Obstacles to Innovation:

Organizational Limits to Sequential Action from an Agency Perspective

Craig Randall
Bentley University, Waltham, MA
randall_crai@bentley.edu

Abstract

Why are development (R&D) projects late so often, yet management is repeatedly caught surprised? Academic literature confirms that the ability of firms to consistently innovate is vital for success in dynamic markets. Yet R&D projects and innovation – which is planned, organized, and executed in project form – have high rates of failure and delay. This study examines the phenomena of project delays and failure in the context of smaller/newer technology firm innovation (where innovation is particularly important to success).

R&D performance has traditionally been studied using the Resource Based View in that capabilities are rare, valuable, hard to imitate or substitute. Under this view specific knowledge of the technologies being developed would be rare and valuable. But what of the ability to perform R&D in general? Since it occurs in virtually every product-based firm, RBV and Population Ecology theories would suggest that failure and delay rates should improve over time.

Agency theory argues that goal differences between principals and managers have a high influence on operational outcomes. While it would appear pertinent to project research (in R&D and innovation contexts), the theory has seldomly been applied below the CEO level, and never to R&D. This paper uses agency theory to develop and test hypotheses about project performance and management/agent intent as the agency relationship transcends through vertical corporate layers; from owner down to developer. Agency relationships are used to predict and explain recurring and disappointing project outcomes.

This field study of multiple software development firms shows predictable agency relationships at multiple layers in the hierarchy; from the individual development engineer to CEO and owner. Furthermore, the regular agency impacts that occur at each phase of project and task accomplishment can explain their recurring failure, lateness, and feature deficit outcomes.

Introduction

A common pattern within companies that pursue technology innovation is often reported: unexpected missed project release dates. The largest and most well recognized software companies such as Microsoft, Oracle, or Apple regularly have missed release dates reported and scrutinized in the national news. The stories are often reported with new release dates provided– dates that are repeatedly missed a second or even a third time.

Yet, the public sees only a small fraction of the total "delay" activity that occurs in technology operations. Only significant new products - those anticipated by a very large number of consumers - warrant media coverage. Most project release-date slippage goes unnoticed (by all but the waiting customers), especially since most R&D projects are not new products at all but are feature upgrades, modules or fixes. More importantly, however, is that this phenomenon of unanticipated project delay is well known to software firms of every size and is common for projects of every scope and size, no matter how small (Flowers 1996, Fortune & Peters 1995).

This paper investigates this seemingly nonsensical pattern: how can project delays in any firm be so systemic, yet still be a consistent surprise to the participants. It would appear counterintuitive that an activity so critical to a technology organization –innovation – would have significant surprises (project release date slippage) at such high rates, yet management is caught off guard. Furthermore, if the problem was mostly procedural (a resource-based problem of acquiring proper skills, training, or applying best practices), then we would expect that the paltry success rates (e.g. 29% Standish 2001) for projects should improve with time.

We propose to apply Agency Theory to analyze (for new product development [NPD], innovation, and technology projects,) how results differ from management expectations and desires. If managers are regularly surprised by the same poor outcome, what larger organizational issues might be at play outside the project process? The research questions are broad: for innovation dependant firms, where each project is a major investment and potentially critical to the continued operations of the firm,

- Why would significant date slips be a normal or systemic occurrence?
- What role does senior management and the principal/agent dynamic play?
- What role does information flow and information quality play?

Discussion and Hypothesis

Research on product development processes and new product development (NPD) has largely focused been bounded by three parameters. The first is that the environment of study has been concentrated on large isolated projects in big companies; researchers have typically looked for significant projects (most often new products) and mostly at Fortune 500 size firms. The second is that past studies have focused on a search to find and expose successful (and poor) process or project skills that could correlate to outcomes. The third has been the goal-orientation to establish recommendations for best practices (Wheelwright & Clark 1995). These past approaches rely heavily on the resource-based view (RBV) of the firm, in which leveraging and enhancing firm competences and capabilities can create organizations capable of "doing innovation well" (Iansiti & Clark 1994). While looking for insights that can help build skill-based competency is sensible, underlying theories on inherent manager/worker dynamics – dynamics at work at every firm – should also be critical to understanding outcomes.

In both empirical literature and in the popular as well as trade press, product and project delays receive extensive coverage. Project delays are pervasive – 65% to 85% of projects are late – with an average delay of 220% of the original time estimate (Heemstra 1992, Standish 2001). Despite the surprising extent of the phenomena, researchers in organization theory literature have been unusually silent about possible explanations. Seldom is ongoing senior management or manager hierarchy involvement considered as part of the problem (i.e. corporate management is often studied as part of the project/portfolio selection phase, not as impacting project outcome).

Successful innovation is a critical determinant of company success, especially in early stage technology firms (Iansiti 1995, MacCormack, Verganti, Iansiti 2001). These prior research streams have profiled and analyzed project successes and failures, but they have focused almost exclusively on the dynamics of large project teams which tend to predominate at large companies (Baumol 2002). Such teams that may even be sequestered away from the main development organizations in an attempt to isolate and insulate them from distraction. Nonetheless, is it from the far larger number of small technology firms that much or most innovation emerges. These smaller firms are critical for economic development and form the basis for new economies (Birley 1986, Walsh 2004, Walsh et al. 2002). Smaller firms also have resource limitations (total employees) that render large "isolated and insulated" project teams dedicated to one innovation a practical impossibility.

Existing resource-based research has concentrated on exposing the skill sets, processes, and personnel dynamics within individual projects, which can often be described as isolated, "closed-system" cases. A closed system perspective is less applicable to smaller firms, where the one development department must handle the myriad of engineering issues as they surface each day. In such small firms, the entire development department is smaller than a single project team at a large company. Even so, given the central role of innovation in competitive advantage, it is not surprising that the internal workings of development projects and how design tasks cause delay have received academic attention (Cooper 1995). The research has tended toward establishing project "best practices" (Kahn, Barczak, Moss 2006,), or uncovering how large project processes advised in the literature diverge from those in actual practice (Griffin 1997).

Innovation and development problems

The intent of this paper is not to discount the importance of past research or to question the value of continuing to find resource–based explanations, best practices, or dynamic capabilities that correlate to better outcomes (Doz 1996, Teece, Pisano, Shuen 1998). But if the endemic project failures or delay patterns are mostly the outcomes of common skill deficits, then population ecology and other competitive forces should logically result in decreasing instances of problems over time. As better skills are adopted by companies and by industries dependant on them (as RBV predicts), better outcome patterns would emerge. Especially since product delay announcements have been linked to a decrease in the total valuation of firms by 5.25% on average (Hendricks & Singhal 1997), population ecology suggests that better skilled firms should prevail in "natural selection".

This study suggests that there are strong and consistent agency processes at work, outside of the operational RBV perspectives of skills and design tasks at work. Since innovation in dynamic markets is crucial to company success, it would seem self-evident that the microscope of senior management attention, if not direct interaction and intervention, would be among the top factors that should be considered as influencing eventual project outcomes (Balkin, Markman, Gomez-Mejia 2000). While extensive literature exists on the role of senior managers as project champions/sponsors/advocates, providing internal political support and ensuring priority for funding and resources (Graham et al. 1994; Buttle, 1997), principal - agent dynamics (including information asymmetry and goal misalignment) is not considered.

In economic theories of organizational design, delegation is sometimes analyzed with a principal–agent model. These models have been extensively published in business and economics literature, but with a focus on the very highest level of management; agency theory is normally applied to the interaction between business owners (the principals) and the CEO/managers (agents). But the agency model can be a useful analytical device for all organizational levels, and while the concept of principal and ownership is being modified in this paper's framework, the fundamental dynamics still apply. For instance, a basic implication of past agency theory research has been that formal and implied contracts can be designed to better align principal and agent interests. As a step toward making an incremental contribution to innovation research and agency theory, this research is focused on filling the following gaps:

Gap 1: Research the principal / agent contract as the unit of analysis in product development and projects.

➔ Existing project and innovation research is focused on the project team or the project as the unit of analysis

Gap 2: Extend Agency theory to lower organizational layers (below owner/CEO) in order to gain explanatory or predictive insights into project delay and lack of management awareness for internal development projects.

➔ Agency theory is not generally applied below CEO/Board level dynamics to analyze organizational structures and operations (such as development projects). When the theory is applied to projects, it is used exclusively for the study of external contracts.

Gap 3: Study smaller/earlier companies (sources of most innovation Birch 1987)) and the interrelatedness of many simultaneous projects done by small R&D departments.

➔Case study innovation and project research predominates on large established firms (e.g. Microsoft, IBM, etc), and on their larger, isolated, dedicated projects.

Gap 4: Agency theory as the foundation for innovation, project, and NPD research.

➔RBV is the predominant theoretical framework for such research. Existing literature takes a resource-based view which lends itself to maximizing the project <u>skills</u> required for regular innovation or on establishing "best practice" development processes.

Theory & Model: Agency and Development

Agency theory can reveal the effect of multi-level management/principal/agent hierarchies on development projects, and is a foundation for analyzing the problem of ongoing project delays. Since it explains how information, goals, and incentives guide divergences between managers and principals (The *principal* in our use of principal-agent theory is the person who delegates. The *agent* represents the people to whom authority has been delegated), we can look at project development surprises as being multi-layered principle-agent problems. The problems stem from the self-interest and conflicting goals among both principals and agents as well as asymmetrical access to important information, e.g. Board level to CEO, CEO to Engineering Manager, Engineering Manager to Developer. Since Agency theory is applied to patterns of behavior of the agency relationship – the dynamics when one entity (the principal) appoints another (the agent) to perform work – it should be useful to analyze the key players in development projects to see if:

a) the desires or goals of the principal and agent conflict and
b) the difficulty or expense for the principle to verify what the agent is actually doing.

The context for an agency analysis is the contract – which in the case of full time employment is an implied one (Robinson, Kraatz, and Rousseau 1994). To some degree, all contracts have information asymmetry, uncertainty, and risk. In agency relationships surrounding development projects, these and other dynamics are also at work. For development organizations, there are multiple levels of principal-agent interaction/relations that must be examined for any holistic examination of the systemic lateness and subsequent management surprise. For this paper, the four levels shown in diagram 1 are of significance:

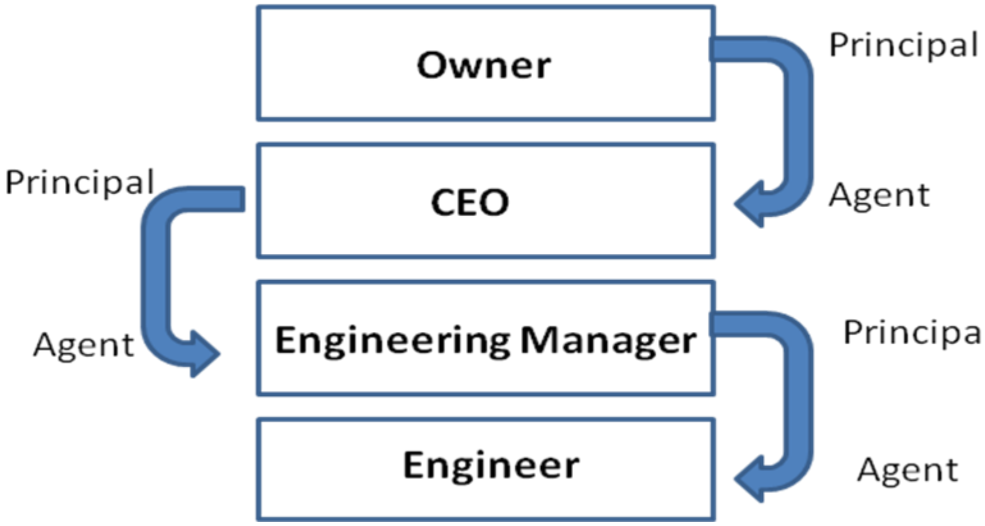


Diagram 1: Agency relationship through organization levels

At each level except owner, the employee can take on the role of principal (delegating) or agent (performing). This paper is concerned with exposing the problems that can be anticipated due to agency relationships in the organizational hierarchy (**implied** contract relationships) and within captive/internal development organizations (versus outside contractors).

There are, in general, two types of principal-agent dynamics (Bromley 1989). The first is the hidden action (moral hazard) model where the principal can't directly observe the agent's actions. The principal can verify outcomes of an agent's activity, but not the agent's effort. This dynamic implies that the agent will shirk. The second type is the hidden information (adverse selection) model where the agent has concealed information or is better informed than the principal about important issues (e.g. the difficulty of the project). This dynamic implies that the agent will use the information for inappropriate advantage. The model this paper analyzes is both types; the agent has various concealed information, can hide information, and his action/effort can't be observed. To some degree the agent can control the measurement and timing of results, too.

Agency issues can be exposed and described following theoretical basis (Eisenhardt, 1989). The **goal** problem is that the desires of the principal and agent conflict and will shift over time concerning the best outcome of projects and the best use of scare resource (development time or man hours in the case of software) as well as:

1. Goal for return on assets, and defending current assets.
2. Job security, advancement, satisfaction.
3. Salary, bonus, or other remuneration

The **information** problem is that it is difficult or impossible for the principle to know what the agent is actually doing, the quality of the work the agent did, the resource needed to perform a task (in the case of software code, programming is a solo task only known to the programmer) as in:

1. The true complexity of the project.
2. What the agent is actually doing (content or quality).
3. The true resource needed to perform a task (programming is a solo task).
4. The relative risk/reward of projects for which:

a. Specific knowledge of markets & demand is unclear.
b. Actual riskiness is unknown

The **risk** problem is that the principal and agent have:

1. Different risk aversions. (risk willing to be shouldered),
2. Different incentive preferences (rewards/punishments).
3. Perceive different levels of risk with each project.

Propositions

Agency Theory based propositions, concerning both management hierarchy and agency phenomena, are in six areas and logically constructed according to the following chart:

	Board: Principal ⟷ Manager: Agent	Manager: Principal ⟷ Developer: Agent
Goal	P1	P4
Risk	P2	P5
Information Asymmetry	P3	P6

Chart 1: Propositions relative to agency relationships

Agency: Principal to CEO

P1 CEO's will discuss those projects which are most likely to help meet the short term goals that relate to his bonus, or retention.

P2 Projects that are high profile (discussed at Board meetings) will be less likely to slip

P3 CEO will seek information on urgent projects. CEO's will delay news until it is made positive through resource reallocation, or downplay projects that are off schedule.

Agency: Manager to developer

P4 Manager will divert resources to put or keep high profile projects on schedule

P5 Resources are allocated away from less urgent projects such as innovation in order to keep high profile ones from slipping

P6 Agent knows of non-urgent project delays, yet does not forward the news or change the perceived difficulty level

Method

The underlying methodology of this papers' research is grounded theory building using case study (Eisenhardt 1989, Yin 1999) in which an initial provisional theory is used prior to fieldwork. Under this exploratory model, data collection is designed to construct alternative models that are used for further analysis or tests for adequacy. The process used two phases. First, data gathered at one specific site (the pilot) via a semi-structured interview was used to make a first pass in determining why the phenomenon occurs. Building on the insight gathered from this initial case, models of information flow and Agency relationships were built. A more focused approach and expanded set of cases (5 more discrete sites) were selected.

In the context of <u>software</u> new product development and the phenomena of information flow and project delay, the persons involved, relationships and interactions among the parties are particularly important (de Weerd-Nederhof, 2001). Numerous works on issues relating to New Product Development (NPD) use a case study approach because in-depth probing questions can be asked, which may not be possible with other methods. The information collected can then be used to build theories (Rahman, Rahim, Shariff, and Baksh 2003). A conceptual framework was constructed and, following a peer-reviewed proposal, a case study protocol was constructed prior to the case research. The interviews were transcribed within 24 hours along with the notes and reflections. A chain of evidence including the initial data recording, transcription process, and report writing was catalogued.

It was important that the case profiles have the potential to result in data and conjecture that might be generalized to populations of 1. smaller innovative firms and 2. broader software project development. That context was defined as small technology companies in the non-consumer software sector, with a shipping product. The small firm perspective was chosen because it is conducive to an "open system" study of projects. In small firms, project isolation is not attempted. Projects are small, management input is ongoing and multi-level, outside impacts and interruptions are assumed as a matter of course. One case study on a single development department can yield complex organizational insight into many projects, at many stages of development, all in parallel: a perspective which can consider very senior management interaction and activity that spans an entire development department. This structure, in which a number of Agency relationships (in the form of implied contracts) exist in a hierarchy, is the theoretical basis on which the cases are to be selected.

The non-consumer software profile was selected because software products have few external dependencies (supply chain related); software is design. In contrast, hardware firms have regular project issues injected from external supply or design problems with sub components. These externalities make it harder to isolate meaningful organizational issues. Non-consumer products, in general, have fewer channel dependencies and are driven by identifiable customer input rather than from the "market". Lastly, important to a case selection was that growth (versus owner lifestyle) should be of primary importance to the firm.

The specific small software companies were selected because of profile and proximity for face to face interviews with follow up. They all compete in segments of enterprise software market which have many and various size competitors. In this type of market setting, economic and competitive theory would suggest that the competitive nature of the products would force smaller companies to seek market niches and to produce sustainable advantage via innovation and high levels of service (Porter 1998). The innovative requirements of the market make these firms very suitable for the first case study.

The second criterion for selection was the size of development organization. This study is focused on the practices that predominate at smaller, innovative firms. These firms can not afford to have large dedicated project teams. Instead, all development needs and projects of the organization must be handled by the same resource pool of 10 to 20 engineers. Revenues at the chosen firms ranged from five to about $20 million. The products developed by the selected firms were in document management, web intranet applications, database tools, and networking software. The products typically sold with a sales price of between $10,000 and $50,000 depending on the number of modules desired and the number of "seats" per installation.

A third criterion for case selection was to have existing customers for two reasons. First, choosing firms with shipping product is a simple means of ensuring external validity that the cases are representative of "functional firms" - with credible product development skills. Distinguishing between incompetence in development, weak idea, or other issue in a failed "startup" whose product never gets to market is a complicating factor that is best avoided. Second, once a company has a shipping product the complexity of customer bugs and market burdens arise. Shipping products have more multifaceted and dynamic development processes due to market feedback loops and customer demands.

It was important to an agency dependant study to interview multiple types of principal ownership profiles in order to maximize generalizability. The profiles of the firms selected included publicly traded, numerous venture investors, and few venture investors with large founder ownership. Software development firms have faced a dynamic environment of rapidly advancing technology and intense competition for decades; market forces that demand the delivery of innovative products just to keep pace **(**Deeds, DeCarolis & Coombs 2000**)**. As a result, the relative capability of a company's research and development operations are a key to company valuation (Kelm, Narayan, Pinches 1995, Pakes 1985), as new products are compulsory for cash flow, visibility, market share, and increased survival (Schoonhoven, Eisenhardt, Lyman 1990). Last, studies of firms that deliver information systems (IS) technology are important due to the leverage it has on economies (Pisello 2005, Maglitta and Sullivan-Trainer 1991*)*.

Findings

I. Engineer/developer as Agent. Engineering Manager and CEO as Principal

For parsimony reasons, we couple the CEO and Engineering manager together as Principal (both are managers and hierarchically elevated), and the engineer/developer as agent.

Contract

In the case of development projects, two dimensions of implied contract exist in concert. A contract exists per project (which will have stronger or weaker rewards/penalties depending on the importance of the project), as well as an ongoing employment arrangement/contract with its incentives and risks (Rousseau 1989). The components of the employment contract (usually implied) include expectations of effort and competent work output in return for regular paycheck and benefits (Harvey & Johnson 2003). The components of the project dimension (again implied) are that an added benefit or penalty will accrue to the agent from each new assigned project. Project success, as defined by the principal, is based on on-time project completion with acceptable content and quality. But the concept of success has other dimensions as well. In development organizations, success is enhanced if the principal perceives that unusual difficulties were overcome in completing the project. Also, by perceptions of how much skill was applied, or if there was an ingenious element to the solution, or how much overtime was put in at the office. Measuring degree of success is therefore not straightforward. Furthermore, the benefits that accrue from "success" accumulate with time. In organizations, results are not memory-less so that as an agent successively succeeds or fails, an ongoing "tally" is kept about that agent's relative justification for benefits and his relative "worth" compared to peers.

Risk (Reward)

The agent risk (related to projects) is multi-level and is based on penalties the principal might impose; the most basic of which is job loss. Yet the risk of job loss in development organizations is often not high due to technical specialty, singular knowledge of past work, and market shortage. Furthermore, if a developer/agent has had many project failures (a cumulative memory of failure), it is prudent to change jobs before the axe falls. In this scenario, the downside risk is in finding and starting a new job: not a large issue for software engineers. A second risk is that bad performance will bring less desirable future project assignments. A less desirable project may consist of bug fixing, older technology based work, or other less prestigious or mundane undertakings. Third, the agent has a risk of a declining reputation. A fourth risk is that any future raise will be small or zero.

The complexity of hiring developers, however, limits the principal's ability to enforce any of the penalty mechanisms he might have; whether it be dismissal or reprimand. There are two aspects to his restriction. The first is that if the availability of qualified engineers is low (a normal situation), it may take a significant amount of time to hire a replacement and the cost (salary and fees) of the replacement will be high. Second, if the company is in a specialty market, the learning that might be needed in order for a new-hire to become productive (complete some projects) may leave the company with no ability to complete projects for a significant time gap. The real cost of a new employee is magnified in that their productivity is often small for months unless they have a specific skill (such as database or user interface). Furthermore, there is no guarantee that the replacement will perform better than the former engineer. As a result, the principal may fear losing even his well-below average engineers.

This knowledge (limited penalty enforcement for an agent) is known to both the principal and the agent, and effectively allows the agent to substantively ignore some contract risk (employment and project). The principal must for the most part forgo effective penalty, and as in all contracts, the effect of repeated non-enforcement of contract penalty reduces the likelihood of on time delivery. It is not only the downside risk that is limited for the agent. The incentive problem (the principal's ability or inability to provide meaningful incentives) is hampered as well. The promises of salary increase are unlikely to motivate the agent to perform differently on projects. In other words, the after-tax difference between a zero percent raise and the best possible raise may only be a few thousand dollars; not enough to produce extra effort, let alone daily overtime and weekend work. The prospect of an agent's internal promotion is often small as well, because principals desire that their best performers continue to complete projects rather than manage. Or the agent may have no desire for promotion. In any event, salary for developers is primarily set by the local market conditions. The principal's risk is that either systemic project delay or failure becomes viewed as a management failure, or that a specific important project failure will significantly impact financial performance. For each Principal up the management chain, the downside risks are higher than for the engineer/agent. The risks include actual threat of job loss, deferred promotion, or smaller raise. Relative to the agent risk, the principal risk is higher and more likely.

Goals

In general, assuming that an acceptable level of quality is achieved, the goal of the principal is for each agent to finish their assigned project as soon as possible, and then be assigned a new project to complete. Ensuring the most efficient use and scheduling of the development resource (engineer time) is the key to completion of more projects. Therefore, the principal will demand schedules that are as short as possible. Nevertheless, it is also important to the principal that when "emergency" issues (ones that affect short term financial performance) arise such as a large customer's bug, that the agent will quickly move onto the emergency and solve it. Agents, however, see little distinction between "emergencies" and projects since there is no risk or incentive distinction. Project resources can thus be expected to flow to:

- Assigned projects

- "Important" bugs – as deemed by the principal.
- Support for important customers and prospects
- Projects deemed "important" for other reasons

Where do resources not flow? Longer term projects and those without short term revenue or major customer visibility – such as innovation projects.

Conversely, the agent can be assumed to have an aversion to undue effort and schedule "pressure". With few benefits to the Agent upon completion of a project, and potential downsides if there is failure traceable to him, the agent has an incentive to stretch the completion time as far as possible and do fewer projects. In other words, the agent will attempt to convince the principal that his assigned project will take as long as he can get away with. In fact, there should be an attempt at non-commitment by the agent to any schedule, and a preference for longer project times over shorter ones (to reduce "evaluation events"). In the absence of a clear benefit for meeting a project schedule, the optimal contract - for an agent - is one in which there is no set completion time for the project. On the other hand, only if an agent perceives that a clear benefit exists for meeting each schedule will the agent desire schedules, shorter project length, and will produce at a level of effort in to maximize his expected benefit. If there is no clear benefit, the agent will desire fewer projects (of longer duration) over time with slippages.

Information

Project-based contracting is imperfect because of asymmetric information. That the agent has more specific information and principal has average information (at best) on any given project helps to produce lopsided risk sharing. Since the agent is exposed to increasing risk (worse reputation) after each failure, his effort will be to have no commitment to a schedule, longer projects, and to generate longer development estimates (using exaggerated complexity – information asymmetry) if a schedule is demanded (Jenkins, Naumann, Wetherbe, 1984). In addition, he is incented to not allow any adequate measures of project results to be used. If a project is difficult to judge, it is difficult to determine failure. The agent makes a project difficult to judge via insisting that there are far too many external dependencies and uncertainties over which he has no control. Since any bad news (such as a delay in the project) will cause the agent problems, he is incented only to report good news to his superiors. The agent will report bad news only when there is no alternative. Furthermore, he is incented to create believable excuses for any delay in order to dampen any reprimand when the bad news is delivered. In other words, the agent is highly incented to be drawn into "emergencies" or other diversions while working on a project, so that any blame for a delay (that might occur later) is clear, compelling, and diverts attention from shirking.

Information asymmetry also comes into play if projects are assigned based on "bidding". If an agent wishes to work on a desirable project, he can easily "low ball" the date of completion expectations of the principal and have the project assigned to him. As the project progresses, the same information asymmetry previously described provides methods to "let him off the hook" if a schedule is to be missed. This phenomenon can also be expected when the use of an external contractor is being considered and the development department wishes to keep it "in-house".

Especially in software development, at every step an agent will have comprehensive actual technical data on every component of a project, while the principal will have limited average historical data on completed projects - the details of which were also provided by the agent:

- The engineer knows more about how much time a project will take at the onset. He writes the specification and he knows the design approach.
- The engineer knows in advance when a delay will occur and has an estimate of its magnitude - since only the agent knows how much has been done and can estimate the effort required for completion.
- The engineer knows the quality he is producing. Engineers run ongoing tests as they complete their own modules.
- The engineer knows how much effort he is expending. He knows the number of man hours he is working on any project.

Given an absence of incentive considerations and the asymmetrical information used in an agent's forecasting, the data provided to the principal will be incorrect. No matter the amount of information obtained or his experience on similar projects, the principal is unlikely to gauge the completion time correctly. The Engineering Manager will estimate completion times (based on data provided) sooner than is correct, and will be surprised by the slip.

II. The CEO as Agent to the Board

Risk

As has been widely researched, the risk profile of the board/principal will be higher risk taking than the CEO (Eisenhardt 1989). The board will be more accepting of risky projects with high value outcomes, more aggressive for shorter schedule dates, and more risk taking on leveraging asset allocation than the CEO. The Board will have some understanding that product delays reduce the valuation of the firm (decrease of 5.25% on average, Hendricks et al 1997)

Goal

The impact of the risk profile difference on development projects is that Board members (principals), in hopes of influencing stock price, will demand development activity that will significantly affect shorter term stock valuation (Balkin, et al 2000). For engineering/development this demand means pressure for projects that include high-revenue producing, blue-chip alliance creating, or major account winning projects. The ability to "get press" is also a criterion for the board to value a project.

The effect on the CEO as agent – whose goal is to keep his job and maximize compensation - is twofold. First, the CEO will come to Board meetings prepared to discuss high profile projects, and will initiate additional major projects as proof that he is acting in alignment with board wishes. Second, meeting these project target dates become very important to the CEO because they are visible to the board, and failure or delay is a sign of management problems. As a result, these projects will get more attention than their business case merits, because <u>only</u> high profile projects get attention from the Board. This dynamic results in the CEO/agent imposing unwarranted urgency on "Board visible" projects into the organization.

Information

Board members have little access to information outside of what the CEO/agent tells them. While a Board will often attempt to place "friendly" employees within the organizations, most information remains formal and under CEO control. As a result, the CEO can manipulate to some degree, the content and accuracy of any data related to projects. Secondly, it is best (for the CEO) if dates remain tentative. The more tentative, the less the potential for repercussions due to date slip.

Measurement

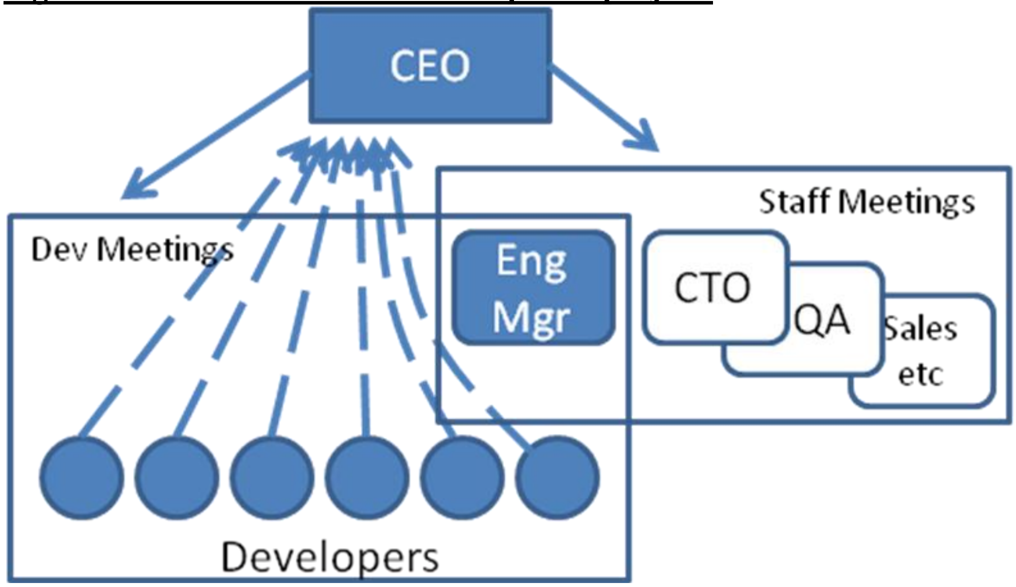
Measurement of the agent (by the Board) can be expected to create counterintuitive dynamics. First, the board can not know if its goals (as related to selecting development projects) are proper ones, since they have no in-depth knowledge of company operations. The projects that the CEO decides to discuss are therefore 100% at the discretion of the CEO. It is in the CEO's interest to offer up projects that "appear" important, are simple to explain, are straightforward to make schedule, and whose impact on revenue "appears" significant. The board will demand press coverage, so PR worthy projects must be part of the CEO/agents list. The board can not tell if the activity delivers results and valuation unless a press release is done AND the company is public. Otherwise, the revenue for any project is rarely immediate. Even projects for partners or major prospective customers may not bring in an immediate order. In most small tech companies, therefore, the measurement is again provided by the agent/CEO.

Information if the project released on time, and was complete is under the control of the CEO/agent. A press release can be done before a product ships and features can be sent to a few customers well before it is generally available. A delay can be explained as "necessary because the partner or customer added an essential new component last week". The underlying result is that the Board lives with a CEO-based constructed reality that can be removed from the empirical facts.

Analysis

On average, the CEOs determined that a full ½ of all projects are significantly delayed – defined as three or more months past the *last* scheduled date. While tentative, information (via interview) was gathered on the CEO perspective of project dynamics, which is quite helpful as an aid to illustrate and depict the agency relationships. At each firm, the CEOs were project oriented. Development efforts, the Engineering department and engineers are mostly measured according to a project-based yardstick and the CEO is involved in many phases of the project process. This process has specific checkpoints and properties at the early phases, which are fairly easy to monitor and track via formal meetings. Figure 1 shows an example of a formal Development meeting and the Company Staff meeting. The Engineering manager is common to both, and both of these meeting are as much for management control downward as for information flow. Informal meetings – with engineers – are intended mostly to ensure information is gathered when formal means would not be complete.

Figure 1- Information flow on development projects



Solid arrows = management directives
Dashed arrow = informal information patterns
Boxes = formal meetings

It is at the point when development begins (software coding in our cases) when information exchange and control are no longer executed at formal meetings. Individual engineers work on projects, or on segments of a project, in isolation. Progress may not be linear, and in any event, progress is specific to each developer. In smaller firms, with many ongoing parallel projects in various stages of completion being accomplished by overlapping and changing teams, formal meetings were not seen as practical to gain timely information. Projects do not progress according to the scheduled meetings and the CEO may seek out engineers individually to gain information. As stated by more than one CEO “these meetings occur often”. At one extreme, the CEO stated “I may meet with almost every engineer once a week”. Calculating the amount of time this takes, using estimates from the CEOs themselves, the conclusion is that agency costs associated with this direct monitoring is large. Even huge - at up to 1/3 of total workweek hours.

Why would the ongoing information gathered be wrong?

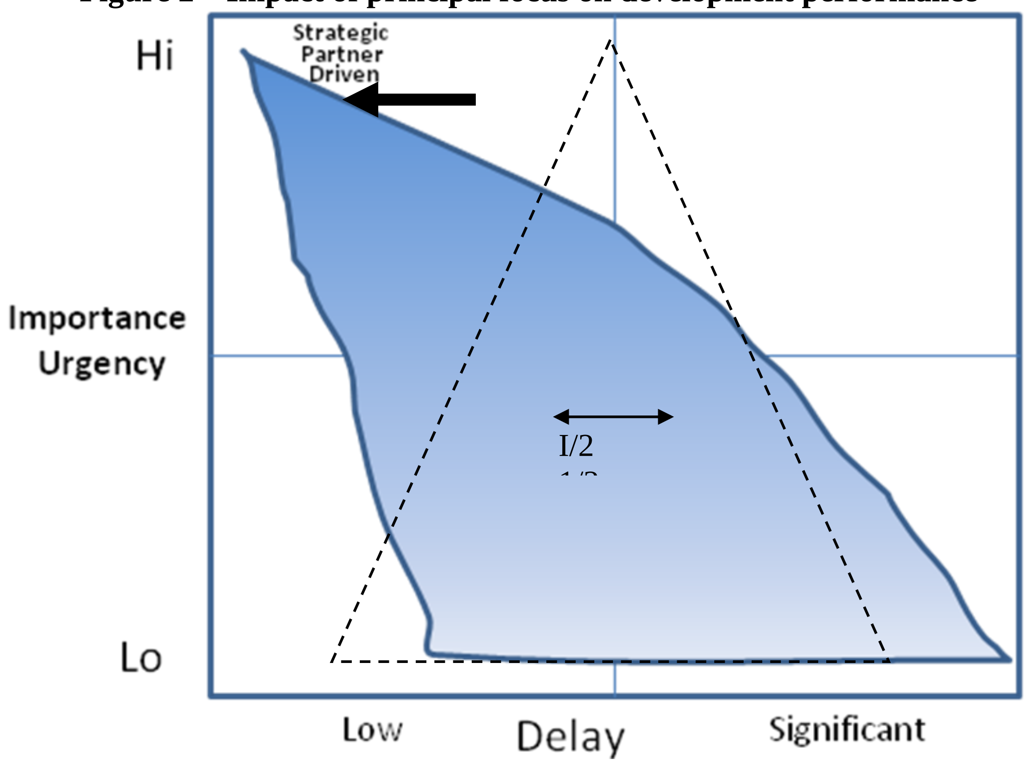
Even though the small firm CEO meets with engineers and managers often, he must still prioritize which projects he can afford to spend his time discussing. Therefore, information is gathered by the CEO with a focus on the “most important” projects. The consistent statement made by CEOs concerning customers is “we never miss partner projects” or “for major sales, resources are moved if needed”. When asked how many of these projects there were relative to the total, the answer was that they were relatively small. The most critical projects at to the firms CEO’s were consistent; they are projects that will help the company make short term growth targets and ones with Board exposure. These included: partner projects, large customer bugs, new customer issues, projects with customers waiting to buy, etc.

The conclusion, which is consistent across companies, is that the projects considered important and urgent are those that are tied to an important partner, or tied to meeting the company's aggressive revenue growth or customer acquisition targets (such as a name brand customer). Discussions at the multiple sites turned up a familiar pattern: the most critical projects (described above) do not miss their release dates, yet a full half of all projects do miss. This dynamic leads to the unavoidable conclusion that lower urgency projects must have a much higher than 50% miss rate.

Figure 3 shows the previously discussed dynamic graphically. The urgency of any project, as defined by the CEO's is one axis, and project delay is the second horizontal axis. The graph shows the set of all projects as a dotted line pyramid, with many more low urgency/important projects existing (the base) than critical level ones (the apex). The dotted pyramid, furthermore, is shown as the theoretical set of projects where ½ of them are on time and ½ are significantly delayed. If project times were random – in that the issues that affected delivery dates were the same for all projects - we could expect the results of each project to fall within the dotted pyramid and for the results to straddle the average delay time as the dotted pyramid does.

The solid figure in the matrix shows the dynamic of CEO attention and resource shifting (more CEO attention = less delay) as a function of the relative importance of the project from the CEO/Board perspective.

Figure 2 – Impact of principal focus on development performance



All projects are represented in figure 3 as falling somewhere inside the solid "shark fin". Since there are more lower priority projects than there are high priority ones, the polygon will still have a "pyramid" shape (larger base of less important/urgent projects and fewer urgent and important ones at the top). But the effect of CEO attention is to "bend" the top of the pyramid – the very high priority projects – into the low or no delay quadrant: "we do not miss on partner projects". This "bending" affect which moves the urgent projects to the left (urgent/on time) declines with increasingly less important (less visible to the board or less significant short term revenue) projects. At the low end of the pyramid, they receive little or no CEO attention. If "one half of all projects are late", yet the firms do not miss on the most urgent projects, then the significant delay and potential failure due to lack of resources would fall to the remaining projects. On the graph, this dynamic is shown as the base of the pyramid (low urgency projects) shifting right into the low urgency and significant delay quadrant.

Discussion

Why is underestimation (resources used, missed dates) a recurring issue? Using the case firms, a model of asymmetry in information from the engineers to the CEO, as well as a difference in risk profile between the engineers and the CEO can be seen. The incentive of the agent/engineer is to accomplish schedule dates on important projects (as deemed by the principals), and to rob time from their other tasks if needed in order to succeed. They are incented to deliver positive information relative to their own competence, and have believable excuses whenever dates are missed.

Chart 1 is a breakdown of where the interviewed CEOs believed development resources are applied according to general categories of development. These categories represent a breakdown on average of the amount of resources being applied at any time in the form of development projects. For instance, fixing a bug that takes 4 full days would be considered one project, and it would use a percent of all available development resources while being accomplished. At no firm was this information known to the CEO from formal reporting. In fact, a breakdown of where resources were applied by category was a novel question. CEO's did not know how their resources were applied by any metric other than project.

Chart 2

System Compatibility	40
New Features/Products	20
Supportability	20
Verified Bugs	10
Assist Customer Support	10
Customer Specials	5
Efficiency Rewrites	0

Percent development time expended by type of work (not project) – CEO estimates

While counterintuitive, it is because the CEO is focused on meeting high-profile project dates that only important project progress information is regularly requested and gathered. As a result, agents focus on these urgent projects and deadlines. In other words, because the CEO demands data on shorter-term high-profile projects 1. resources are allocated away from innovation, and 2. it is the information flow imposed by the CEO that causes no alarm to be raised that innovation projects are delayed or in trouble. Little data is gathered on innovation project progress. More broadly, managers are unaware of resource allocations in general, as no measurements on total resource allocations are taken. Agency Theory, when used to align principal and agent goals, makes an assumption that the outcomes of agents' decisions can be measured. This assumption is often suspect, if not incorrect when dealing with software projects because measurement assumes that one can link the outcome to be measured to an agents work.

Conclusion

Extending the Agency Theory approach to NPD and to the principal/agent contract through multiple layers of management, the manager/agent dynamic is shown to be a key factor in determining project outcomes and how it both arranges expectations and also causes unforeseen outcomes.

Research on delegation shows that agency loss is minimized when the principal and agent share common interests (Lupia and McCubbins, 1998) or desire the same outcomes. Agency loss is also minimized when principal is knowledgeable about the consequences of the agent’s activities and knows enough to determine whether or not these actions serve their interests.

Can the asymmetric information issue be reduced? Because of asymmetric information, agency theory proposes that a principal can never be certain when an agent has prolonged a task to serve his own interests, or when there are legitimate, unexpected roadblocks or diversions. Agent competence can only be discerned over time, and agent motivation is ever changing.

References

Flowers, S. (1996) Software failure: management failure: amazing stories and cautionary tales. John Wiley and Sons, Chichester.

Fortune, J., Peters, G. (1995) Learning from failure: the systems approach. John Wiley & Sons, Chichester.

The Standish Group (2001) Extreme Chaos. http://www.standishgroup.com.

Wheelwright, S., Clark, K. (1995) Leading Product Development. Free Press, New York.

Heemstra, F. (1992) Software Cost Estimation. Information & Software Technology, 34(10).

Iansiti, M, Clark, K. (1994) Integration and Dynamic Capability: Evidence from Product Development in Automobiles and Computers. Industrial & Corporate Change. Vol.3.

Iansiti, M. (1995) Shooting the Rapids: Managing Product Development in Turbulent Environments. California Management Review, 38.

Baumol, W. (2002) Entrepreneurship, Innovation and Growth: The David-Goliath Symbiosis. Journal of Entrepreneurial Finance and Business Ventures, Vol. 7, Issue 2, Fall, pp. 1–10.

MacCormack, A., Verganti, R., Iansiti, M. (2001) Developing Products on "Internet Time": The Anatomy of a Flexible Development Process. Management Science, Vol. 47, Issue 1, pp.133-150.

Birley, S. (1986) The Role of New Firms: Births, Deaths, and Job Generation. Strategic Management Journal 7: 361–76.

Walsh, S. (2004) Roadmapping a Disruptive Technology: A Case Study – The Emerging Microsystems and Top-down Nanosystems Industry. Technological Forecasting and Social Change 71(1): 161–85.

Walsh, S., Kirchhoff, B., Newbert, S. (2002) Differentiating Market Strategies for Disruptive Technologies. IEEE Transactions Engineering Management 49(4):341–51.

Cooper, R. (1993) Winning at New Products. Addison Wesley, Reading, MA.

Kahn, K., Barczak, G., Moss, R. (2006) Establishing an NPD Best Practices Framework. Journal of Product Innovation Management, Vol. 23, Number 2, March.

Griffin, A. (1997) PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices. Journal of Product Innovation Management, 14, pp. 429-458.

Doz, Y. (1996) Managing Core Competency For Corporate Renewal: Toward A Managerial Theory Of Core Competencies. INSEAD Organization and Strategy in the Evolution of the Enterprise London: Macmillan.

Teece, Pisano, and Shuen (1998) Dynamic Capabilities and Strategic Management. Strategic Management Journal, Volume 18, Issue 7.

Hendricks, K and Singhal, V. (1997) Delays in New Product Introductions and the Market Value of the Firm: The Consequences of Being Late to the Market. Management Science, Vol. 43, No. 4.

Graham, R.. & Englund, R. (1997) Creating an environment for successful projects: the quest to manage project management. San Francisco: Jossey-Bass Publishers.

Balkin, D., Markman, G., & Gomez-Mejia, L. (2000) Is CEO pay in High Technology Firms Related to Technology? Academy of Management Journal, 43(6), 1118-1129.

Buttle, T. (1997) Hitchhiker's guide to project management. Project Management Institute: 28th Annual Seminars and Symposium. Chicago, Illinois: Project Management Institute.

Birch, D. (1987) Job creation in America: How our smallest companies put the most people to work. The Free Press, New York.

Robinson, S, Kraatz M, and Rousseau D. (1994) Changing Obligations and the Psychological Contract: A Longitudinal Study. The Academy of Management Journal, Vol. 37, No. 1.

Bromley, D. (1989) Economic Interests and Institutions: The Conceptual Foundations of Public Policy. Oxford: Basil Blackwell.

Eisenhardt, K. (1989). Agency Theory: An Assessment And Review. Academy of Management Review, 14: 57-74.

Eisenhardt, K. (1989) Building Theories From Case Study Research. Academy of Management Review, Vol. 14 No.4, pp.532-50.

de Weerd-Nederhof, P. (2001) Qualitative Case Study Research: The Case Of A Phd. Research Project On Organizing And Managing New Product Development Systems. Management Decisions, Vol. 39 No.7, pp.513-38.

Yin, R. (1999) Case Study Research: Design and Method (3rd ed.). Thousand Oaks, CA: Sage Publications.

Rahman, A., Rahim, A., Shariff, M., Baksh, N. (2003) Case Study Method For New Product Development In Engineer-To-Order Organizations. Work Study Volume:52.

Porter, M. (1989) Competitive Strategy: Techniques for Analyzing Industries and Competitors. Free Press.

Deeds, D., De Carolis, D., Coombs, J. (2000) Dynamic Capabilities And New Product Development In High Technology Ventures: An Empirical Analysis Of New Biotechnology Firms. Journal of Business Venturing, Vol. 15, Issue 3, pp. 211-303.

Pakes, A. (1985) Patents, R & D, And The Stock Market Rate Of Return. Journal of Political Economy, 93, pp. 390–409.

Kelm, K., Narayan, V., Pinches, G. (1995) Shareholder Value Creation During R&D Innovation And Commercialization Stages. Academy of Management Journal, 38 3.

Schoonhoven, C., Eisenhardt, K., Lyman, K. (1990) Speeding Products To Market: Waiting Time To Product Introduction In New Firms. Administrative Science Quarterly, Vol. 35.

Pisello, T. (2005) IT Spending At Midsized Companies: Does Size Matter? Sept. TechTarget.

Maglitta, J. Sullivan-Trainor, M. (1991) Do the Right things. Computerworld: The Premier 100 supplement, pp. 6 – 13.

Rousseau, D. (1989) Psychological And Implied Contracts In Organizations. Employee Responsibility And Rights Journal. 2 121-139.

Harvey, J. and Johnson, D. (2003) Why are there Explicit Contracts of Employment? October. No. 01-06. Law and Economics.

Jenkins, A., Naumann J and Wetherbe J. (1984) Empirical Investigation of Systems Development Practices and Results. Information and Management, 7.