~
· Changes in client's senior management or financial situation	[5,8]	Minor	Minor
Feedback			
· Client does not communicate frequently enough, police the brief, and/or provide prompt replies to questions	**[2,3,5,7]**	**Significant**	**Significant**
· Consultant does not communicate frequently enough and/or manage client's expectations	**[3,4,5,7]**	**Significant**	Moderate
· Client inadequately involved due to lack of time	[7]	**Significant**	**Significant**
· Client inadequately involved because consultant and/or client personnel do not enjoy collaboration	~	Moderate	~
· Development decisions and/or scope changes not documented	~	Moderate	Moderate
· Poor version control	[1]	~	~
Transfer of Design			
· Transfer of design too abrupt, a "handoff" mentality	~	Moderate	Minor
· Deliverable doesn't include design history or intent	~	Moderate	Minor
· Poor transfer due to consultant negligence	~	Minor	Moderate
Reintegration of Design			
· Client personnel resist design; Not-Invented-Here	[5]	Moderate	Moderate
· Client organizational inertia resists reintegration of design	~	Moderate	Moderate
Refinement of Design			
· Client fails to perform necessary follow-on work	[7]	Moderate	Moderate
· Client makes changes that compromise the design	~	Moderate	~
Follow-up with Design Provider			
· Client fails to involve the consultant after the design transfer	~	Moderate	Minor
Production Supplier			
· Consultant not put in contact with supplier early in project	~	Moderate	Moderate

* Legend: [1] Amaral and Parker 2008, [2] Bruce and Morris 1994, [3] Goering 2006, [4] Mokhoff and Wallace 2005, [5] Rassam 1995, [6] Rayner 2005, [7] Roy and Potter 1990, [8] Roy and Potter 1993

5.1. Factors related to the Client Firm

Capabilities. Our respondents noted three client capabilities that improve the likelihood of project success: capability in *managing* traditional new product development; experience with *outsourced* product development; and *technical* expertise sufficient to specify requirements, monitor development, and refine the delivered design. Firms lacking these capabilities include start-ups and holding companies, as well as established process- and service-driven companies with little experience in *product* development.

Corporate culture. While new entrants often lack experience, established firms may suffer from several cultural factors. Client respondents in particular noted that highly structured companies tend to overly prescribe or schedule creative innovation:

> *"Everyone's gone to a Six Sigma mindset, where you try to make sure that eight of ten projects actually go to market. That's a good approach for line extensions, but if you really want explosive innovation it's not going to get you there."* – former Client Project Manager

Consultants stressed that innovation is an iterative, free-flowing activity, and that success is favored by a client culture that is flexible, open-minded, and trusting:

> *"The clients that are the most rigid actually need our help the most, but they may not be receptive to the way that we work."* – Consultant Project Manager

Both consultants and clients noted that large bureaucratic client firms often are not nimble enough to keep up with the smaller consultancy. In particular, some firms tend to involve too many people in decision making.

Project team. Although development is outsourced, the composition of the client-side project team remains critical. All key stakeholders must be included or at least consulted.

"It's having the right people in the meetings. When there's supposed to be someone who's providing technical depth on their side, they have technical depth. They're familiar with the company, it's not just some new person. I think a clear sign that failure is going to happen is when it's just the marketing posse, or some subset of their organization that itself doesn't have the power to make it happen." – former Consultant Project Manager

To mitigate this, the client's team should include a "diplomat" who is deeply familiar with, and ideally powerful within, the organization and its politics. Strong client team leadership is also critical. Problems often occur when the consultant's key contact is not the true decision maker.

"Too many clients have project managers, not project leaders. I say it that way for a reason. If you're going to be successful you have to drive the project with a leader. In larger companies project managers are basically schedule facilitators and documentation providers to management. Status updates, budget updates, meeting minutes. They're not the one who is going to drive actual decisions. When there's a disagreement between disciplines, they're not in a position of authority to manage that conflict and negotiate a consensus decision." – Consultant Engineering Director

A "heavyweight project manager" (Wheelwright and Clark 1992) is often effective.

5.2. Factors related to the Specification of Requirements

Internal divisions. Prior studies noted internal divisions within the client over project objectives, but our results suggest that divisions run much deeper. In many firms, functional specialists don't even communicate with each other, let alone achieve consensus on project objectives:

"It doesn't even seem to be necessarily endemic to larger companies. We've worked with some very small start-ups, there may only be a handful of people. Those people don't communicate. How hard is it? You're right there! There's only three of you! But you'll get

different answers from different people, whoever answers the phone is going to give you a different answer." – Consultant Design Director

"The only time the whole [client] team gets together is when we [the consultancy] hold a design review. We joke that we should sell our services as 'design mediators' or management consultants." – Consultant Engineering Director

"Blue sky" projects. Firms often engage a consultant when they seek a dramatically original, "outside the box" solution, but our interviews suggest that these projects often disappoint. The client firm may overestimate the likelihood of success. The relative absence of constraints makes it more difficult for the consultant to manage the client's expectations. Even if the consultant develops a radically innovative solution, the client firm may be unable or unwilling to reorganize sufficiently to implement it (Henderson and Clark 1990).

High technical risk projects. Whereas "blue sky" projects have too few constraints, high technical risk projects have too many. In extreme cases, the client's vision may defy the laws of physics. In others, the vision may be achievable, but only with the application of significant time and resources. Given that consultants are usually costlier than in-house resources on an hourly basis, extensive development projects often leave clients unsatisfied. The resulting design, even if technically successful, may not justify the expense. A third type of technical risk involves "needle in a haystack" projects, in which the solution lies with locating just the right material or production vendor to meet the requirements. The "right material" may not actually exist, but the client may feel that the consultant simply did not look hard enough.

5.3. Factors related to the Negotiation

Excessive cost focus. While the literature emphasizes the importance of "shopping around" for a consultant (Roy and Potter 1990, Bruce and Morris 1994, Rassam 1995), both consultants and

clients agreed that client firms compromise development quality by being too aggressive during price negotiation. Some treat design services as a commodity, considering only the price of the contract to the exclusion of factors such as consultant capability or prior history with the firm.

> *"Clients shop for design services like they're shopping at Wal-Mart."* – Consultant Senior Engineer

> *"Whoever signed the proposal may not have even read it. They skip to the last page where it shows the cost. Proposals average three to eight pages, depending on the program. That's their chance to see that we understand what they've asked us to do. We don't ever get a lot of back and forth on the language of the proposal, it's just numbers. 'You need to take $5,000 off this program.'"* – Consultant Engineering Director

In extreme cases, we heard of clients using reverse auctions to solicit bids for contracts. Others use strong-arm purchasing tactics to drive down costs.

> *"The issue I would run into was getting what I thought was a realistic estimate [from the consultant] and then automatically being told [by client management] to go back and tell them they had to cut 20% off the cost."* – former Client Project Manager

The trouble with this approach is that the consulting industry is competitive to begin with. Consultants rarely pad quotes because jobs are bid out to multiple competitors. When the prospective client demands price cut, the consultant removes design, prototyping, and/or testing iterations, increasing project risk. Given that many client firms operate in a low-bid manner, it seems hardly surprising that the literature reports high design outsourcing failure rates.

Aggressive project schedule. As with insufficient budget, respondents reported that projects often fail because their firms attempt to complete them on far too aggressive a schedule.

Misunderstandings about project objectives. While the literature highlights misaligned objectives between client and design provider, we find that simple misunderstandings are equally problematic. The parties must invest significant effort during the negotiation, briefing, and early development phases to ensure that the client's vision has been adequately specified and transferred. The better consultancies formalize this into their processes, using "alignment" phases, "boundary box exercises," and the like.

Mutual under-appreciation of project risk. Given the inherent uncertainties in innovation and product development, it can be difficult to price the project appropriately. Some consultants bid uncertain projects on a time-and-materials basis, or on a per-phase basis, with the upfront understanding that later phases will have to be re-bid after initial development. Transaction cost economists would caution the client against the risk of hold-up in such cases, but we find this to be rare in consumer, industrial, and medical product design consulting due to the relatively low asset specificity and the great number of alternative suppliers.

Consultant oversells. Former consultants observed that their firms sometimes overstated the likelihood of innovation success, particularly on "blue sky" projects.

> *"Certain firms hire a lot of really good salespeople, not just the people who are drumming up new business, but well-spoken practice leaders who can go in and sell you anything. There's a lot of those at [consultancy withheld], and I think that's why it can command top dollar."* – former Consultant Engineering Director

Currently-employed consultants accused their competitors of overselling their capabilities:

> *"I think a lot of companies have been burned expecting more out of their consultants than their consultants were expecting to provide."* – Consultant Vice President of Design

5.4. Factors related to the Distance between the Client Firm and the Consultant

Geographic distance. Clients in particular stated that geographic distance between parties compromises coordination. Some choose to only use local consultants.

> *"Even though we work in a fairly 24-hour world, the fact that you can just drop in rather than emailing and making PowerPoints, I think you get to a solution faster with the local guys, or within a day's travel."* – Client Senior Engineer

Cultural distance. Significant differences in corporate culture make it difficult for clients and consultants to relate to one another, impairing trust and communication:

> *"We're a fairly conservative company, and one of the consultants had a Mohawk, and they were lying on the floor during the meeting to 'get a different perspective.' It was a little goofy, and of course people were looking at that and wondering 'what are we spending our money on?' I'd say cultural differences are probably frequent, and some of them aren't significant, but some of them are."* – former Client Project Manager

5.5. Factors related to the Briefing

Use of "blinders" to foster creativity. The literature attributes poor briefing to client ignorance or carelessness. Our respondents confirm this, but identify an additional problem: clients will sometimes deliberately withhold information so as not to constrain the consultant's creativity. Our research suggests that this practice creates more problems than it solves.

> *"A lot of clients will come in, 'we're hiring you guys because you're an innovation firm, we're hiring you for fresh thinking, so we don't want to tell you anything, just dream' and we say 'no, that will be a disaster unless you're really looking for all the possibilities.' Our philosophy is that if we do that, we're going to come up with some wow-bang idea that doesn't move your business."* – Consultant Chief Operating Officer

To be sure, excessive constraints can suppress creativity, but this effect is less due to the *awareness* of the constraint as it is to *organizational pressure to adhere* to the constraint:

> *"Even people who are prone to being creative can find themselves limited [by peer pressure]. So we don't even push the boundaries anymore. Because the last twenty times we were slapped down for pushing it."* – Client Senior Industrial Designer

Consultant personnel are less stifled by the client's history and political pressures; they are more likely to challenge constraints than let them limit their creativity. However, if the consultant is unaware of rigid constraints, he will likely propose something that the client considers "impractical" (Roy and Potter 1990). A good balance is to provide the constraints, but encourage the consultant to propose both conservative and free-thinking solutions.

5.6. Factors related to Discontinuities in Development Team Membership

Client-side discontinuities. Both empirical and theoretical literature stress the risk of discontinuities on the consultant side, but our research suggests that discontinuities on the client side are more frequent and more problematic.

> *"You may start off talking to the president of the company, and once you shake hands and they sign the check, you never see that person again, and now you're dealing with a project manager or director of engineering, somebody who's down in the trenches and has a very different idea of what this project should be."* – Consultant Design Director

> *"Client turnover is a huge problem for us. Marketing teams churn so frequently, you can go through three marketing directors in one project. The vision for the project came from the first one, then the next guy comes in and he's got a completely different vision, and then the third guy's not even sure the project should be done."* – Consultant Engineering Director

5.7. Factors related to Feedback

Client involvement. Infrequent communication and poor expectations management are significant problems, but true success requires more than frequent status reports and design reviews:

> *"We're really looking for* collaboration *with the client. It's great to have the clients that really get in there and want to be a part of what's going on, versus the ones that don't give you much feedback, and you don't know until ten years later that they liked working with us or they didn't."* – Consultant Engineering Director

Unfortunately, several factors work against extensive client involvement. For example,

> *"Customers can get lazy. Management thinks 'I'm spending all this money to have this taken care of,' so they start to expect that it's taken care of, and don't put a lot of resources, a lot of thoughts to it. What management doesn't see is the amount of effort I have to put in. For it to work well, I still have to spend a lot of time on it."* – Client Project Manager

To address this, some consultancies contractually stipulate the level at which key client personnel must be dedicated to the project. A more troubling finding is that some consultants do not enjoy the collaboration that they espouse publicly:

> *"A lot of people at [consultancy withheld] talk about collaboration, but don't actually like collaborating with the client. They don't like the intensity of that much time with them, they don't like having to travel, they like the lifestyle of 'you give us the brief, we do our magic, and then we hand it off to you.'"* – former Consultant Project Manager

Clients should emphasize their desire to be involved, and select consultants who will do so. Other things being equal, use of a local consultancy makes client involvement much easier.

Decisions not documented. Even if feedback is sufficient, problems occur if it is not documented:

"Scope changes are inevitable. But when they get the bill, they tend to forget about those instances of re-directing, and that sets up conflict." – Consultant Project Manager

Some consultants use formal documentation programs, particularly for medical projects, but:

"No one wants to pay for that! And it's really boring. And you turn into an [aerospace company], where everything has an ECO, and everything takes longer, and everything's expensive." – Consultant Project Manager

If nothing else, major development decisions should be documented in email or meeting minutes.

5.8. Factors related to the Transfer of the Design

Prior research has stressed the importance of the briefing in transferring knowledge from client to consultant at the start of the project, but has largely neglected several factors related to knowledge transfer at the end of the project, from consultant to client. The consultant may develop an excellent design, but if it is transferred poorly the client may not fully understand it, causing them to question its value or experience difficulty in refining it. Two issues are common:

Transfer too abrupt. Ideally, the transfer of knowledge and responsibility is gradual, but budget and time pressures may reduce it to a design review and handoff of CAD files:

"I always feel that it's very abrupt. It's like 'here's the packet of stuff, here are the files' and then the door is closed. It's not as collaborative as I would like it to be." – Client Senior Industrial Designer

"When it gets to this phase, you're typically out of budget. There's never a 'knowledge transfer' phase in the budget, but there should be." – Consultant Engineering Director

Some consultancies do include "deployment" phases in the budget, but these are among the first things cut if the client demands a sharpening of the quote.

Deliverables do not include design history or intent. The problem with abrupt, "throw it over the wall" handoffs is that typical design transfer media such as engineering drawings, CAD models, and prototypes are inadequate to fully capture the consultant's developed knowledge. They readily convey product form, but are less able to describe function, let alone design intent:

> *"I have no clue what their design thoughts were when they came up with it. It had five gears. Why five? Why not six? Why not a belt? Did they analyze the fatigue stress? I have no idea!"* – Client Project Manager

Some consultancies make a point to deliver more comprehensive information, including meeting minutes, bills-of-materials, email correspondence, etc. Others stressed the impossibility of transferring so much data, or questioned whether the client would even want it:

> *"How do you teach all that? Until you've walked a mile in my shoes? It's not like I would sit down and write a document saying 'this is all the stuff we thought about.' I don't know that there's an intent to teach them everything we've learned. They didn't hire us for that. They hired us for a thing, the design."* – Consultant Engineering Director

The difficulty of transferring design history ex-post reiterates the importance of client involvement during the development:

> *"Constant engagement, ask their opinion, get their input, get them to help make decisions, those are all key. Communicate the theory, not just the solution. When you develop a concept, what are the benefits, what are the risks? Detailing those, articulating those, constantly reminding your client why this makes sense, why it's a robust solution and why that robustness or innovation are worth some of the potential trade-offs or risks that you're taking to achieve it. And how decisions that they might make [later] will impact that."* – Consultant Engineering Director

5.9. Factors related to Reintegration

Organizational inertia. Even if the consultant develops a suitable design and transfers it well, it may be rejected by the client firm because of resistance by the personnel or by the *structure* of the organization itself. Rejection is likely if the design is transferred to the wrong part of the organization, or requires refinement by a group other than the one sponsoring the project, or novel coordination between parts of the organization, or the creation of a new group altogether:

> *"It has so much to do with who your audience is. We did some fairly innovative development work, and had a great result, because we delivered it to the 'Advanced Concepts Group,' whose sole purpose was to go out and discover new technologies. If we had given that same presentation to the engineering group, who were the CAD guys and the quality people, it would have been dead on arrival. There wouldn't have been any interest."* – former Consultant Engineering Director

> *"The reason one project didn't get implemented was that the organizational power for new product development resided in R&D. We were working with an innovation group that was based in Marketing. We proved that it was a new, novel idea for their category, but no one within R&D was willing to back it up, so the project failed."* – Consultant Project Manager

> *"The consultancy will come up with a service design or user experience concept and they'll have a beautiful scenario drawn out with all the various touch points laid out, but the reality is that it the current user experience is such a mess because of how the company has sliced and diced itself. And unless that company – and I've never seen it happen – reorganizes itself around the experience of the customer, it's not going to work because their silos aren't structured properly."* – former Consultant Project Manager

Such organizational issues can be the most difficult to solve. As a start, clients should do a better job of mapping their organization and its constraints at the beginning of the project, so that the consultant has an idea of what is possible and what is not.

5.10. Factors related to Refinement

Client compromises the design. Consultants lamented that clients sometimes hurt the marketplace success of products by making changes that compromise the design intent:

> *"I think clients have gotten a lot better at executing to cost than they have to holistic design intent. And it's not just the aesthetics [that get compromised], it's the brand, it's usability and ergonomics, it's line logic. And there are lots of reasons why it doesn't happen. The engineers on the client team don't recognize that it's the right thing to do, they haven't been exposed to it, they don't value it. It makes lives more difficult. They don't have a budget for it. Their management staff doesn't promote it. You can do the best job in the world transferring the design intent, but if you don't have management buy-in, and technical team buy-in, your chance of success goes down."* – Consultant Engineering Director

In addition to impacting market success, these changes are wasteful in that they discard consultant effort that the client had already paid for. Minimizing this waste requires consistency on the client's side. If it truly values only certain aspects of the design, this should be communicated during negotiation so that the consultant can reduce the cost of the contract. Alternately, if the client does value the design intent, it must incentivize its own downstream employees to preserve it.

5.11 Factors related to Follow-Up

Client fails to involve consultant. Consultants stressed that many of the problems discussed above can be mitigated by continuing to involve them, even at a low level, during downstream development, but some clients view projects as transactional rather than relational.

> *"Some clients deal with you like a deli-counter. They place their order and take it to go. They don't really see you as a partner in it, it's none of your business. So you hand it off and you have no clue what happens later."* – Consultant Project Manager
>
> *"The expectation is that it's a one night stand. You don't expect a phone call in the morning."* – Client Senior Engineer

5.12 Factors related to the Production Supplier

Consultant not put in contact with supplier. To keep designs practical and speed downstream development, the client should put the design consultant in touch with the intended production supplier (or internal production resource) as early in the process as possible. Clients sometimes defer identification of a production supplier, intending to "shop the design around" to several contract manufacturers after development, but this prevents the designer from optimizing the design for the supplier's capabilities. A related problem occurs when the client encourages the consultant to identify suppliers on its own, but does not provide its approved vendors list. Development is performed with the assistance of a supplier who may not ultimately be involved in production.

6. Types of Client Dependency and Hazards Affiliated with Each

The complete list of factors influencing project outcomes is quite extensive, but it can be simplified by classifying several types of outsourcing engagements and focusing attention on the

particular hazards associated with each. Client motivations for outsourcing are varied. Some seek to reduce costs, improve responsiveness to variation in capacity requirements, share risk, or gain access to local markets (Rothstein 1998, Smith and Reinertsen 1998, Grant 2000, Wallace 2005, Eppinger and Chitkara 2006). Others need specialized expertise or knowledge brokering across industries and markets (Walsh 1996, Hargadon 2002, Utterback et al. 2006). Using the terminology of Fine and Whitney (1996), these can be condensed to dependency of the client for *capacity* and dependency for *knowledge*, respectively.

We propose that design consulting may also be motivated by a deliberate desire to disconnect the design from the client's organizational and product legacies to encourage innovation. Prior research suggests that a firm's organization evolves to match the architecture of its primary products (Henderson and Clark 1990). Communication channels, information filters, and strategies develop that help the organization handle complexity but may prevent it from conceiving or even recognizing new product architectures (ibid.). Similarly, a firm's values and cost structure (Christensen 1997), core capabilities (Leonard-Barton 1992), and design process bureaucracy (Whitney 1988, Wheelwright and Clark 1992) may all inhibit innovation. In light of these tendencies, a client may choose to hire a design consultant even when it nominally has the capacity and knowledge necessary to do the work itself. It is dependent for *originality* or new ideas. Other situations in which a client firm possessing knowledge and capacity might hire a consultant include need for an independent second opinion or *audit*, or dependency for the *prestige* of the designer. Figure 2 classifies the dependency types according to how routine the work is and the degree to which it requires an objective, outside view. The dimensions are meant to be continuous rather than binary, and combinations of dependencies are possible.

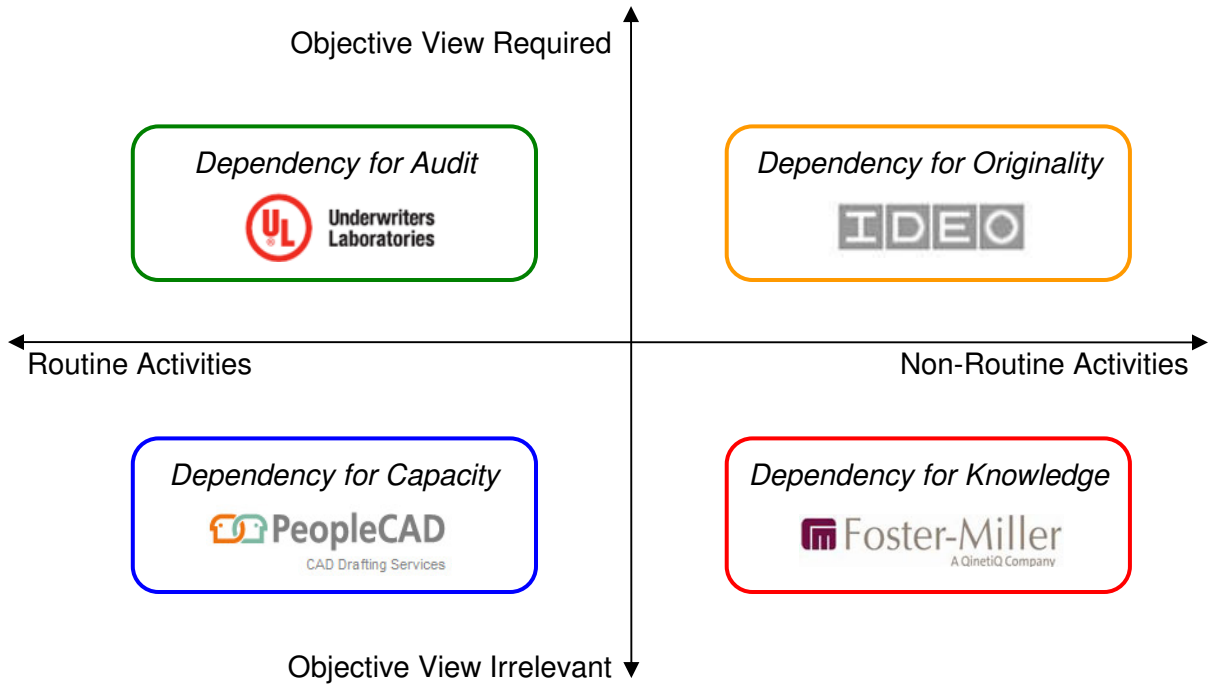

Figure 2 Types of client dependency, and examples of consultancies specializing in each

We have found that each type of dependency creates certain risks (Table 2). A client dependent merely for additional capacity is competent but is likely to be short on time, which can compromise involvement of all stakeholders, as well as the quality of the specification, briefing, feedback, design transfer, and refinement. Because the firm has internal development capabilities, it may be unfamiliar with hiring design services, may take its own knowledge for granted during briefing, and may resist reintegration of a design that does not adhere to its standard design procedures. If its outsourcing motivation is to save money, it may shortchange the project budget, or partner with an incompetent low-bid consultant.

A client dependent for technical knowledge may have difficulty specifying requirements, choosing a suitable consultant, briefing and guiding development, and refining the design (Fine and Whitney 1996). Misunderstandings during negotiations are likely due to the knowledge gap between parties. The consultant may overstate its expertise, either because the client cannot

Table 2: Particular Hazards Associated with each Type of Client Dependency

Client Dependent for Capacity	
Client Firm	▪ Lacks experience with, is not a knowledgeable *buyer* of, design services ▪ Project team does not include or consult all stakeholders
Negotiation	▪ Client is overly focused on project cost and schedule, neglecting quality ▪ Misunderstandings about project objectives
Consultant	▪ Lacks technical capabilities and/or domain experience
Briefing	▪ Poor briefing, due to difficulty of encapsulating client's tacit knowledge, inherent uncertainty of innovation ▪ Poor briefing, due to client ignorance or carelessness
Development	▪ Design impractical to manufacture
Feedback	▪ Client does not communicate frequently enough, police the brief, and/or provide prompt replies to questions ▪ Client inadequately involved due to lack of time
Transfer of Design	▪ Transfer of design too abrupt, a "handoff" mentality ▪ Deliverable doesn't include design history or intent
Reintegration of Design	▪ Client personnel resist design; Not-Invented-Here
Refinement of Design	▪ Client fails to perform necessary follow-on work ▪ Client makes changes that compromise the design

Client Dependent for Knowledge	
Client Firm	▪ Lacks capability, experience, and/or processes for *managing* new product development ▪ Lacks experience with, is not a knowledgeable *buyer* of, design services ▪ Lacks technical capabilities and/or domain experience
Specification of Requirements	▪ Project lacks definition; client cannot specify what it wants ▪ Project has high technical risk; client expectations unrealistic
Negotiation	▪ Misunderstandings about project objectives ▪ Mutual under-appreciation of risk; difficult to price project ▪ Consultant oversells their capabilities or the likelihood of project success
Consultant	▪ Lacks technical capabilities and/or domain experience
Distance between Client Firm and Consultant	▪ Geographic distance
Briefing	▪ Poor briefing, due to client ignorance or carelessness
Feedback	▪ Consultant does not communicate frequently enough and/or manage client's expectations
Transfer of Design	▪ Transfer of design too abrupt, a "handoff" mentality
Refinement of Design	▪ Client fails to perform necessary follow-on work
Follow-up with Design Provider	▪ Client fails to involve the consultant after the design transfer

Table 2: Particular Hazards Associated with each Type of Client Dependency (Continued)

Client Dependent for Originality	
Client Firm	▪ Lacks experience with, is not a knowledgeable *buyer* of, design services ▪ Corporate culture is to over-specify, over-schedule innovation; significant risk-aversion ▪ Project team does not include or consult all stakeholders ▪ Project team lacks leadership, authority, and/or influence within client organization
Specification of Requirements	▪ Project lacks definition; client cannot specify what it wants ▪ Divisions within the client firm over project objectives ▪ Project is about "blue sky" innovation
Negotiation	▪ Misunderstandings about project objectives ▪ Consultant oversells their capabilities or the likelihood of project success
Briefing	▪ Poor briefing, due to client deliberately withholding information to stimulate creativity
Development	▪ Design impractical to manufacture
Feedback	▪ Client does not communicate frequently enough, police the brief, and/or provide prompt replies to questions ▪ Consultant does not communicate frequently enough and/or manage client's expectations
Reintegration of Design	▪ Client organizational inertia resists reintegration of design
Refinement of Design	▪ Client makes changes that compromise the design
Production Supplier	▪ Consultant not put in contact with supplier early in project

* Depenency for audit and prestige are omitted for the sake of space and because they are less common and less risky than dependency for capacity, knowledge, or originality

articulate exactly what it needs, or because an unscrupulous consultant takes advantage of the client's limited knowledge. The client firm may be unfamiliar with the product development process, requiring additional guidance from the consultant before and after the transfer of the design. Excessive geographic distance hinders the consultant from doing so.

A client who is independent for knowledge and capacity but dependent for originality likely suffers from internal strife or organizational inertia. The project may originate from one part of the organization but lack universal support. The vision may be vague, and the client may overestimate the likelihood of radical innovation, or the consultant may overstate it. The client may withhold important constraints during the briefing or fail to re-direct the consultant from

wrong paths during development. The consultant may fail to exploit the client's expertise or manage its expectations, perhaps yielding a design the client considers impractical. Finally, the client's organizational inertia may limit its ability to re-integrate and implement the design after the project.

By identifying the client's motivation for outsourcing at the start of the project, both client and consultant can monitor to the particular risks associated with that type of dependency, simplifying project management and improving the chance of a successful project outcome.

7. Conclusions

Drawing from the wisdom of experienced design professionals, we have developed a process model of outsourced product development and used it to organize the many factors influencing project success and failure. Our findings suggest that several factors dominate over all others. To maximize success, a client firm should: 1) invest the time to carefully *specify* project requirements and objectives, 2) negotiate with the consultant as a *partner* rather than a vendor, 3) provide the consultant with *all* of the design constraints (including organizational inertia and politics), 4) *actively participate* in the development process, and 5) commit to shepherding the innovation back into their organization. Consultants must foster these activities, and in particular strive to *enfranchise* client personnel throughout the development process.

The validity of our findings is supported by the use of multiple data collection techniques and a diversity of respondents, as well as the general agreement between our findings and prior research. In particular, we confirm prior findings that internal divisions within the client firm, poor specification and briefing of requirements, and insufficient communication between parties are all significant risk factors. Discrepancies between our findings and those of prior studies are directly attributable to the significant differences in the study populations. We found more

evidence of reintegration problems than did Roy and Potter (1990), but they were expressly studying small and medium-sized client firms for whom organizational inertia would be low. Conversely, we found less evidence of gross consultant incompetence, perhaps because the design consulting industry has matured in the last 20 years. We did not replicate Amaral and Parker's (2008) findings of version control problems and vendor rivalries, and suspect that these may be particular to outsourced *platform* product development by original design manufacturers.

Our work extends the literature by organizing previously disparate findings into a comprehensive model and by simultaneously considering both client and consultant perspectives, enabling us to identify additional risk factors (e.g., client inexperience, excessive cost focus) and offer alternative explanations for previously observed facts. For example, consultants are often accused of creating "impractical" designs. The traditional, client-centric perspective attributes this to poor work by the consultant, or perhaps an inadequate briefing by the client. From the joint perspective, however, an "impractical design" is also a symptom of an inflexible client. That is, the underlying problem may be the client organization's inability to adapt to what the market demands. Similar alternative explanations can be developed by inverting the traditional wisdom for other phenomena. A poor briefing may be caused by the client's negligence, but it could also be caused by the consultant's failure to explain what it needs to know.

The nuance offered by the joint perspective and the detail provided through in-depth interviewing are the study's greatest strengths. Its chief limitations are the risks of recollection error or deliberate deception by the respondents. We guarded against the former by having respondents describe current as well as past projects, and the latter by including both current and former employees. Those no longer buying or selling consulting services should have less vested interest in promoting or criticizing the consulting model. A secondary limitation is that our study

population consists primarily of domestic consultants and clients. International outsourcing may offer additional challenges, but it certainly does not diminish those identified herein.

The project risk factors identified in this study suggest several broader themes. First, client firms often turn to outsourcing to address their internal limitations – of capacity, expertise, or organizational agility – but these very limitations are what compromise outsourcing outcomes. The client firm that is short on resources will be unable to effectively manage the consultant's progress, the firm short on expertise will be unlikely to refine the consultant's design, and the firm seeking to escape its own inertia will be re-confronted with it when it attempts to reintegrate the product. Outsourced product development is a tool, not a panacea. Second, the difficulties that firms have in pre-specifying requirements, and the need they exhibit for constant collaboration, call attention to the limitations of traditional systems engineering approaches to multi-party development. If firms struggle to specify requirements on relatively simple consumer and medical products, one can imagine the challenge of doing so for an airliner. Even proponents of modularity concede that design rules can only be formulated a priori for relatively mature product categories (Baldwin and Clark 2000). The traditional solution for new-to-the-world products has been physical co-location and concurrent engineering, but these are not always feasible. Thus, need exists for new approaches for performing dynamic product development in a distributed manner.

A start is to recognize that outsourced design is incompatible with old-fashioned "purchasing" approaches. Many of the risk factors we have discussed stem from arms-length, transaction-based engagements and the commoditization of design. Our findings suggest that innovative design cannot be pre-specified, cannot be modularized, cannot be "handed off." Rather, consultant and client must maintain a constant dialog throughout the project. Perhaps the

key to improving outcomes in outsourced product development is not to think of them as *outsourced*, but as *collaborative*. Our findings suggest that collaborative projects succeed where outsourced design projects fail.

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References

Allen, T. J. 1977. *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R&D Organization*. MIT Press, Cambridge, MA.

Amaral, J., G. Parker. 2008. Prevent disasters in design outsourcing. *Harvard Business Review* **86**(9) 30-31.

Anderson, E. G., Jr, A. Davis-Blake, S. S. Erzurumlu, N. R. Joglekar, G. G. Parker. 2007. The effects of outsourcing, offshoring, and distributed product development organization on coordinating the N.P.D. process. C. Loch, S. Kavadias, eds. *Handbook of New Product Development Management*. Butterworth-Heinemann, Amsterdam.

Anderson, E. G., Jr, A. Davis-Blake, G. G. Parker. 2008. Managing outsourced product design: The effectiveness of alternative integration mechanisms. Working paper, McCombs School of Business, Austin, TX.

Baldwin, C. Y., K. B. Clark. 2000. *Design Rules: The Power of Modularity*. MIT Press, Cambridge, MA.

Brown, T. 2008. Design Thinking. *Harvard Business Review* **86**(6) 84-92.

Brown, T. 2009. *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. HarperCollins, New York.

Bruce, M., B. Morris. 1994. Managing external design professionals in the product development process. *Technovation* **14**(9) 585-599.

Carlile, P. R. 2002. A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization Science* **13**(4) 442-455.

Christensen, C. M. 1997. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business School Press, Boston.

Clark, K. B., T. Fujimoto. 1991. *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Harvard Business School Press, Boston.

Corbin, J. M., A. L. Strauss. 2007. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 3rd ed. Sage, Thousand Oaks, CA.

Core77 Inc. 2010. Core77/BusinessWeek design firm directory. http://www.designdirectory.com/.

Design Continuum, Inc. 2010. Revolutionizing an industry. http://www.dcontinuum.com/content/portfolio/30/264/.

Eppinger, S. D., A. R. Chitkara. 2006. The new practice of global product development. *Sloan Management Review* **47**(4) 22-30.

Esslinger, H. 2009. *A Fine Line: How Design Strategies Are Shaping the Future of Business*. Jossey-Bass, San Francisco.

Fine, C. H., D. E. Whitney. 1996. Is the make-buy decision process a core competence? Working paper, MIT Center for Technology, Policy, and Industrial Development, Cambridge, MA.

Goering, R. 2006. Design outsourcing: Navigating a maze of decisions. *EE Times* (January 9) 1.

Grant, P. L. 2000. Outsourced knowledge: Knowledge transfer and strategic implications from design outsourcing. Unpublished M.S. thesis, Massachusetts Institute of Technology, Cambridge.

Handfield, R. B., G. L. Ragatz, K. J. Peterson. 1999. Involving suppliers in new product development. *California Management Review* **42**(1) 59-81.

Hannan, M. T., J. Freeman. 1984. Structural inertia and organizational change. *American Sociological Review* **49**(2) 149-164.

Hargadon, A. B. 2002. Brokering knowledge: Linking learning and innovation. *Research in Organizational Behavior* **24** 41-85.

Henderson, R. M., K. B. Clark. 1990. Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly* **35** 9-30.

Joglekar, N. R., S. R. Rosenthal. 2003. Coordination of design supply chains for bundling physical and software products. *The Journal of Product Innovation Management* **20**(5) 374-390.

Leonard-Barton, D. 1992. Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal* **13** 111-125.

McCracken, G. 1988. *The Long Interview*. SAGE Publications, Newbury Park, CA.

Mokhoff, N., R. Wallace. 2005. Outsourcing trend proves complex by design. *Electronic Engineering Times* (January 31) 10.

Novak, S., S. D. Eppinger. 2001. Sourcing by design: Product complexity and the supply chain. *Management Science* **47**(1) 189-204.

Parker, G. G., E. G. Anderson, Jr. 2002. From buyer to integrator: The transformation of the supply-chain manager in the vertically disintegrating firm. *Production and Operations Management* **11**(1) 75-91.

Pisano, G. P. 1990. The R&D boundaries of the firm: An empirical analysis. *Administrative Science Quarterly* **35**(1) 153-176.

Quinn, J. 2009. Boeing's Dreamliner takes flight at last. *The Daily Telegraph* (December 21) 3.

Rassam, C. 1995. *Design and Corporate Success*. Design Council/Gower, Aldershot, England.

Rayner, B. 2005. Design outsourcing: Beware of pitfalls. *Electronic Engineering Times* (January 31) 20.

Rothstein, A. J. 1998. Outsourcing: an accelerating global trend in engineering. *Engineering Management Journal* **10**(1) 7-14.

Roy, R., S. Potter. 1990. Managing design projects in small and medium-sized firms. *Technology Analysis & Strategic Management* **2**(3) 321-336.

Roy, R., S. Potter. 1993. The commercial impacts of investment in design. *Design Studies* **14**(2) 171-193.

Sanchez, R., J. T. Mahoney. 1996. Modularity, flexibility, and knowledge management in product and organization design. *Strategic Management Journal* **17** 63-76.

Smith, P. G., D. G. Reinertsen. 1998. *Developing Products in Half the Time: New Rules, New Tools*. Van Nostrand Reinhold, New York.

Trost, J. E. 1986. Statistically nonrepresentative stratified sampling: a sampling technique for qualitative studies. *Qualitative Sociology* **9**(1) 54-57.

Ulrich, K. T., S. D. Eppinger. 2004. *Product Design and Development*, 3rd ed. McGraw-Hill/Irwin, Boston.

Utterback, J. M., B.-A. Vedin, E. Alvarez, S. Ekman, S. W. Sanderson, B. Tether, R. Verganti. 2006. *Design-Inspired Innovation*. World Scientific Publishing Co., Singapore.

Wallace, R. 2005. India, China exert inexorable pull. *Electronic Engineering Times* (January 31) 16.

Walsh, V. 1996. Design, innovation and the boundaries of the firm. *Research Policy* **25**(4) 509-529.

Wasti, S. N., J. K. Liker. 1999. Collaborating with suppliers in product development: A U.S. and Japan comparative study. *IEEE Transactions on Engineering Management* **46**(4) 444-461.

Wheelwright, S. C., K. B. Clark. 1992. *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency, and Quality*. Free Press, New York.

Whitney, D. E. 1988. Manufacturing by design. *Harvard Business Review* **66**(4) 83-91.