Creative Construction

The Capacity for Environmental Innovation in Real Estate Development Firms

By

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Abstract

Based on his own experience as a green development entrepreneur, the author builds a model of real estate development firms. Using that model, he identifies four areas where green development practice creates tension in the conventional development process. These tensions lead to four hypotheses that green developers will share several common characteristics.

1) Large developers with easier access to capital are likely to have pushed further than small, local developers in the adoption of environmental innovation. The small firms who have been leading adopters are likely to utilize alternative financing arrangements with at least some investors that give the developer or the investor a longer-term stake in the project.
2) Early adopters of environmental innovation have moved away from price competition in the selection of development team members, in favor of long-term relationships, inter-project learning, and negotiated bid arrangements where partners, especially the providers of design and construction services, are familiar with the requirements and the past projects of the developer.
3) The developer exerts greater control throughout the entire development process, especially in the provision of design and construction services.
4) Early adopters of environmental innovation have moved aggressively towards industrial construction and CAD/CAM construction techniques because it gives the developer more control over the installation of products and the ability to reduce waste.

These hypotheses are tested through a survey of commercial and residential development practitioners, including the author's own firm, that are leading adopters of green development practices.

Section I. Introduction

I teach a class on Sustainable Real Estate Development at the Tulane School of Architecture. Over the last three years, I have had 43 Architecture students who wanted to learn about sustainable real estate development. All of them come with the impression that a developer earns more money than an architect, but none of my students have entered the course with a good sense of what a real estate developer does. As a result, I begin by defining terms. We discuss real estate as a "bundle of rights associated with the use of, ownership of, and benefit from real property." We talk about all sorts of examples that illustrate the edges of our definition: property rentals, easements, national parks, air rights development, etc. We move from there to discuss what development is, and my students are generally as imprecise about this as they are about real estate. But we ultimately define development as an "Entrepreneurial activity that assembles and applies the financial and physical resources to construct new built space, convert existing buildings to a new use, and/or reallocate the bundle of rights associated with real property." This makes it much easier to define the job of a developer. Developers are entrepreneurs who assemble and apply financial and physical resources to create new space, reuse existing space, and/or reallocate the bundle of rights associated with a particular piece of real property.[1]

This difficulty understanding the industry is not unique to my students at Tulane. Despite the fact that real estate development is a huge portion of our national economy,[2] the development process remains poorly understood. In my own review of the 2007 North American Industrial Classification System (NAICS), I found that the words "real estate" show up in 84 different NAICS 6-digit industry descriptions, and there are at least 5 NAICS 6-digit codes related to development, though none that are called real estate development. The most closely related 3-digit sectors to real estate development include sector 236 (Construction of Buildings), sector 237 (Heavy and civil engineering construction), and 531 (Real Estate). So this study will begin by trying to describe the industry itself. What motivates conventional action in development, how does the organizational architecture of the industry reflect those motivations, and how can we understand what a traditional development process looks like? From there, I will move on to the challenge that green development presents for this conventional case, and the particular pressures that green development would put on developers and other members of development teams. From this foundation, I will build a hypothesis about four common characteristics of leading adopters of green development, and test this hypothesis through a survey of leading adopters of green development practices.

[1] This definition is intended to be inclusive of for-profit and non-profit developers, including community development corporations.

[2] In 1992, investment in new space accounted for 7% of our gross domestic product and was the largest single industry (DiPasquale and Wheaton). By 1994, Christopher Gordon estimates that building construction had grown to nearly 10% of the economy in the United States (Gordon).

Section II. The Development Process

In this section, I will build a model for the development process, laying out the conventional motivations for firms in this industry and then describing the conventional architecture which defines firm size and relationships. That exploration begins with what I will call the three principles of the structure of development firms:

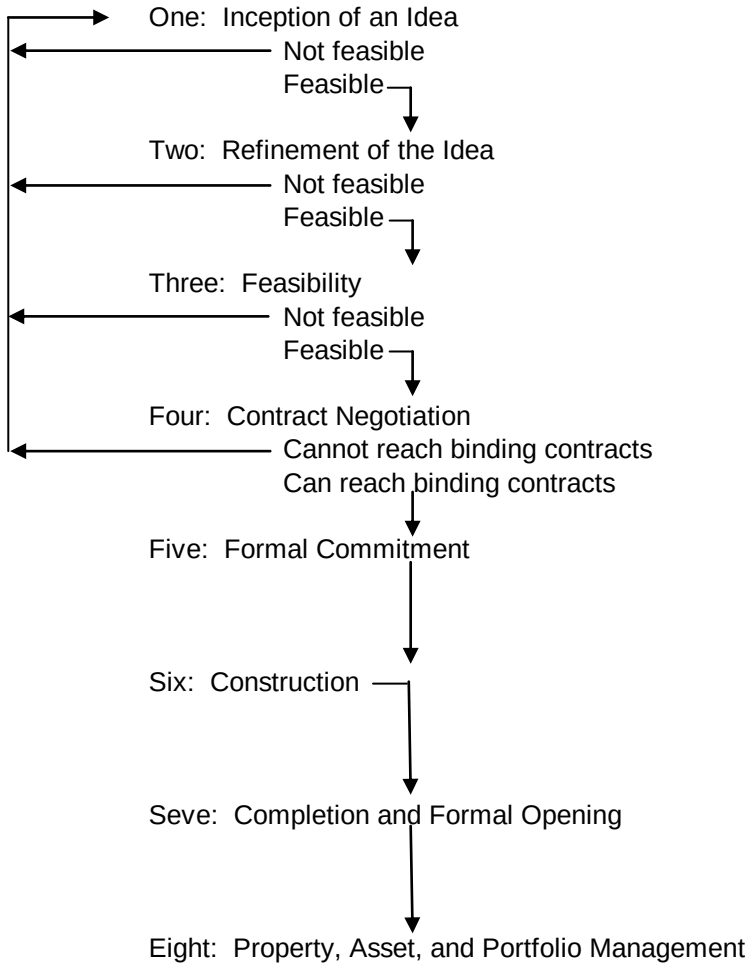
Principle 1 – Development firms are small, on average.
Principle 2 – Development teams make buildings; development firms assemble and disassemble development teams.
Principle 3 – Development is a complex task requiring the coordination of many discrete players, each with their own interests.

The three principles of the structure of real estate development firms

To begin, we will return to the North American Industrial Classification System, and look at the 3 digit sectors that imprecisely include real estate development companies. Those 3-digit sectors consist of firms that are very small. The average number of employees for sector 531 (Real Estate) is 5.1 people per firm, the lowest of all 3-digit sectors. Sector 236 (Construction of Buildings), with 6.7 employees per firm, has the sixth lowest average among 82 3-digit NAICS sectors. Sector 237 (Heavy and civil engineering construction) with 25.6 employees per firm is just above the median, but the 6-digit designation related to real estate development within that three-digit classification (Industry Code 237210 – real estate sub-dividers) has only 12.8 employees per firm, which is slightly higher than the 25th percentile of firm size in the 3-digit sectors. So while we cannot precisely define real estate development from the classifications within the NAICS, we can make a case for the first principle of the structure of real estate development firms, namely that on average real estate development firms are small. The work of Sommerville adds some interesting depth to this prediction about small development firms. In looking at the size of homebuilders[3] in multiple markets, Somerville finds that builder size increases in more active markets with larger supplies of available land and greater demand, and that builder size is also inversely proportional to the scope and intensity of municipal land-use regulation. This finding on regulation mirrors some work by Oster and Quigley (1977).

The chart below lays out a basic conception of the development process, moving from the idea stage through to asset management, once a building is completed.

[3] The author notes that there is a distinction between homebuilders and developers, an issue that will raise itself multiple times in the literature review around real estate development and development firms.



Miles et al: Real Estate Development: Principles and Process (published by ULI)

One of the key aspects of this diagram is that development is iterative, and the successful developer has to be able to manage the critical feedback being received and make appropriate decisions, often with incomplete information.[4] For example, the author is interested in renovating the abandoned convenience store by his house for making and selling ice cream. The initial review of this idea requires some basic analysis of the area. Is there another ice cream shop nearby? Can one acquire the building? Is there a market for ice cream sales in the area? Are there ice cream companies who would want to move to this space? If the answers to these early questions are yes, then the idea might move to the second stage, where this idea is refined. At this step, one might begin discussions with the building owner, begin discussions

[4] The connections to the model used by Eccles (1981) and adapted from Williamson (1975) that discuss pairs of factors, one human and one environmental, that effect decision-making in firms are clear here. Development is an endeavor with uncertainty/complexity where there is bounded rationality as a result of that uncertainty. We will return to this framework throughout.

with various ice cream makers, visit the building to get a sense of what it would need to be converted, and carry out a more detailed study of the size of the market for ice cream at this location. It is entirely possible that some obstacle would be encountered at this point that makes the development unfeasible, but if not, then the team would continue to a full feasibility study. At this point, the developer would determine, to the greatest extent possible, the true costs and benefits for acquiring and converting the building to an ice cream store. This might include a number of formal and informal investigations like a structural analysis of the building, a survey, an appraisal both as is and as intended, a preliminary design concept, construction cost estimates, an environmental study of the subject property, and a complete market analysis for the intended use and location. The developer might also begin negotiations for use of the space with several of the ice cream manufacturers he reached out to in the previous step. These formal investigations are intended to uncover reasons that the project might not go forward, but again information is somewhat incomplete. Still, if the project looks feasible, it will proceed to the fourth step, where the developer seeks out binding contracts with the interested parties involved. In this case, those binding contracts might be a lease with the ice cream store operator, a purchase agreement with the property owner, a construction contract with the builder, a design services agreement with the architect, a loan from the bank financing the project, a commitment of equity from any equity investors that are needed, and the necessary entitlements (zoning approvals, building permit, etc) to allow the conversion to be undertaken. What originally seemed like a simple idea, let's buy the building and make it an ice cream store, now has a number of moving parts. Once you reach formal commitment, construction begins, the project is completed and opened, and then it must be effectively managed as a long-term asset.

This description of the process points out another critical component of development, namely that the product of development (a building) generally requires participation beyond the boundaries of the development firm. To state another way, the developer must rely on a number of other actors (generally not within her own firm) to deliver on key components of the project. These other actors are frequently coordinated in a development team, where each actor has key roles and responsibilities, and the developer keeps their progress coordinated and on schedule. This insight leads to what we will call the second principle of the organizational structure of developers. Simply stated, development teams make buildings; development firms assemble and disassemble development teams. This concept is closely tied to Eccles conception of the quasi-firm, and underscores the idea that contractual obligations in development tend to last for the duration of a project and then dissolve to free up all parties to pursue other opportunities.

The second principle of the organizational structure of developers leads to an obvious question: who are these other members of the development team? That question can be answered by thinking about the sort of specialized services needed to carry out the work described above in the story about opening an ice cream shop. First, we need an architect or design professional and a contractor. The design professional is generally responsible for providing the plans and specifications for how the building will be put together and then certifying that the contractor made the building in keeping with those plans and specifications. The contractor, in turn, is

responsible for choosing the means and methods to be used to put the building together. We will return to this discussion in intricate detail in the next section, as we work through the "OPC" Model, which stands for **O**wner, Design **P**rofessional, **C**ontractor (Poage 1990). But the Owner, Design Professional, and Contractor are certainly not the only people needed on the project. Miles, in his seminal work on the development process, lists over 20 other professionals that may be involved on a development team, everyone from the lender to the plumber.

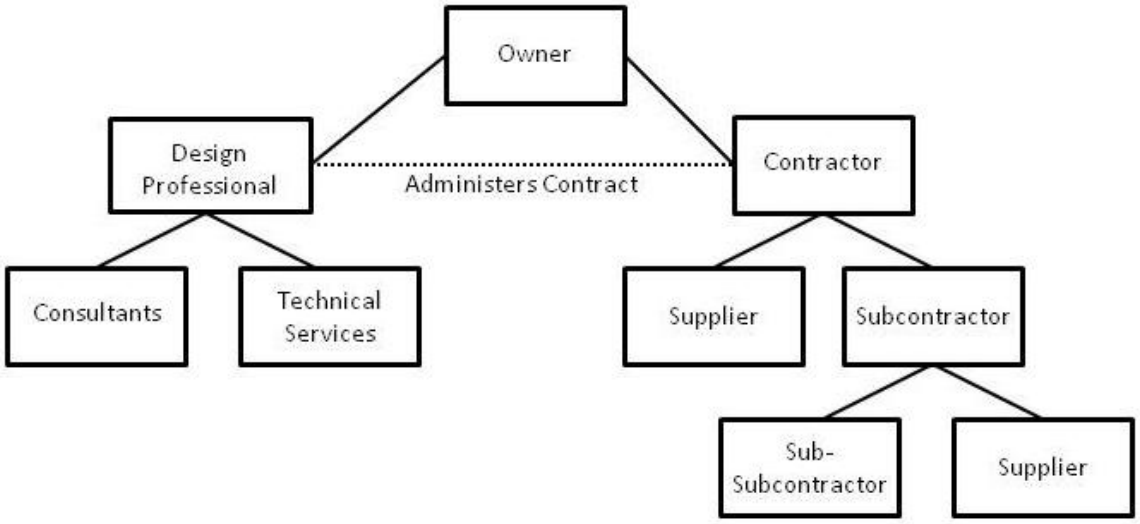
The developer's role is to coordinate these disparate parties and get them to act in concert in order to deliver a particular project. This description leads to the third principle of the organizational structure of development, namely, development is a complex task. It requires the coordination of many discrete players with their own particular interests. The developer's job is to keep everyone moving towards a common goal, completion of the intended project. In doing this job, the developer frequently must make decisions with limited and incomplete information, and must understand the dynamics and motivations of the other members of the team. This framework matches well with Eccles discussion of industries that are characterized by complexity and bounded rationality.

The "OPC Model"

So far, we have laid out the three principles of the organizational structure of development firms, which are:

1) Development firms tend to be small on average, though they are not always in any individual instance, and there may be reasons that average size may vary based on market and product type as suggested by Somerville;
2) Development teams make buildings, and development firms assemble and disassemble development teams (Eccles model of the quasi-firm);
3) Development is a complex task marked by uncertainty, and decision-making is marked by bounded rationality, as described by Eccles (1981).

The conventional and most common organizational model for development teams, the "OPC model", addresses the complexity of the development process, the need for efficient contracting, and the capacity concerns of small firms who are embarking on complex projects. The OPC model focuses on the most critical relationships in any development team, those between the owner, the design professional, and the contractor. The traditional method for organizing this relationship is shown in the diagram below.



OPC Structure Diagram adapted from Figure 1.1 in Poage 1990, page 4.

There are several critical components to this OPC structure that relate back to our three principles of the organizational structure of development firms. First, the Owner has a direct relationship with the Design Professional and the Contractor, but the Design Professional administers the Owners' agreement with the Contractor. In addition, many of the other professionals needed to carry out a project are sub-consultants to the Design Professional or the Contractor. The Design Professional manages all engineering, landscape architecture, etc. In turn the Contractor is responsible for all relationships with materialmen/suppliers, and sub-contractors. In this conception of the development process, the Owner is responsible for the maintenance of the relationship with the Design Professional, and all other parties who are directly involved with the creation of plans for the building or the construction of the building are managed as an outgrowth of the agreement with the Design Professional. This is an excellent model for a small firm with limited capacity taking on a complex task. It puts significant emphasis on the skills and capacity of the Design Professional and to a lesser extent the Contractor. It also makes the assembly and disassembly of a team fairly straightforward. The Owner needs to contract with a Design Professional and a Contractor, and the majority of the other critical relationships are taken care of by those two members of the team. This convenience doesn't come without a price. The Owner is giving up significant control, but he is also adding expertise, capacity, and networks to the resources already available to him and his firm.

Another interesting implication of the conventional OPC structure is the suggestion of linearity in the development of a project. In this structure, the Design Professional fully designs the building, and then the Owner and Design Professional competitively bid the project in order to retain the services of a Contractor. This framework works best when the building can be fully conceived through the design process, and there is no time constraint pushing the developer to overlap the design process and the construction process (Gordon 1994).

The conventional OPC structure also has some significant drawbacks that may make other structures more desirable. First, the process puts enormous emphasis on the knowledge of the Design Professional (Gordon 1994). Not only must the Design Professional be a skilled designer, but he must also be knowledgeable about building materials, construction cost, constructability, and the availability of certain types of labor in order to make good decisions in the design process. Such expertise is unlikely to be held in a single person or even a single firm, particularly as projects become larger and more complex. Second, this process provides little flexibility for future changes. This lack of downstream flexibility puts a significant premium on understanding all future contingencies, something that is hard for any development project (due to its complexity) but particularly hard for innovative ones. Once the design documents are complete, construction bids are received, and a construction contract is awarded, it is generally expensive to make even small changes in the plans. However, other forms of this OPC relationship provide for more flexibility later on in the process. Third, the conventional OPC relationship creates an adversarial quality in the relationship between Design Professional and Contractor (Gordon 1994; Schlosser 2010). The Design Professional in effect becomes the policeman of the Contractor, working on behalf of the Owner to ensure that no corners are cut, that quality is high, and that delivery of the building matches the intentions as laid out in the plans and specifications. While such oversight is critical in a successful project, this structure can also mean that the Contractor has little to no incentive to protect the interests of the Owner or otherwise improve the project. These agency issues become particularly important in innovative efforts when the long-term impact of various decisions may not be well understood ex ante, and an owner will want as much expertise from all team members as possible and for those team members to protect her interests in ways that cannot be easily contracted.

Section III. A Theory of the Green Development Firm

This section will rely heavily on Eccles and his look at firm structure among general contractors. Even though general contractors and developers are different but related entities, there is much that is helpful in this exploration; in particular, it helps illuminate critical differences between the theory of the manufacturing firm (relying heavily on Williamson) and the construction firm, a much closer cousin of developers. In fact, Eccles sums up the challenge for understanding the organizational structure of developers when he says:

> "A fundamental question of economic organization is the extent to which a firm is directly responsible for producing all of the inputs required for its products. This is the general question of vertical integration. Should the firm decide to vertically integrate, it is then faced by the question of how to organize to complete the work. If the firm chooses to obtain certain inputs from other firms it faces the question of how to manage these relationships."

The balance of this section will be devoted to building a theory about how development firms answer these questions about self-organization.

The Make, Buy, or Contract Decision

The literature on the theory of the firm can be distilled into two competing strands, contract and control (Gibbons 2005). Control ideas spring from Ronald Coase in his seminal paper, "The Nature of the Firm" (1937). His idea was that because transactions are not costless, firms are created around the most common routines of business, allowing a business to internalize its transactional costs and negotiate a long-term fixed price for certain things, like the labor of a given worker. To paraphrase Oliver Williamson, firms exist because it is more efficient to make decisions by fiat rather than haggling. The contract line springs from Alchian and Demsetz (1972) who argue that because of incentives to shirk in team production, firms create greater efficiencies by hiring a central manager with hiring and firing capacity who owns the residual from team production.

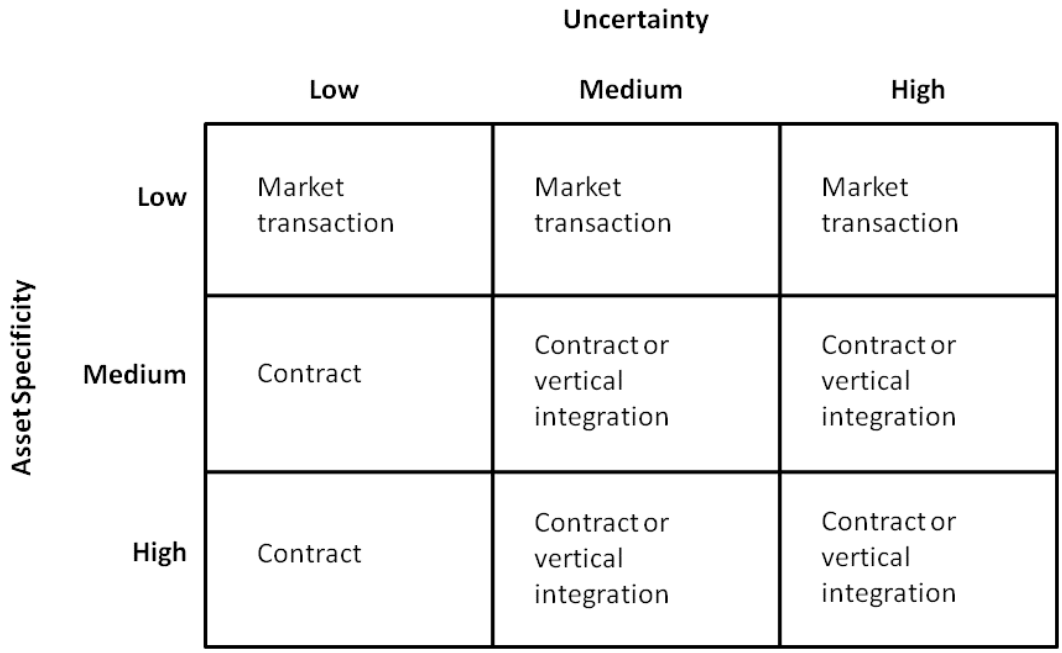
This control theory is nicely summarized by Brickley, Smith, and Zimmerman (1997), who lay out a continuum for every transactional decision between purchasing on the spot market and vertically integrating around a given activity. On the spot market, the business has no price control, and must pay the going rate for goods and services. At the vertical integration end, the firm internalizes this activity, and begins acquiring this particular good or service from itself. In the middle, a business creates a contract with a particular supplier. These contracts may be short-term, and may be almost the same as a spot market purchase, and they may be long-term and look almost like a vertically integrated business, but some interesting theory explaining the differences has been developed. Where a certain activity falls on this continuum has been distilled to two characteristics of the activity and its relationship to the firm's core business:

1) How specialized the good or service is to the needs of a particular business. (Klein, Crawford et al. 1978; Anderson and Schmittlein 1984; Williamson 1985; Kim, Mayers et al. 1996)
2) How volatile the market is for the delivery of a particular good or service (Milgrom and Roberts 1994)

If a firm has a highly specialized need with a low residual value of the good or service in the second-best use, then this activity is likely to fall on the vertical integration end of the continuum. If the second-best use will pay close to as much for this particular good or service, then it is likely to fall on the spot market end of the continuum.

The other characteristic has to do with price volatility in the market for a specific good or service. If the delivery of that good or service has a very volatile price, then firms are likely to move towards the vertical integration end of the continuum. If the delivery of that good or service has a stable price, then firms are likely to move towards the spot market end. These characteristics allow one to draw a decision matrix[5] that helps predict whether a business will vertically integrate around a certain activity, purchase that good or service in the spot market, or enter into some form of a contract with a given supplier.

[5] This figure is drawn from page 477 of Brickley, Smith, and Zimmerman (2003).



A critique of this theory arose in the idea, first voiced by Alchian and Demsetz (1972) that it was not the control of assets, skills, or services that led to the creation of firms (control theory), but rather a way of organizing or motivating work to reduce the tendency to shirk in team production (contract theory). This theory argues that when it is difficult to measure the direct connection between your work and output (i.e. in situations with team production), workers have a tendency to free-ride on the efforts of others. As a result of this tendency to free-ride, having someone who is responsible for the structure and operation of the team, and who then receives at least part of the residual from the work of the team, creates a more efficient management process and leads to the creation and continuation of firms.

Eccles work is an interesting extension of this case, also growing out of the contract strand of this literature. He points out that the choice to use subcontractors rather than vertically integrate may be strategic and efficient in areas like construction because of the ability to hire expertise but not maintain that expertise in-house through volatile periods of demand. Sub-contracting is a preferred method because the relationship does not have to last any longer than a particular project. His investigation revolves around Williamson's "inside contracting system" where one firm contracts with an individual or other firm for piecework and/or certain tasks under fixed price contracts, with all necessary materials, equipment, etc. provided by the subcontractor firm.

In summary, we have four critical points that will help us build a predictive model of the make, buy, contract decision around the scale and scope of developer operations. Those ideas are:

1) The need for highly specialized products or services in a production process will tend towards integration, where less specialized products or services will be purchased in the marketplace (i.e. not become part of the firm).

2) The need for inputs with highly volatile pricing in a production process will tend towards integration, where inputs with more stable pricing will be acquired in the spot market (i.e. not become part of the firm).
3) Successful firms engaged in team production (where connecting firm outputs with individual inputs is hard) will employ a manager who has control of hiring and firing and is compensated at least partially by the residual between firm revenues and costs.
4) Firm size may not be just a function of ability to integrate or not, but there may be particular circumstances where team production is more efficient with sub-contractor relationships (inside contracting) rather than vertically integrated ones. In those cases, small size results from industry characteristics, not firm performance (in fact bigger firms may perform less well).

Towards a theory of the real estate development firm

Eccles describes five drivers of inside contracting in construction and why Williamson's eight impediments to inside contracting are not major problems for general contractors. Using this framework as a base, I will translate it into our discussion of the development firm. As I describe each driver or impediment, I will also provide commentary on how Eccles assumptions about construction relate to the development industry. Eccles' five drivers of inside contracting in construction are listed below.

1) Inside contracting puts all the people needed to do a job in one physical location. As Eccles points out, this is almost tautological for conventional construction processes, because the project gets built on a particular site where all the laborers come to work. However, the introduction of industrial construction techniques (which has grown rapidly in the 30 years since Eccles published his study) does present an interesting challenge to this premise. In addition, co-location on a single site is one of the places where construction and development differ considerably. The development team is not necessarily assembled in a single location to carry out successive manufacturing processes, as in Williamson's initial model. So a developer may need to emphasize the "economies of communication" that Eccles sees in on-site construction, and that communication is probably most important in the P-C relationship, which is the axis along which most critical decisions are made in a development project.
2) The general contractor has little physical capital he needs to use productively because the subcontractor provides the expertise for the use of capital. This can be even more pronounced in the development realm. A developer can subcontract for most or all of his responsibilities. This ability to bring in talent, expertise, and capacity on an as-needed basis is not only a hallmark of the development process; it may have significant advantages for the developer because he does not need to build that expertise in house, and pay to maintain it through volatile market conditions. But this also creates an agency problem– i.e. the developer is not sure whether the people he contracts with will fulfill their responsibilities. In standard economic theory, competition is supposed to handle this problem by weeding out the bad guys, but one or two bad projects may put a developer out of business, and that competitive mechanism may take too long to work.

3) Special trade contractors have incentives for efficient labor production in order to maintain competitiveness in the market for that trade. Because there is not generally a shortage of particular types of subcontractors (electricians, plumbers, HVAC subs, etc) and because engagements don't have to last longer than one project, there are significant incentives to be efficient with labor. Otherwise, the specialized trades will be uncompetitive with others in the market. This is also generally true for developers, who have the universe of general contractors and design professionals to choose between, along with a myriad of other potential development partners.
4) The temporary nature of construction projects resolves the problems with monopoly power that the sub-contractors could have over a general contractor. The same is true for development, where the term of engagement means that the developer's partners have to continually prove their value to the development firm.
5) Information flow is improved by having all parties at the same site. Like the closely related discussion in point 1, above, generally all parties to a development agreement do not do the majority of their work at the site. The best developers are able to create an environment where information flow happens despite any challenges around the geographical separation of team members, and a focus on building a stronger P-C relationship is critical in that effort.

Eccles also recounts Williamson's eight constraints to inside contracting, which he claims are mostly not a problem for general contractors because of their differences from standard manufacturing firms (Williamson 1976; Eccles 1981). Those constraints are:

1) The inside contracting structure can create a bilateral monopoly. Eccles argues that this is not a problem in construction because of the temporary nature of the contracts. The same would be true for development.
2) Periodic renegotiation of agreements encourages the hoarding of information. Eccles argues this is not a problem because the market price is knowable (there are many providers of any service even though quality may not be consistent) and constantly being re-established. The same would be true for development agreements.
3) It's difficult to regulate the flow of components in an inside contracting structure. Eccles argues that there is no component flow in construction. Everything comes to the site and is built there. In development, this problem exists, and one of the central challenges for the developer is ensuring that the right members of the development team have the right information and resources at the right time. Work product really does need to flow from the Design Professional to the Contractor to the Lender to the Environmental Consultant, etc. and back again in this series of iterative loops. While many of the components of development are not physical products (as in manufacturing) this same challenge is present with the sharing of information.
4) Inside contracting leads to excessive work-in progress, and later-stage processes will waste components from early stage work. Eccles claims this is not a problem in construction because the trades rely on each other. In development, this can be managed through the draw process, where work is only paid for as completed, inspected, and accepted by the Design Professional or Owner.

5) Inside contracting can lead to situations where contractor incomes are excessive in relation to the capitalist. Eccles argues that this is not a problem in construction, and provides data on the average compensation earned in general construction versus specialized construction. The wages earned in general construction are higher. In development, it is likely that a similar situation is true, but because there is no good data on real estate development firms from NAICS, it is unclear how to make the comparison quantitatively.
6) Equipment is not utilized and maintained well under an inside contracting structure. Eccles argues that this is not a problem in construction because of the short-term nature of projects, and the need to maintain competitiveness in a marketplace with lots of competition. The same situation is true for development.
7) Inside contracting drives innovation on labor-saving approaches, rather than material saving. Eccles argues that selecting construction materials are not in the Contractor's or Sub-contractor's scope so it's not a problem. This is not true for development, where both labor-saving and material-saving innovations may be desirable. In addition, the standard contract forms for development (fixed-price for Contractor, percentage of construction for Design Professional) do not create an environment where material-saving innovations are likely to be paramount. It's likely related that, globally, buildings use 40% of raw materials produced annually (Lennssen and Roodman 1995).
8) There are few incentives for product innovation in an inside contracting structure. Eccles argues again that this is unimportant in construction because product innovation is not in the contractor's scope. But this is not true for development, just like above. And there is much evidence that the development industry (along with construction) lags other industries in the development of new products (Oster and Quigley 1977; Egan 1998; Pauly 2005).

To sum up, developers would experience many of the same drivers towards inside contracting that builders do, especially a desire for the efficient use of capital, a desire for the efficient use of labor, and recognition that projects are temporary which solves the monopoly issues that could develop in longer-term engagements. However, the nature of the development process makes physical co-location and information sharing somewhat remote from the framework laid out by Eccles, and places more emphasis on creating a strong working relationship between the Design Professional and Contractor. With respect to the impediments to inside contracting, a developer faces obstacles that the contractor does not. The problems of bilateral monopoly, information hoarding, excessive work-in-progress, excessive income for the contractors, and poorly maintained equipment are not likely impediments for developers. However, regulating the flow of components, a lack of material-saving innovations, and a lack of product innovation may all impact the operations of a developer or development firm. These problems might drive them away from inside contracting or push them to create special innovations that allow them to address these problems through contracts.

Beyond this, there are at least four major differences between real estate development and a conventional industrial process that motivate organizational form in real estate development. Those four differences are 1) product uniqueness, 2) on-site assembly, 3) local regulation, and 4) localized markets. What do we mean by each of these terms?

1) Product uniqueness argues that the process of building any particular building has never happened before and will never happen again. A development firm gets one chance to make that particular building (DiPasquale and Wheaton 1995; Geltner and Miller 2001).

2) On-site assembly refers to the fact that most buildings are made by having component parts shipped to the site where the building will be used and then put together. During assembly the component parts are exposed to the weather and subject to handling by a large number of sub-contractors who are acting with limited oversight, in comparison to factory-based production (Eccles 1981; Gordon 1994).

3) Local regulation points out that unlike other industrial processes, development is regulated locally as a police power, and there is wide variation between municipalities around the cost of doing business as a developer (Oster and Quigley 1977; DiPasquale and Wheaton 1995; Geltner and Miller 2001; Koebel 2008).

4) Finally, real estate products trade in a highly localized market, and not a national or international one. Buildings are not transferable between locations, and one cannot understand the real estate market nationally. You have to look at the price for particular types of space in particular locations, i.e. office space in Chicago (DiPasquale and Wheaton 1995; Geltner and Miller 2001; Bradshaw 2006).[6]

While it is true that many aspects of the development process are replicable and can even become rote, every project is unique in some way, causing at least some level of specialization within the team that is fairly uncommon in most industrial processes. Based on our previous discussion of the theory of the firm, this uniqueness creates pressure to internalize some goods and services needed for production to the firm, either through contracting or vertical integration. Consider a particular building, the value of that building in its second-best use may be significantly lower than the first. Development projects also have a long production process, and market conditions change during the timeline that it takes to complete a project. Very frequently, someone begins a deal in a time when demand for a particular product is strong, and by the time they finish the project that segment of the market is overbuilt. A building is also capital intensive to create, and the level of risk taken on by many developers is well beyond their personal ability to repay. In effect, many real estate projects have two potential outcomes for the development firm: the project is successful or the firm (possibly along with its principals) goes bankrupt. This represents significant volatility, and would also push developers towards creating greater access to capital, which would allow them to muddle through downturns and

[6] Granted, there is some heterogeneity in this, i.e. the residential market is most localized (one is not likely to move across the country because you found a nice apartment) and more regional/national markets develop for more homogeneous space (i.e. a retail facility may want to locate in a certain type of building in the Southeast or the market for self-storage may be under-supplied in Georgia), but the basic premise holds. Geography is a critical component of the market for space, in a way that it is less important in the market for tires or shoes, which can theoretically be shipped anywhere.

survive until the market was stronger. In practice, some mechanisms to deal with this problem have been developed. First, developers quite commonly have relationships with large-scale capital interests, either with high-net worth individuals or with other institutional grade investors like banks, life insurance companies, and pension funds. In addition, successful developers frequently become high net worth individuals, effectively allowing them to act as their own financing source. Second, some firms that engage in development activities (REITs and REOCs) have created new mechanisms and legal structures that provide access to public capital markets. This creates a financing efficiency that has historically been lacking in development. Third, firms frequently utilize strategies that minimize the volatility of their assets. These might include internal rules about loan to value, lease guarantee requirements, developing only in supply-constrained geographies, and more. Over the long-term these strategies are a hedge against catastrophic events, like project or firm bankruptcy.

Development projects are also highly durable, and they are expensive to replace or change once they are completed. There is a high premium placed on getting something right the first time since how it is done the first time is likely how it will stay for a generation or longer. Again, this points development towards the vertical integration end of the continuum, emphasizing the developer relationship to design and construction services. There is a difference, however, between being pushed to the vertical integration end of the continuum and being pushed to vertically integrate with design and construction, which is well described in Eccles. As we have seen earlier in this work, there may be strategic reasons that project to project contracts with design and construction services are preferable for a developer rather than true vertical integration. First, there is a problem with having to pay for these services in house when demand is quite volatile, and developers may not be able to afford such services in the valley of the economic cycle. Second, there is an efficiency that has been developed in the industry about how such contracting relationships work, and a developer can rely on the norms and processes that have been created. Third, allowing for specialization may create greater labor productivity overall because the Contractor, Design Professional, Sub-contractors, etc. will become very good at doing one particular thing in the development process, and therefore can deliver that thing much more efficiently than a firm or person seeking to do many things. In effect, this labor productivity argument is really a dressed up version of an argument about scale economies – i.e. a design firm may reach greater efficiency and productivity by getting really good at design, rather than also getting good at construction or development.

Despite any pressure to integrate (and create larger development firms), the first principle of the structure of development firms theorizes that they are small, on average. There are several other industry characteristics that support this empirical result. First, many places have fairly nebulous rules for development, particularly big projects, and much of the work of the developer is to secure the necessary entitlements to carry out the vision for the project. Not only is this a long and painstaking process with unclear direction in many cases, but it is particular to the municipality in which the project is proposed. So just because one understands the permitting process in San Diego does not mean that he will be able to navigate the same process in Fresno. This characteristic points away from horizontal integration (i.e. working in many geographies at once) and is supported by the work of Somerville and Oster and Quigley.

Second, developers experience lumpy returns, and they have highly varied access to capital. Because the time lag between payoffs is so long (a characteristic of the long production process and an uncertain regulatory environment) it is hard for a development firm to create a highly integrated company that controls suppliers and labor used in production. The lumpy and uncertain nature of the returns from development mean that there is a lot of pressure to maintain a small, efficient labor pool in house and to contract with other factors of production especially construction labor, material suppliers, and debt investment. Where other firms might attempt to vertically integrate to control their production and supply chains, most developers do not do this. The lack of integration may be a function of inability, or (as suggested by Eccles) it may be a function of strategy. This question underscores a distinction between a development firm and a development project.

While development firms, from project to project, will keep a lean staff, they will very quickly scale up their ability to deliver on projects by creating fairly long-term contractual relationships with other parties that fill in the areas of expertise and product distribution that they do not have. This generally includes design services, construction services, debt investment, and the supplying of materials, systems, and building components. In a sense, the development team becomes Eccles quasi-firm delivering on a particular project in a particular time period, before it is dissolved again, with the participants left to pursue other opportunities.

This underscores the importance of contract law in development, and how contract law has established well worn relationships between the various actors in a development project, most especially the Owner, Design Professional, and Contractor. These well worn contractual relationships make it much easier to assemble, dissolve, and reassemble the factors of production needed to create buildings and develop property. However, it also means that these relationships rely on institutional norms and modes of practice much more frequently than in other industries. It is also of note, that we are not discussing spot market transactions. Because of the nature of the real estate product, spot market transactions are avoided, but because of the timing of the cash flows, full vertical integration is rarely possible and probably not desirable. Most developers would prefer to be in the inside contracting space described by Eccles, as it responds better to their size, capacity, and the characteristics of their industry, especially complexity/uncertainty coupled with bounded rationality.

There are several dominant assumptions in this analysis that deserve mentioning. 1) Development firms are organized in order to make money. In this initial attempt at understanding the structure and nature of the development firm, this is the single motivating force – a desire for profit. 2) The norms and standards of practice are critical in the industry because of the reliance on standard contract forms to lessen transaction costs between different actors in the development process. This need for contracts is the result of a central tension in the development industry: the product of development pushes firms towards integration, but long lead times, lumpy returns, lack of scale economies due to the fractured nature of the regulatory environment, and the strategic advantages of inside contracting prevents significant integration from occurring in the industry, at least within smaller, localized firms. My theory is that this ability to contract easily has replaced the need for full vertical

integration on an inter-project basis and has evolved to a situation where the legal, financial, and functional relationships between parties to a development project are so well understood and well litigated that the assembly, dissolution, and re-assembly of the team can happen very easily.[7]

Section IV. Why green development is hard

Environmental innovation in development or green development is defined for this study as double-bottom line in its approach, meaning that the developer is working towards goals for financial and ecological performance.[8] This is considerably different than what we saw in the conventional model of development where nothing other than financial performance mattered. In practice, ecological performance may take on several forms. The most common forms reflect an approach that has been described as eco-efficient (McDonough and Braungart 2002), meaning that the approach focuses on minimizing ecological damage throughout the building's life cycle (from construction through operation and demolition). This would include things like using energy-star appliances, replacing your incandescent bulbs with CFLs, buying materials from near the construction site, and other things intended to do less harm than standard practice. Another approach has been labeled eco-effective (McDonough and Braungart 2002), meaning that the approach is intended to repair previous damage and do more things that grow the stock of resources available to building users. The eco-effective approach eliminates the concept of waste by making the output of any process an input for another, by breaking the world into biological (compostable) and technical (very long-lasting – think steel) nutrients, and by removing mutagens, carcinogens, and other harmful materials from the supply chain altogether. Such an approach would include developing buildings that produce all of their own energy, that purify water and air, or that grow food for their users. There are many rating systems that have been developed which attempt to measure the performance of buildings in one or both of these ways. Eco-efficient systems include the Leadership in Energy and Environmental Design program (LEED) promulgated by the US Green Building Council, the Green Building Standard promulgated by the National Association of Homebuilders, Energy Star promulgated by the US Environmental Protection Agency, Building America promulgated by the US Department of Energy, and scores of local and state programs. Eco-effective systems include Cradle to Cradle™ promulgated by William McDonough and Partners, and McDonough Braungart Design Chemistry and the Living Building Challenge.

Environmental innovation, which will be used interchangeably with the term green development throughout, presents problems for the conventional real estate development

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[7] This is not intended to imply that the characteristics of individual firms don't matter, in the sense of quality versus price competition which will be discussed later in this study. I am simply trying to point out that contracting for development team members is a remarkably easy thing to do given the level of complexity involved in the ultimate development product, and this is a critical aspect of the industry structure.

[8] Many green developers, including myself, are self-consciously triple-bottom line, meaning that they also have goals around social equity and community, but this definition does not preclude the triple-bottom line developer from being green.

firm. Rather than an entrepreneurial team organized solely around making money, green development projects are organized around making money and meeting goals for environmental betterment. These environmental goals require a rethinking of the product of development (a building), but more than that they point towards a reorganization of the development process that cuts against established norms in the field, and changes well-trod contractual relationships between firms that are constantly being assembled, dissolved, and reassembled in the development process. This reordering of relationships is significantly problematic because it causes friction at every level of the development process. To understand more about how this may work, we will start by looking at research on innovation in construction, despite the important caveat that a real estate development firm and a construction firm are distinct, but related businesses. In particular, innovations in construction are likely to be sustaining in nature, meaning that they are a variation on an already established idea (doing something better). In contrast, innovations in development are likely to be disruptive or transformative in nature (doing something different altogether) as a way of pushing the industry towards a new path.[9] This rule is certainly not hard and fast, and we will return to it later, but one should keep that in mind as we discuss the literature on innovation in construction.

C. Theodore Koebel carried out a national survey of construction firms (Koebel, Papadakis et al. 2004) and later wrote about the influence that planning practice can have on innovation in homebuilding (Koebel 2008). He finds that residential construction firms bear significant risk from building product innovations, while receiving little reward (Koebel 2008). Beyond this, he supports much of the accepted knowledge about the structure of construction firms, ideas that are transferable to development firms. Those characteristics include:

1) Construction firms are characterized as a small, fragmented group (Oster and Quigley 1977; Egan 1998; Pauly 2005)
2) Construction firms lag other building-related industries (design, engineering, etc) in the adoption of technological innovations, and under-invest in research and development (Oster and Quigley 1977; Koebel 1999)
3) The fragmented regulatory environment around construction and development (where local jurisdictions are responsible for setting and enforcing rules) further restricts innovation adoption by decreasing the market reach of innovations (Oster and Quigley 1977).
4) The builder receives little benefit when innovation improves performance (Koebel, Papadakis et al. 2004).

Koebel has also looked at the characteristics that motivate innovation in construction and found that increased profit, decreased construction costs, and reduced build time are the three least important benefits driving innovation in construction for both large and small builders. To state this another way, builders don't try to innovate because they see it as a short-term cost

[9] The use of sustaining and disruptive in this context borrow from the work of Christenson and Raynor.

savings (in time or money) or because they believe their profits will go up in the short run, and this sensibility is independent of size (i.e. small builders and large builders have the same results). The three most important reasons for innovating, among builders in Koebel's survey, did vary between small and large builders. For large builders, the three most important drivers were increased quality of homes built (64% of respondents), helped meet customers' expectations (46% of respondents), and increased competitiveness (45% of respondents).[10] For small builders, the three most important drivers for innovation are: increased quality of homes built (74% of respondents), created image as an innovative builder (41%), and helped meet customers' expectations (38%). Despite the variation in their answers, both small and large builders were adopting innovation as a way of making themselves more competitive in the long-run and improving their reputation as a company.

This result implies a long-run view for both small and large construction firms when making decisions about innovation adoption. Both small and large firms innovate for long-run benefits that have to do with a continued presence in a market, rather than short-run benefits that are related to the maximization of profits on a particular job. Construction firms that have chosen to innovate have done so not because it makes them more profitable in the short run, but because they expect it makes them more competitive in the long-run.[11]

These ideas echo a point made earlier in the discussion of cost-benefit studies about green development. Most of these studies treat the costs and benefits of a particular approach as if they are certainties. A different (and likely more accurate) kind of evaluation would involve simulating the costs and benefits of an innovative project and a standard project multiple times, like one might simulate the performance of a stock portfolio, including the uncertainties attached to the various stages of production in each project. Comparing these simulations might show that while the innovative project performed better on average (which is what the standard cost-benefit study is saying), it also has a higher chance of losing money. Over multiple simulations, this would be offset by higher chances of big gains but an undercapitalized development firm may have a primary focus not on maximizing return but on getting acceptable return while minimizing downside risk. In that case, they would stay away from innovation. The results of Koebel's work may be telling us something similar to that in reverse. Here, we are seeing firms that have taken a long-run view and therefore invested in innovation. In other words, they believe they will survive to see the bigger (albeit more volatile) payoffs from an innovative approach.

Despite the significant corollaries between Koebel's work and this research, there are significant differences. This thesis is not focused on general innovation in construction firms, but rather environmental innovation in development firms and so confronts two critical gaps in the literature on innovation in construction. First, environmental innovation is a particular type of

[10] Respondents could select three choices.

[11] It is also likely that the smaller, more poorly capitalized firms take on less innovation, but Koebel's survey result is inconclusive on that question.

innovation, and lessons about innovation generally may not apply to environmental innovation specifically. Second, as we have already mentioned, a construction firm is not a development firm. Both of these gaps start to be addressed by thinking about the difference between a sustaining innovation and a disruptive innovation as discussed by Christensen and Raynor (2003).

Innovation in construction, as we have discussed it so far, is largely a series of sustaining innovations that are incremental in nature, and do not fundamentally transform the process of construction. In effect, you build green by selecting a series of alternative products that replace other products used in the building process (an eco-efficient approach). Adoption of green building practices may never reach beyond a sustaining innovation for a builder. You take widget A and replace it with widget B in your construction process. However, the rub that green building puts in the theory of the development firm we were building earlier cuts right to the core of how development happens in the United States. For a development company, green building is a disruptive innovation that requires a rethinking of all the processes of development and forces significant changes in practice. In order to create real estate projects that are green in the most cost-effective and repeatable manner, one must fundamentally change the set of relationships on which the conventional development process is based. These changes reach into the structure of the team, the nature of financing for the project, who bears ongoing performance risk, the tenure of ownership, and the timing of when certain types of consultants are used in the development process. In particular there are three critical challenges created by green development.

1. The norms for the assembly/disassembly of a team are upset. That team is no longer trying to deliver the best building it can for everyone to make money. The team now has to concern itself with the realm of environmental innovation, and this will reduce the possible universe of partners that a developer could use on a project, possibly upsetting Eccles notion that the market for development-related services is large (i.e. there may only be one general contractor in a particular market with the experience one needs in green commercial construction).
2. The greening of the building may create a bigger upfront investment in the structure. This leads to changes in the temporal nature of payoffs, and means that financing relationships will be different. Some developers (REITs and other big players) may be better suited than others to take on these challenges, and some development team structures may also work better than others in delivering such projects.
3. The developer needs to invest in inter-project learning in order to deliver the best green building possible. This is especially true when you start doing things like making buildings that purify water and air. How does one begin to do that? This investment in learning over the long-term causes more changes in relationships and also spreads risk in new ways.

To be more specific, based on these challenges developers must have a different relationship with investors because the temporal payoff from double-bottom line projects is frequently longer, the contractor needs to participate in a different phase of the design/development

process with different responsibilities whose risks aren't well understood, the design firm has to give up some control over design decisions without knowing what that does to their liability for performance, the contractor has to use materials and systems that may be unfamiliar, and the relationship between suppliers, materialmen, subcontractors, and the contractor is likely to be different with unclear impacts on pricing, long-term product liability, and how rewards are shared for successful innovation. In short, green development requires closer coordination of various processes that heretofore were much more independent of each other. This likely requires a greater degree of developer control.

Beyond this, green innovation makes inter-project relationships more valuable, and price competition in the letting of contracts less important. In effect, there are at least four areas where the disruptive nature of environmental innovations creates significant problems in the development process.

1) Investment – By taking on a green project, the developer has changed the temporal nature of the payoff from development. Green development may create super-normal returns over the long-term for a variety of reasons, as Miller, Spivey, and Florance, and Eicholtz, Kok, and Quigley have claimed, but there is much debate over that idea. Where there is wide agreement between proponents and opponents of green development is the idea that greening creates at least some up-front increases in cost (through having a larger development team working for a longer period of the development process and/or through an increased first cost for the building). An increase in up-front cost means that the financing and investment structure of the project needs to be nudged in some ways. Many early green projects utilized developer cash or guarantees to satisfy these up-front premiums, but to institutionalize the process of green development in a way that makes it easy would require a rethinking of how investment flows into a project, and when returns are expected. In addition, this idea of higher (on average) but more volatile returns points out an interesting possibility that may restrict any individual company's appetite for green innovation because they worry that increased volatility puts them at higher risk of any particular project failing (and possibly taking the company with it).
2) Design and Construction expertise – We discussed the adversarial relationship that can develop between contractor and design professional as one of the drawbacks of the conventional OPC relationship earlier in this study, but the process innovation of green development makes a strong design professional – contractor relationship even more critical. Green buildings do not have typical pieces and parts, and they do not utilize typical methods for assembly. This means that without excellent communication between Owner, Design Professional, and Contractor, the project could very easily miss its performance targets or spiral out of budget. In addition, a team approach becomes critical for incorporating the knowledge and experience of everyone on the team in a way that improves overall performance. For that reason, I would expect to see that green developers are starting to adopt organizational structures that lead to a more team-based approach to the OPC relationship and that involve the contractor earlier and with greater authority than a conventional, linear bid process.

3) Developer control – I would expect that green projects will result in developers taking a much more active role in the delivery of their projects, especially the design and construction of their buildings. In contrast to the conventional OPC relationship described earlier, it is difficult to imagine a green developer entrusting so much responsibility to her architect or requiring so little thinking from her contractor. To deliver a project that incorporates environmental innovation will require the best efforts of everyone involved, and those efforts will be coordinated more directly by the developer.
4) Industrial construction and CAD/CAM techniques – As we discussed earlier, most construction happens by having suppliers ship a bunch of materials to a site where they are exposed to the elements, and then installed by a series of sub-contractors acting with limited oversight. This is a difficult scenario for a developer interested in improving the environmental performance of her development because too much is left to chance. The right system or material may get installed wrong. Unnecessary amounts of material may get thrown away. Certain materials may become toxic through exposure on site while they are waiting to be installed. Industrial construction and CAD/CAM technologies present a solution that provides a greater level of control in green development. By building everything off site in a factory, the developer can retain more control in a centralized facility that is protected from the elements and where waste streams can be more effectively managed and controlled.

Based on this analysis, my hypotheses are that development firms who have been leading adopters of environmental innovation share some characteristics.

1) Large developers with easier access to capital are likely to have pushed further than small, local developers in the adoption of environmental innovation. The small firms who have been leading adopters are likely to utilize alternative financing arrangements with at least some investors that give the developer or the investor a longer-term stake in the project. [12]
2) Early adopters of environmental innovation have moved away from price competition in the selection of development team members, in favor of long-term relationships, inter-project learning, and negotiated bid arrangements wherey the providers of design and construction services in particualr are familiar with the requirements and the past projects of the developer.
3) The developer exerts greater control throughout the entire development process, especially in the provision of design and construction services.
4) Early adopters of environmental innovation have moved aggressively towards industrial construction and CAD/CAM construction techniques because it gives the developer more control over the installation of products and the ability to reduce waste.

[12] One way of testing this idea will be to investigate whether products that lend themselves to long-term investment (rental housing and office space) are more frequently greened than for sale housing. Unfortunately, my sample does not allow me to test this particular point.

I test these hypotheses by asking developers how they have adopted and failed to adopt environmental innovation in development. This survey occurs in 3 parts. First, I carried out an original, web-based, large N survey of mostly green developers. In doing this, I collected critical demographic information about 102 unique development firms, and got a glimpse of the changes they made and did not make in their development process as a result of greening. Second, I carried out interviews with two leading adopters of green development, and one firm that has rejected green development as a practice. These analyses capture the story of how and why these firms adopted or rejected green development practices and processes.

Section V. The Why and How of Green Development

In the last few sections, I laid out a working model of the development industry that predicted specific ways in which green practices would disrupt the processes of traditional development firms. I also showed how we would expect conventional developers to behave, and was able to juxtapose that against the expected behavior of green development adopters. In doing this, I predicted that green development adopters would take certain approaches to address these challenges.

1) Large developers with easier access to capital are likely to have pushed further than small, local developers in the adoption of environmental innovation. The small firms who have been leading adopters are likely to utilize alternative financing arrangements with at least some investors that give the developer or the investor a longer-term stake in the project.
2) Early adopters of environmental innovation have moved away from price competition in the selection of development team members, in favor of long-term relationships, inter-project learning, and negotiated bid arrangements where, especially the providers of design and construction services, are familiar with the requirements and the past projects of the developer.
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4) Early adopters of environmental innovation have moved aggressively towards industrial construction and CAD/CAM construction techniques because it gives the developer more control over the installation of products and the ability to reduce waste.

To test these hypotheses I carried out an original large N survey with development firms. That survey provides a broad-based understanding of how frequently firms engaged in green development also engaged in these practices. Later, I will describe how that survey was carried out and analyze the survey results.

Finding Respondents

I assembled a list of 1,085 firms[13] involved in the real estate development industry largely from two websites: 1) Five hundred and thirty-six (536) firms came from the US Green Building Council's (USGBC) member list for groups classified as Real Estate Service Providers (they have no category for developers), and 2) Four hundred and ninety-three (493) firms came from the participants in the Builder's Challenge program of the US Department of Energy (DOE). The additional fifty-six (56) firms were organizations involved in real estate development to which I had a personal connection. In addition, I asked friends and family involved in the industry to fill out my survey during a pilot phase which helped me to revise the survey instrument. I received 12 responses during this pilot phase. I have included these responses in my results. It is important to point out that this sample of survey respondents is not representative of developers as a whole, but rather green developers. This limits the sample in some critical ways (i.e. I cannot say much about why firms chose not to develop green buildings), but also creates an interesting perspective for interpretation, especially as it relates to my hypotheses.

I sent every potential respondent firm a personal email beginning on February 14th, 2010[14] asking that they participate in the survey. I sent this note with a read receipt from my Massachusetts Institute of Technology (MIT) webmail account, and confirmed that two-hundred and ninety of these emails were read by the intended recipient, and forty-seven survey responses were received from this group. Another sixty-three email requests were deleted without ever having been opened. Seven hundred and thirty-two emails generated no read receipt response. Of these, forty-three firms filled out the survey, so some significant portion of these emails got through to their intended recipient, but there is no way to know how many. At least ten days after receiving the initial request to complete the survey, a follow up email was sent reminding people of the survey and asking again for their participation.[15] This note also came from my MIT webmail account, and included instructions for checking my identity to ensure I was an MIT student.[16] I closed the survey on March 20th. All results were compiled on SurveyMonkey, where the survey was designed and disseminated.

There were significant data problems with my list of potential respondents. First, neither is a list purely of real estate developers. The USGBC list includes attorneys, real estate brokerage firms, material suppliers, consultants, and other professionals, though it is predominantly developers. The DOE website includes policy-makers, building science consultants, and contractors who do not traditionally act in an owner-developer role. Second, the USGBC list includes many foreign firms, which needed to be excluded from my study population. Third, the real estate industry has struggled during this financial downturn, and fifty-nine firms no longer had working email addresses. In addition, some of the firms where I got no read receipt response may have gone out of business or terminated the position of my company contact. Fourth, these lists are

[13] By I, I mean that my research assistant, Marda Lugar, assembled this list, for which I am overwhelmingly grateful.
[14] Text of letter available as an appendix.
[15] Text of second letter available as an appendix
[16] I received several responses to the first email doubting my purpose and student status.

heavily slanted towards firms who are interested in green building and energy efficiency. I tried to address these shortcomings in the following ways:

1) I attempted to remove groups who were not development firms from my list by looking at the company name, and by clearly stating in the survey invitation and instrument that it was intended for people who were active real estate developers. In 102 unique responses, I did not find a single respondent who doesn't seem to undertake some development activity.
2) I removed firms from my participant list if they had an international phone number. I received no responses from firms who did all of their work overseas, though several respondent firms were international with a US headquarters. I kept these US-based firms in my respondent list.
3) I removed firms if my email was undeliverable. In two cases, respondents had started new firms under a different name than what was in my list but retained the same email address. I accepted those responses into my results.

Once groups who are not developers, groups who have an international phone number, and undeliverable email addresses were removed from my list of potential respondents, I was left with a population of 955 potential respondent firms. From this group, I received 102 unique responses, 90 not including the pilot responses, for a total response rate of around 10% (9.4% not including pilot, 10.6% including pilot). The respondent firms were geographically distributed as follows:

Table 1. Region where company is headquartered

	Unique responses	Percentage	Unique excluding pilot	Percentage
Northeast	28	27.5%	27	30.0%
Midwest	8	7.8%	7	7.8%
South	45	44.1%	35	38.9%
West	21	20.6%	21	23.3%
Total	102	100.0%	90	100.0%

Characteristics of the respondent firms

The median respondent firm in my study was a small, privately-held, male-led firm, where the principal had a graduate degree and was based in the South. Almost every respondent firm had developed at least one project they self-labeled as green,[17] and they were equally likely to be involved in single-family residential, office, multi-family residential, and mixed-use development with significant though somewhat smaller representation from retail and

[17] This result is not representative of the development industry and it alone indicates that my survey respondents were generally green developers rather than a cross-section of the development industry. Efforts were made to counter this problem, but ultimately the Urban Land Institute, the National Association of Homebuilders, and the National Association of Industrial and Office Properties declined to support this research by sharing access to their membership or their own demographics in a way that could be cited, and the Economic Survey data provides no baseline for a real estate development firm.

industrial development firms as shown in Table 2 below. Many firms did not specialize in one of these areas, but developed several types of projects.

Table 2. Size of Respondent Firms (Total respondents for each question in last column)

Annual Revenue	< $1 million	$1 to $5 million	$5 to $10 million	$10 to $20 million	over $20 million	Total Respondents
	39%	31%	10%	3%	16%	87
Residential Units Annually	under 100 units	100-250 units	250-500 units	500-1000 units	over 1000 units	Total Respondents
	77%	14%	7%	0%	3%	74
Commercial/Industrial SF annually	Less than 100k sf	100k - 250k sf	250k - 500k sf	500k - 1M sf	over 1M sf	Total Respondents
	71%	14%	3%	2%	10%	63
Number of Employees	< 10	10 to 25	25 to 50	50 to 100	over 100	Total Respondents
	57%	19%	4%	7%	13%	90
Firm Capitalization	< $5M	$5 - $10M	$10 - $20M	$20 - $50M	over $50M	Total Respondents
	71%	5%	8%	6%	10%	78

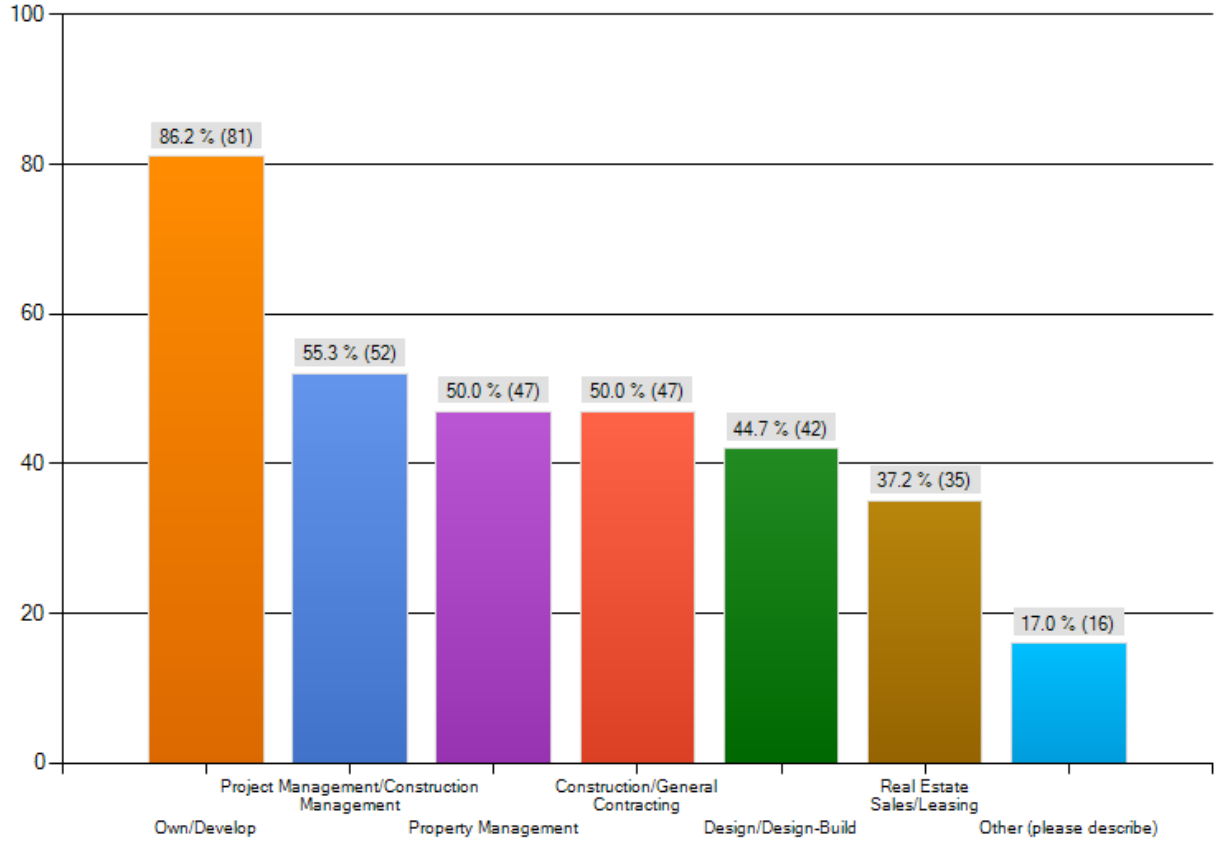
Table 2 shows that regardless of the metric, the respondent firms tended to be small. Even more intriguing is the fact that there are relatively few medium sized respondents. In the case of annual revenue, commercial and industrial square footage developed annually, number of employees, and firm capitalization, the overwhelming majority of respondents were in the first two categories combined, and the third highest concentration of respondents was in the last category, which is meant to capture the biggest firms. This result may imply a story about the advantages of scale in development firms which has been predicted in the work of Pauly, Egan, and others and that we discussed earlier.

Other important demographics on respondent firms include:

- *Age of principals*: top executives in my respondent firms tend to be between the ages of forty and sixty with some significant representation from people under forty.
- *Gender of principals*: Executives in my respondent firms were overwhelming male, 84%
- *Education level of principals*: Nearly half of the top level executives in my respondent firms had a graduate degree or had pursued some graduate school. Over eighty percent had an executive with at least a bachelor's degree. This implies that people engaged in green development activities are a very well educated group.
- *Development experience of principals*: Most executives had between ten and thirty years of experience, but it was more likely that an executive had less than ten years of experience than it was that they had more than thirty.
- *Professional background of principals*: The most prevalent background for executives was in construction, followed by finance and design. Interestingly enough, the lead executive was most likely to have a construction background, where every other executive was slightly more likely to

have a background in finance. In addition, many people had experience in real estate sales, brokerage, and property management, engineering of some type, and Law.

Table 3. Services offered by Respondent Firms (94 responses)



As table 3 shows, respondent firms tended to do more than develop projects, offering a broad range of additional services including project management/construction management, property management, construction/general contracting, design, and real estate sales and leasing. In the overwhelming majority of cases (83%), the respondent firms were privately held with five or fewer people having control. The next most prevalent ownership structure was as a non-profit (nearly 10%), then private with more than five people having control (5%), and finally firms that are publicly traded (4%).

Respondent firms also had a very high level of interest in green building and significant experience in that area. This is to be expected based on the source of my respondent firms, which was the membership list for the largest green building advocacy organization in the country, the US Green Building Council, and the participant list for the flagship residential energy efficiency program of the US Department of Energy, the Building America Program. Over 70% of respondents had completed a green project, nearly 90% had a green project in construction, and over 94% planned to have one in construction in the next two years, leaving

just under 6% of my study sample with no experience in developing green and no plans to start a green development.[18] Beyond this, firms are anticipating that their green development work would become more prevalent. At the time of responding, slightly more than half of the respondent firms do more than half of their work on green development projects at, and the most prevalent response is groups that do less than 25% of their work on green projects. However, in the next five years respondents generally expect that trend to shift, where the median firm expects to be doing 75% plus of its work on green projects and fewer than 10% of respondent firms expect to be doing less than one quarter of their work on green projects. In short, respondent firms expect this sector of the market to grow and to become an increasingly large share of their company's business.

Why did people develop green

The respondent firms had a wide range of experience with various green building standards, with LEED and Energy Star being the most prevalent. In addition, there was significant use of the DOE Builder's Challenge criteria and the National Association of Homebuilder's Standard both before and after it was adopted as the National Green Building Standard by the American National Standards Institute (ANSI) in 2008.

Much as predicted by Koebel's survey on innovation in the construction industry, my respondent firms have adopted green practices as a way of improving their long-term competiveness and because they have a personal commitment to developing in this way. Table 12, below, shows why people adopted green practices. The two most prevalent responses of the 92 firms who answered this question were: 1) we believe green projects are the right thing to do (84%) and 2) green building is part of the firm's commitment to high quality spaces (77%). When asked to choose the single largest motivating reason (see Table 13), these two stayed at the top of the list with forty-three percent of respondents saying green development was the right thing to do and 19% of respondents saying it was part of their commitment to high quality spaces. In addition, 10% of respondents said they built green principally because it was more profitable.

When asked to specify the single largest obstacle to their firm adopting green building practices: 1) construction cost, 2) consumers who won't pay for green, and 3) long-term uncertainty about performance were the three most prevalent responses. Again, many people selected "other" in response to this question, but their comments partially reinforced the three areas already discussed in addition to highlighting challenges in the public review process, and general difficulty in navigating green building certification.

Testing the hypotheses

This analysis provides an interesting window into the mindset of firms who adopt green practices, and their motivations and challenges in doing this. In addition, it builds some basic

[18] As noted previously, respondents could self-label as green, so no determination has been made in this study to determine how green a given project was.

knowledge about the makeup and constitution of real estate development firms who have decided to carry out a green project: who runs them, what they do, how big they are, where they are located, and what types of projects they take on. All of this information is very helpful in building a general picture of the green real estate development industry. But the purpose of this study is to take that information one step further. My hypotheses state that real estate development firms are poorly organized for the adoption of green development practices, and that leading edge adopters of green development will adjust those standard practices in predictable ways.

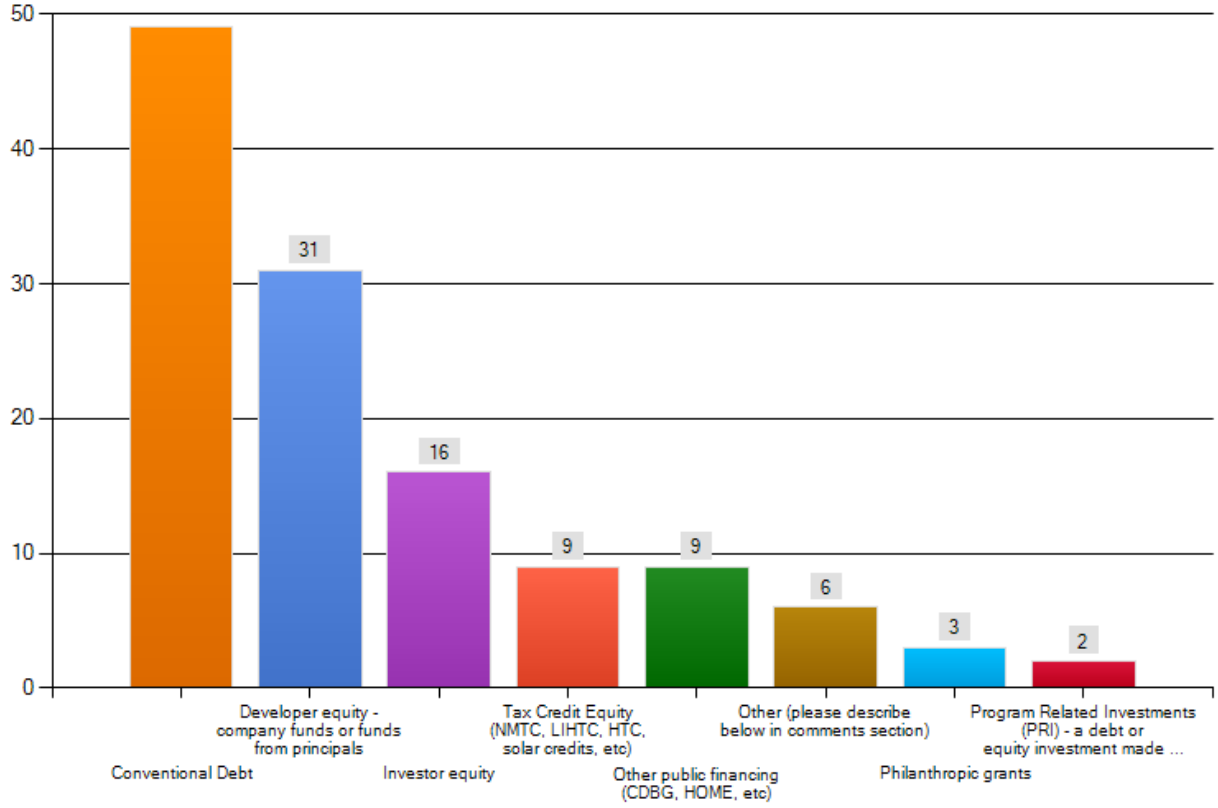
The model of real estate development firms that I laid out earlier made four assumptions about firms aggressively adopting green practices. As stated above, I predict that these adopter firms will:

1) Utilize alternative financing arrangements with at least some investors that give the developer or the investor a longer-term stake in the project. In addition, I expect that large firms with better access to capital will be better positioned to adopt these innovations.
2) Have moved away from price competition in the selection of development team members, in favor of long-term relationships, inter-project learning, and negotiated bid arrangements where, especially for the providers of design and construction services, partner firms are familiar with the requirements and the past projects of the developer.
3) Exert greater control throughout the entire development process, especially in the provision of design and construction services.
4) Have moved aggressively towards industrial construction and CAD/CAM construction techniques because it gives the developer more control over the installation of products and the ability to reduce waste.

My survey responses show mixed results across these four areas.

Finding Investors for the Long-term

Table 4. Funding sources for green developments (70 responses)



Looking at the whole survey sample shows that the two most common sources of project financing for survey respondents were conventional debt and developer equity. This is not a surprising result, and it is not clear that this rate would be any more or less for developers of conventional projects. Beyond this, there were fairly low rates of participation by non-traditional sources of equity that are likely to be very patient sources of capital such as direct public investment, program-related investments from foundations, and the use of specialized financing tools like the New Markets Tax Credit or Low-Income Housing Tax Credit. In addition, only two of ninety-four firms that responded to another question said they had created their own equity or financing practice, independent of their development work. Table 16 shows the breakdown of the types of investments that were made in projects.

Even more instructive than the tabulation of responses to this question were the comments that people made in response to it. Sixteen respondent firms made comments in their answer to this question, and fifteen of those comments referred to patient investments that made the project in question possible. These comments ranged from people saying that the project had been built for cash or all equity provided by the developer or ultimate owner, to comments about public investments or guarantees that made the difference in the deal. Of these comments, eight referred to private investments of developers, ultimate owners distinct from the developer, or outside investors. Six of them referred to public investments of some type that pushed the project forward, and the final one referred to small grants and donations

provided to the project. This level of response leads me to believe that there may be more investment of this type going in to projects than my initial survey captured. More research is needed on this point.

These responses become even more interesting when cross-tabulated by ownership structure, including private closely held (control rests with less than five people), private widely held (control rests with more than five people), public, and non-profit/community development corporation. For private firms, both closely held and widely held, conventional debt (74%) is far and away the most frequent source of capital for projects, with developer equity (45%) and investor equity (27%) as a distant second and third. Other sources are rarely present (13% or less of the time) in the capital stacks of these projects. These are all fairly conventional investment sources, and especially with conventional debt and investor equity there are likely to be time pressures around performance that will be placed on a project, notwithstanding its green approach. However, the projects carried out by publicly traded companies were built entirely with developer equity or with the backing of the company balance sheet. No external time pressure would be applied to these projects, except any discipline which would come from the public capital markets. This is a significant advantage for publicly-traded companies wanting to do green projects. The other interesting finding from the cross-tabulation was the frequency that public and philanthropic financing drives the work of non-profit developers, coupled with conventional debt. Even though the use of PRI, public financing, tax credit equity, and other sources that help groups make more patient investments in projects was low in the general sample, these sources were the dominant source of financing for non-profit projects, followed closely by conventional debt. This seems to imply that non-profit organizations may also be well positioned (at least with respect to access to patient capital) to adopt environmental innovations.

In summary, we found that patient sources of capital are not frequently used when looking at the full sample, but when we parse that sample into various types of owners, we see some more interesting results. Our survey bears out the hypothesis that publicly-traded firms have more flexibility around greening because they finance development with their balance sheet and their own liquidity. This gives them opportunities to try things that privately held developers might not be able to do because of requirements of their conventional debt and equity investment sources. Beyond this, non-profit developers do utilize patient equity sources that are outside the firm in large percentages, including tax credit equity (43%), public financing (86%), program related investments (14%), and philanthropic grants (14%). This may indicate that they are another group that has some financing advantages around greening.[19] In addition, only a small number of firms have developed a robust financing or equity arm that might invest in projects developed by another firm. As part of my more in depth analysis, I spoke to an investment firm that is also a large owner of real estate projects, and teased out the reasons for this to see if they lend support for or against my sub-hypothesis that green development firms

[19] Despite a significant interest in this finding, the balance of this study will not test it further. It is an interesting opportunity for further research.

are likely to identify longer term investors and/or vertically integrate with equity investment. In addition, I have asked each of the firms who participated in follow-up interviews to provide some insight into how their financing is structured. This investigation lends support to the idea that publicly-traded firms have significant financial flexibility due to their access to public capital markets, and privately held firms struggle with access to capital, often seeing it as their most significant obstacle to scale.

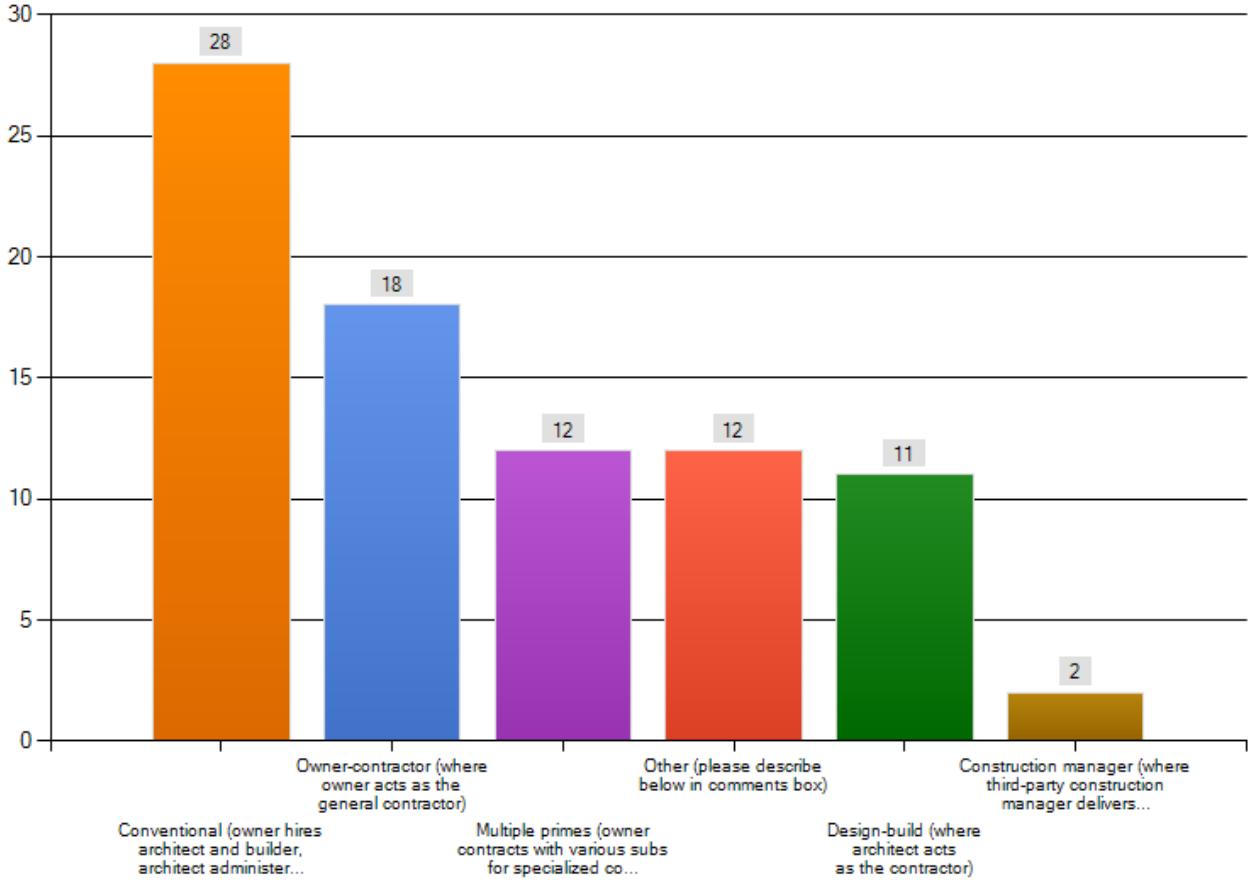
Reduced price competition in design and construction

There is significant evidence that vertical integration of design and/or construction services is happening at the firm level with groups adopting green development. The work of Poage, Miller, and Gordon all claim that the most common way of organizing a development team is through the conventional OPC relationship we described earlier. While we don't have good comparative data, and these studies are somewhat dated (they are between 10 and 20 years old) the author's recent experience supports that claim. However, of the ninety-four firms, predominantly firms engaged in green development, who answered questions about their services shown in table 9, forty-seven included construction, fifty-two included project management and construction management, and forty-two included design and design/build. Twenty-five firms engaged in two of these services, and twenty engaged in all three meaning that seventy-six of the ninety-four respondents to this question had vertically integrated design or construction services on some level. When I crosstab the data to look at firms who have developed green projects versus those who have not the results are intriguing though not statistically significant. Only 1 in 4 firms in my sample who have not completed a green project provide construction/general contracting in-house, 1 in 4 provide design/design-build, and 2 in 4 provide construction management. In addition, one company performs construction/general contracting, construction management, and design/design-build, meaning that 3 out of the 4 firms provide no design or construction services in house, and 2 of the four provide no construction management/project management services either. Even though this sample of non-adopters is very small and non-representative, it agrees with my earlier result that green developers are more interested in longer-term relationships with design and construction expertise, often going so far that they have internalized those services into their shop.

At the project level, there is also significant evidence that owner/developers are utilizing alternative forms of project delivery that create a more team-based approach between the architect and the contractor. Of the sixty-five respondents to a question about the contract form used for project delivery, twenty-eight said they used a conventional contract (think conventional OPC or the GMP-FP from Gordon here), the single largest number. However, eighteen owners self-performed construction work, twelve used multiple primes, another eleven used a design-build process, and two used a construction manager. All of these forms endeavor to create less adversarial relationships between the development team members, especially design-build and the use of a construction manager. In addition, they all imply a more involved owner than would be conventional for a development project. Self-performed construction and the use of a multiple-primes contract generally indicates an owner who has vertically integrated around the delivery of some construction and/or design services. Taken together, twenty-eight owners say they used a conventional contract form while forty-three

used a form that gives the owner more control over the process and engenders a less adversarial approach to the OPC relationship than is conventional.

Table 5. Contract Form Used for Project Delivery (65 responses)[20]



The comments in this section of the survey were also enlightening. Twenty-two of the thirty comments in this section indicated long-term relationships among the OPC partners, relationships that would not be utilized under a conventional OPC structure. In many cases, respondents said that they used traditional contract forms but the designer or the builder worked for or was wholly owned by the developer. In others, the respondent described the increased level of control that the developer/owner exerted in every phase of design and construction. There were also some comments about the owner, designer, and contractor having worked as a team before, or at least starting to work as a team on each project very early in the conceptual design phase.

In summary, there was much evidence that price competition around procuring design and construction services was reduced in favor of quality competition and instilling inter-project

[20] This question did not preclude firms from selecting multiple answers. In fact, almost everyone who selected other did so to clarify the particular nature of the relationship that the owner had to the rest of the team members.

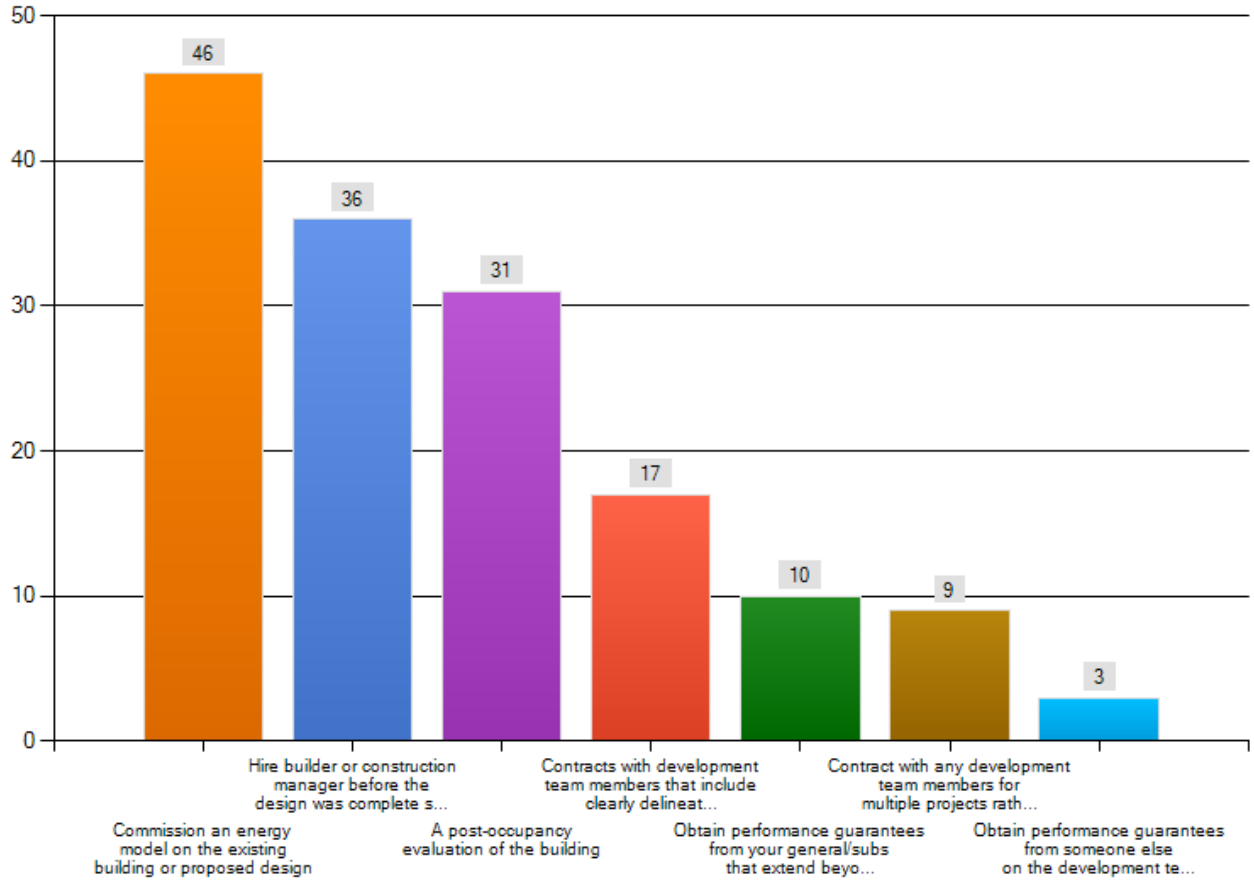
learning among team members. In the extreme cases, this resulted in actual vertical integration, which occurred in a surprisingly high number of cases, in fact it seemed to be the dominant form of organization among respondents.

Increased Developer Control of the process

Most of the evidence for developer control comes out in the in-depth case studies of six firms. However, there are some findings from the web-based survey that provide some support for this hypothesis. First, there are the results from the previous section about the amount of vertical integration that is taking place in design and construction. If developers are finding that they need to aggressively incorporate design and construction services into their own shop, and/or enter into inter-project arrangements with Design Professionals and Contractors, this is a strong indicator that they are taking more control of the process, and they are demanding certain outcomes from their development teams.

Beyond this, Table 18, below, shows that commissioning an energy model (75%), using an integrated design process (59%), and a post-occupancy evaluation of the building (51%) were done fairly frequently by survey respondents. These are changes that would imply greater developer involvement in the design process than typical in a conventional OPC structure. In the case of an energy model or post-occupancy evaluation, the fact that these studies are done show significant developer interest (in fact they are willing to pay someone to do this) in the performance of the building before, during, and after its development. And the use of an integrated design process implies that a developer will also need to be more involved in steering the work of the team, since there will be more people at the table and someone will need to coordinate their energy and activities. That said, this is another area where more specific research would be helpful.

Table 6. Possible Changes in the Development Process (61 responses)

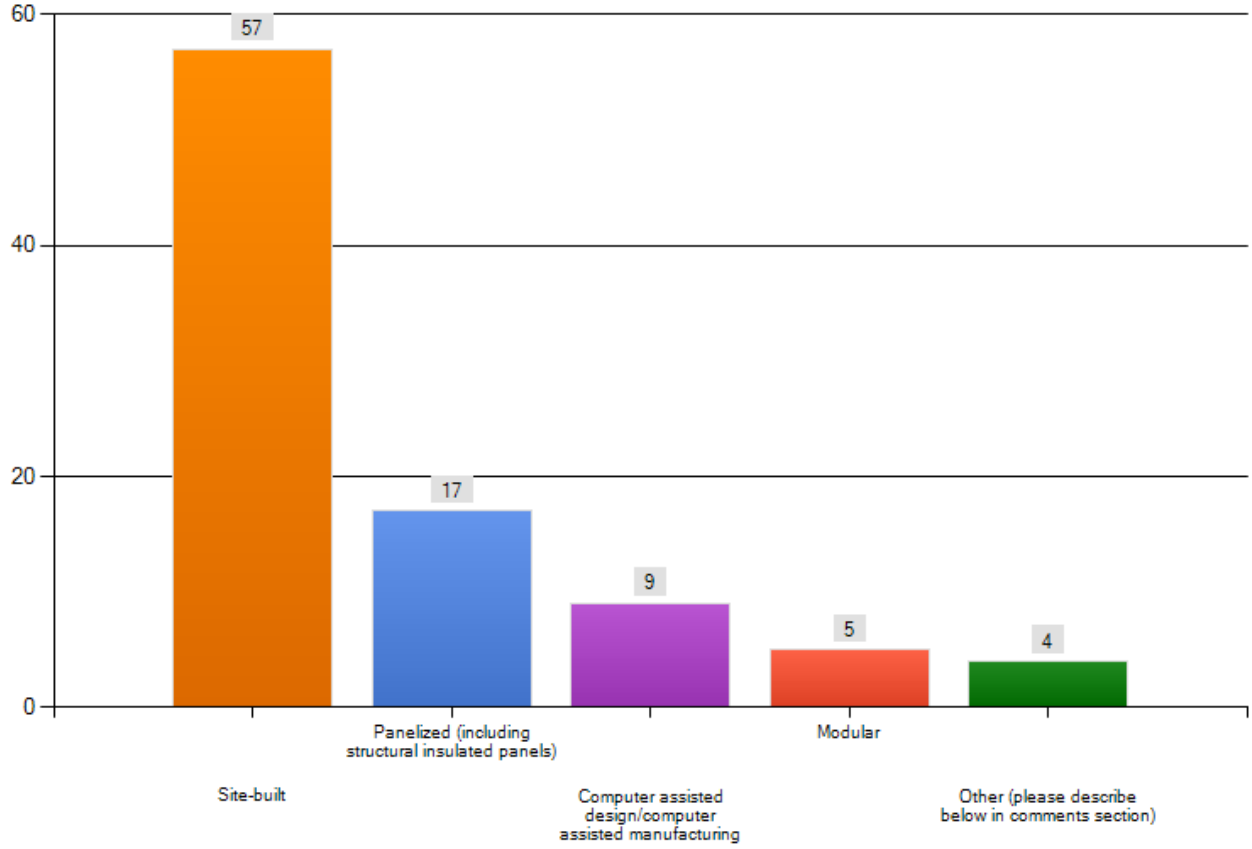


Industrial construction

Though the significant majority of green projects referred to in this study were site-built (nearly 83%), thirty-one of sixty-nine projects (45%) used some type of industrial construction technique, whether it was panelized, modular, or computer assisted design and manufacturing. This statistic points out several things. First, site-built and industrial construction techniques are not mutually exclusive. In fact, the construction industry is generally moving towards the use of pre-manufactured assemblies for many building components, especially roof systems, floor systems, and wall systems that can be shipped to the site and installed there. In addition, the motivation behind the prediction that industrial construction would be widely adopted by green development professionals arose from a sense that a green developer must simultaneously control cost and quality in the building process. Industrial construction is one way among many that this goal can be achieved. Other ways might include having very rigorous field controls in the on-site construction process, having a very involved owner, and/or requiring specific performance goals of the general contractor and sub-contractors. We have already seen that owners engaged in green projects are much more likely to be heavily involved in all phases of design and construction, and that performance guarantees are used in a small,

but non-trivial number of cases. In addition, as discussed at the end of the last section, performance goals may also be established through the use of energy models and post-occupancy evaluations that are not true guarantees and therefore may not have been captured by this survey. In addition, this has an incremental flavor to. A transition to industrial construction may be one way, among many, that green development adopters may begin to transition their practice to a different operating focus. In some ways this partial use of industrial construction techniques could be seen as an incremental step towards a more fully green practice in the future.

Table 7. Project Delivery Approach (69 responses)



In summary, there are also mixed-results about the adoption of industrial construction. We need to know how frequently we would have expected industrial construction techniques to be utilized on any project before we can say more about its adoption by green development firms. In addition, setting up a foil between a site-built project and an industrially constructed one is a false dichotomy. Only modular homes would be widely considered to not be site-built, where panelized and CAD/CAM systems might be used in a site-built development process. Finally, the real crux of this prediction is that the owner/developer will want to exert more control on construction quality than would be typical while still controlling price. Other approaches to achieve these ends may have been utilized by developers who are unfamiliar or unwilling to change their project delivery model, but who still want to oversee construction decision-making in a more direct way than would be conventional. In fact, we have seen throughout these

responses that the green owner/developer is significantly more involved in design and construction, and they exert super-normal control over every aspect of the process.

Section VI. Conclusion

My green development hypotheses are that development firms who have been leading adopters of environmental innovation are likely to share several characteristics:

1) Large developers with easier access to capital are likely to have pushed further than small, local developers in the adoption of environmental innovation. The small firms who have been leading adopters are likely to utilize alternative financing arrangements with at least some investors that give the developer or the investor a longer-term stake in the project.
2) Early adopters of environmental innovation have moved away from price competition in the selection of development team members, in favor of long-term relationships, inter-project learning, and negotiated bid arrangements where, especially for the providers of design and construction services, partner firms are familiar with the requirements and the past projects of the developer.
3) The developer exerts greater control throughout the entire development process, especially in the provision of design and construction services.
4) Early adopters of environmental innovation have moved aggressively towards industrial construction and CAD/CAM construction techniques because it gives the developer more control over the installation of products and the ability to reduce waste.

This study has found notable and significant support for the first three hypotheses, and inconclusive results on the fourth hypothesis relating to industrial construction. While my results show some significant use of systems and components that are factory-built, industrial construction is not a central strategy for how green development goals are met at these early adopter firms. In fact, it is something of an after-thought in their processes. However, given the particular results of the study and the history of industrial construction methods in the development industry, I am not yet satisfied with the results related to this hypothesis.

First, this study was hampered by an inability to say what the prevalence of industrial construction was in conventional development projects. There are significant benefits for greening in industrial construction processes, and there are also a number of significant other benefits that have little to do with green, such as the potential speed and precision with which a project can be put together. However, without a clear baseline of how frequently industrial construction is used in various types of projects, it is impossible to measure whether it is used more or less frequently in green projects. Building that baseline would be a helpful and worthwhile research endeavor. In addition, industrial construction is also an area where much previous research work has been done. Relative to technologies like solar panels that are commonly associated with green building, industrial construction techniques are already widely accepted and utilized in the development industry. A large proportion of building systems are now manufactured offsite and sent to a building, which provides a level of precision and control that it is difficult to create on site. Not only does this include particular building components

like cooling towers or compressors, but it extends to structural systems that have historically been fully-built on site, such as floor systems, roof systems, and wall systems. In addition, the most common industrial construction techniques are not new. Structural Insulated Panels (SIP) have been utilized in the building industry for nine decades. Standard shopping center construction in many parts of the country uses tilt-wall methods where the building pieces and parts come close to fully formed and are literally, "tilted-up" on site and bolted together. Mobile homes have become the dominant form of new single-family housing in many areas, and post-World War II development history is filled with companies that were going to reposition the development industry (particularly in the provision of housing) with the full force of American industrial might. This phenomenon is described somewhat famously in one of the chapters of Travels With Charley, indicating that it was significant enough as a trend that Steinbeck wanted to write about it in 1960 (Steinbeck 1962). One of the earliest efforts at mass-produced industrially constructed housing, Lustron homes, was heavily supported by the US Government post-World War II, and failed spectacularly with their steel-framed house in a box that promised all the modern conveniences (Liles 2010). More recently, Operation Breakthrough, a HUD-financed effort begun in the 1960s, was shut down when private financing partners decided that they didn't want to finance industrially-constructed, highly energy-efficient housing that could be built in a day, because they thought it might also be taken down in a day, and their investment could disappear in a matter of hours (Glicksman 2005).

Taken together, these various stories underscore a couple of critical points. First, industrial construction is fairly well understood and fairly widely used in construction and development practice already. Second, industrial construction has been around for a long-time, but it has not become a dominant part of the narrative for how we put buildings together, even when almost all the parts of a structure are shipped to a site and assembled, that building is frequently described as site-built. Third, and more pertinent to the green development discussion at hand, aggressive adoption of industrial construction practices for the express purpose of delivering green projects has not been seen as critical, at least by the adopters with whom I have spoken.

One way of explaining this result is to revisit the underlying reason for why I anticipated that industrial construction would be adopted by green development firms: these firms have a desire to control contractor performance, waste streams, and other project specifics. However, the increased amount of control that green developers wield over their projects may serve as a substitute for industrial construction in practice. A second story is related to the rub between scaling to a regional or national market and the local nature of regulation. Certain technology heavy innovations, like CAD/CAM technologies, may require a certain scale that is difficult to achieve in a single-market. However, since development is regulated as a local police power, firms that build industrially constructed components may need alternative ways to reach such scale and/or may need national or international standards that guide their development process, such as the 1976 HUD-code for manufactured housing. This has been a significant obstacle for SIP manufacturers in New Orleans post-Katrina who need International

Construction Code (ICC) certification[21] as a building assembly in order to be accepted as a building material that can be used by right in new construction projects in Orleans Parish. This is an expensive certification to obtain, and many smaller firms have not obtained it, making it much harder to build with their material because one must get special approval from the building department every time their SIP is used. These two explanations are not mutually exclusive, and may in fact be reinforcing. But I do believe that more investigation is needed into the use of industrial construction in green development, and the reasons for and obstacles to its adoption as a building method, both in green and conventional development. Beyond this, there are two major conflicts that will help shape the green development industry going forward, which will be discussed in the next two sections of this conclusion.

The market vs. social optimum of green development

The trends toward environmental innovation in development are here to stay. On one hand, we live on a warming, increasingly inter-connected planet with significant risk from sea level rise, and over fifty percent of the world's population lives within fifty miles of a coast. Resource-based conflicts continue throughout the world, and they are focused increasingly on fundamental resources like access to clean water. There are several ongoing armed conflicts that involve access to energy supplies, and the global demand for energy resources is growing. We have already arrived at a time and place where the management of our energy supply and our natural resources has a profound and significant impact on a number of ecological, socio-political, and economic factors that can be ever-more directly tied back to individual actions. As awareness, inter-connectedness, and the ability to share information grow, a movement that offers hope and opportunities to address these problems through individual action will grow with it. The green development movement does that on a consumer level. On the other hand, the business practice of green development is not soft-headed, bleeding heart environmentalism. Some of the largest firms in the world have invested in green production and office facilities and they have seen these facilities help drive their demand (Ford, Nike, Gap, Hewlett-Packard, AT&T, and many more). The largest publicly traded industrial REIT in the United States is also one of the largest (if not the largest) owners of green real estate in the world. Socially-minded investment opportunities are growing through a downturn, and something close to 11% of U.S investments are now invested in explicitly double-bottom line funds according to the Social Investment Forum (though not all of them focused on environmentalism) (Forum 2010). The confluence of this business opportunity with what is rapidly becoming an ecological and social imperative indicates that the green development industry will continue to grow and thrive. In fact, the author believes that ultimately green development will be the only type of development there is, as other practices will be seen as too expensive to pursue because of their human, environmental, and public costs.

As an organizing principle for the understanding of green development, the idea of the market optimum vs. a social optimum has extraordinary explanatory power. It gets right to the heart of

[21] This certification means that the SIP panel is treated like a 2x4 or some other standard building product when used in a wall or roof assembly.

the issue in the adoption of double-bottom line practices like green development, namely that there are externalities which our markets don't price in the real estate development process. This approach claims some measure of market failure, i.e. the market is not delivering the real estate solution we would collectively prefer. Buildings create pollution, the pieces and parts of buildings generate toxins that are released into the world when they are manufactured, shipped, installed, and used in buildings. Building location impacts air quality, public health, access to open space, and the ecology of a particular place. But these issues and many more are not part of the standard decision process in development, in fact thinking about them is often seen as extraneous to the central mission of a developer – to get the project built. Environmental innovation in development provides a framework for measuring the scale of these issues, but it also runs headlong into a debate. One developer in this study argues that he cannot pay a penny more for anything that is not a public or private requirement. Another says that tenants will not pay a penny more for green. A third constantly works with his design, construction, and marketing teams to determine what part of green they can sell and for how much. And a fourth argues that their buildings are more valuable and their tenants pay more because of their overall project quality, of which greening is a component. Beyond this, a fifth, who is a self-avowed "free market kind of guy," wants to see green building principles instilled into the building code and become nothing more than a cost of doing business, which would push the social optimum much closer to the market one. This framework of the market optimum versus the social optimum allows us to make sense of these competing comments, and to put them in a researchable framework. On one side of the ledger, some developers have learned how to extract some of the social value of green building through their projects, and to earn a premium for it. On the other side, a building is a commodity product, and the drivers for space have little to do with a building's impact on ecology. They are defining a market optimum. The real power in this framework is if we can start to define what the market is willing to absorb, and what is optimal for all forms of life, then we can also begin to define a gap between the market and social optima. Understanding that gap creates new opportunities for public and philanthropic investment as well as innovations that narrow the gap over time through policy changes, technological changes, and changes in behavior. To state it another way, I am arguing that there are externalities associated with standard development practice, and that if we accurately priced the environmental impact from development (through a carbon tax, changed utility pricing, changes in building code, etc) then we would observe different development outcomes.

To be more specific, we already know some things about the policy environment for green building. Local, regional, and state-wide regulations related to the environmental performance of buildings have been springing up around the country for the better part of a decade. There are some communities where any new building projects need to meet stringent green criteria (San Francisco, California and Frisco, Texas to name two), and the entire State of Oregon is governed by a land-use law that restricts the ability to develop any land classified as farm or forest. We also know some things about the market environment for green building. It has been growing rapidly through a recession. Green Builder Media is now the largest building material/building industry publication in the world, having overtaken Builder Magazine in

distribution in 2009. And the US Green Building Council has become one of the largest development-related membership organizations in the country in less than twenty years.

Despite this uncommon growth and interest in green development, there is still much evidence of a market failure in this area, and there are a number of approaches in wide discussion about how to internalize some of the externalities related to green development. Some of these approaches are market-based (like a tax on carbon or changing utility pricing) while others (like making green building approaches part of building code) are regulatory in nature. Still others (like direct public or philanthropic investment in the gap between the social and market optima) are more entrepreneurial. I expect that what we will ultimately see is a combination of these approaches where building codes start to adopt more and more aspects of standard green development practice (this is already happening with the energy codes and with work on the International Construction Code) and a number of market-based approaches will also be tried, including a Renewable Portfolio Standard that includes energy efficiency in buildings as a fuel source, some form of a carbon tax and widespread carbon trading in the United States, and utility pricing schemes that benefit end users who consume less energy rather than more. All these changes are already coming in to practice in various parts of the country, and I don't see that trend reversing. What I think is more questionable is a rethinking of the way that public and philanthropic investment flows in to development projects. Using philanthropic balance sheets to guarantee development projects that meet the social and environmental goals of the philanthropy could have a much greater effect on the built environment than standard methods of granting tiny amounts of money to a smattering of organizations. Creating new types of public investments that expect certain social, environmental, and financial performance goals from projects, rather than simply giving away money as direct subsidy to development projects would also be beneficial and allow public officials to steer development in certain ways that approach the social optimum for greening.

Scaling for financial strength vs. staying small and nimble

This research points out a critical tension in the development industry. On one hand, development firms have historically been small, and there are significant productivity and operational advantages to small size as predicted by the inside contracting model of Williamson and Eccles. On the other hand, large firms, particularly firms with access to public capital markets like REITs,[22] have significant operational advantages related to their ability to scale and smooth out the lumpy nature of development cash flows. My first hypothesis predicts that these larger firms will have greater ability to adopt environmental innovation because of their supernormal ability to finance green projects, and this study finds significant evidence for that hypothesis. Beyond this, there is also a significant trend towards the increasing complexity of

[22] There is an alternative confounding factor in the work on REITs, which revolves around the bargaining power that they wield over their partners. There are companies who do an appreciable share of their work just for specific REITs. This is a level of bargaining power that none of the other firms in this study can exercise over their OPC partners with the possible exception of a firm with a captive designer, and even there the scale of bargaining power is different. I have not adequately addressed these bargaining power issues here, but it is worth pointing them out as an area for future study.

development projects and development technology, and large firms are better able to retain expertise and manage such complexity. But decades of development industry history – reflected in what I have called the first principle of organizational structure for real estate development firms, i.e. development firms are small, on average – points in exactly the opposite direction, and there is significant evidence in other research that small firms have more aggressively adopted green building practices because they are nimble enough to do so. This conflict begs the question of which result is dominant, particularly if you accept the premise that the real estate development industry is in a state of flux now, and it will ultimately settle into a new equilibrium. Will that equilibrium look like what Phil Thompson observed in Germany, with a number of small, nimble firms who are leading edge practitioners in green development (Thompson 2010), or will it be a world where large developers with a national reach will dominate the marketplace?

As green development grows, we will also see a continued reliance on relationships, and particularly the OPC relationships that are central to the development process. It's not clear to me whether these relationships will follow a "getting the band back together" contracting model (use the same people on multiple projects but don't vertically integrate or formally contract between projects) or the vertical integration model (vertically integrate with design and construction), but I tend to think that the former is more likely. I believe Eccles argument that based on the structure of development firms, inter-project relationships are hard and may actually be poor strategy except in certain circumstances. The requirements of green development create one of the circumstances that would push towards greater vertical integration, but I also think this is running up against another change that I have predicted here, namely that green development becomes the dominant path. If that's so then the reason that vertical integration is so necessary will cease to be as important over time, and the underlying tension due to the nature of the industry will again dominate this problem, and we will see less reliance on vertical integration, but continued reliance on long-term relationships with particular design and construction partners.

Large developers have significant financial advantages that allow them to take on projects in multiple markets. This ability can also help diversify across geography, which may further enhance the financial advantages that large firms enjoy over smaller firms. However, relationships and reputation, which are the lifeblood of successful developers, are localized phenomena. One cannot translate reputation from one location to another easily, and this may be even harder with relationships. Both relationships and reputation come from a long history of delivering successful projects on the ground in certain locations. Beyond this, there are good reasons that developers behaved as they did for many years, and the conventional OPC relationship has significant learning nested in it. I believe that the new equilibrium will be a structure that retains the labor productivity and flexibility benefits of small firms, while creating new ways of accessing greater financial strength and expertise. The M-shaped formulation that Williamson describes in his inside contracting study combines these characteristics. Such a confederation of small, semi-autonomous firms operating in local markets responds to the need for nimble, flexible, long-standing entities with great reputation and relationships in any local market. However, having a central office that provides greater financial strength to

individual operators and can attract and retain the expertise required to meet the demands of this evolving industry will also create significant advantages. Such a structure recognizes the localized nature of the development process, particularly the regulation of development as a police power, while also recognizing the advantages that scale and balance sheet have for getting deals done. These confederations of many small firms will ultimately dominate the development market, supplanting the independent players that have traditionally been part of the development eco-system. These companies will all operate in a green manner, and will largely be structured as semi-independent offices. Small, local companies will be at an even bigger disadvantage with respect to capital access and volatility in the markets, as they won't be diversified geographically like the bigger firms. Finally, these larger firms will seek out long-term relationships with development team partners, but those relationships will not frequently be contractual or rise to the level of vertical integration. They will instead be characterized by trust and shared understanding built from having worked together on a number of projects.

In Conclusion

The methodology employed in this study has provided some critical insights, but also run headlong against some significant limitations. Most critical among them is a difficulty describing the nature of the real estate development industry writ large. We don't count developers as a single group within our economy, and the trade associations who could most accurately represent the opinions of this nebulously defined collection of entrepreneurs, namely the Urban Land Institute (ULI), the National Association of Industrial and Office Properties (NAIOP), and the National Association of Homebuilders (NAHB), declined to openly share information that could have colored some of the assumptions made in this dissertation. This is reflective of the moment of transition that I believe we are in as an industry, a moment defined by the inadequacy of the conventional OPC structure (the way the industry has traditionally done business) to respond to the pressures of contemporary projects. A need for greater environmental innovation in real estate development is an abiding part of this pressure, but coupled with it is a financial crisis fueled in part by real estate speculation and an increase in the complexity, time pressure, and performance demands placed on projects more generally. As is often true of periods marked by significant volatility, I think these pressures have the industry on the defensive, as firms and industry advocates are trying to sort out what these new tensions, pressures, and public requirements mean for them and the way they will do business going forward.

This inquiry helped uncover two critical problems for environmental innovation in development: 1) that the development industry is poorly understood, and 2) that the motivation of leading adopters of environmental innovation does not match up well with the arguments that green building advocates make to non-adopters. Beyond this, an emphasis on incremental learning – helping people take small steps out of their comfort zone on the way to longer-term, more systemic change – is useful for testing and understanding the process of innovation diffusion. In the end, it's useful to know that there is strong evidence for three of the four hypotheses presented here:

1) Large developers with easier access to capital are likely to have pushed further than small, local developers in the adoption of environmental innovation. The small firms who have been leading adopters are likely to utilize alternative financing arrangements with at least some investors that give the developer or the investor a longer-term stake in the project.
2) Early adopters of environmental innovation have moved away from price competition in the selection of development team members, in favor of long-term relationships, inter-project learning, and negotiated bid arrangements where, especially for the providers of design and construction services, partner firms are familiar with the requirements and the past projects of the developer.
3) The developer exerts greater control throughout the entire development process, especially in the provision of design and construction services.

But even more useful to know that this study has helped point out significant gaps that need much more additional research. I hope you will join me in that continued investigation.

Appendices

A. **Survey Instrument**

B. **Initial email to potential respondents**

C. **Follow-up email to potential respondents**

Green Development Adoption

1. Company and Top Executives

CONSENT TO PARTICIPATE IN SURVEY

The capacity for environmental innovation in real estate development

You have been asked to participate in a research study conducted by Will Bradshaw from the Department of Urban Studies and Planning at the Massachusetts Institute of Technology (M.I.T.). The purpose of the study is to understand more about the capacity for environmental innovation in the real estate development industry. The results of this study will be included in Will Bradshaw's dissertation. You were selected as a possible participant in this study because of your involvement in the development industry. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

• This survey is voluntary. You have the right not to answer any question, and to stop the survey at any time or for any reason. We expect that the survey will take about 30 minutes.

• You will not be compensated for this survey.

This project will be completed by summer 2010.

I understand the procedures described above. By continuing with this survey, I agree to participate in this study.

Please contact Will Bradshaw at willyb@mit.edu or 504-715-1129 with any questions or concerns or to get a copy of the results, which we will be happy to share in a fashion that does not identify any respondents.

If you feel you have been treated unfairly, or you have questions regarding your rights as a research subject, you may contact the Chairman of the Committee on the Use of Humans as Experimental Subjects, M.I.T., Room E25-143b, 77 Massachusetts Ave, Cambridge, MA 02139, phone 1-617-253-6787.

Each respondent to the survey will receive a number, based on their order of response. That number will be used to identify the participants' answers to questions, and their identifying information will not appear with the data.

Paper records related to survey responses will be kept in a locked filing cabinet in the principal investigator's office. Electronic records will be kept on the PI's personal computer and on-line at survey monkey in a password protected account. Records without identifying information will be stored in a regular filing cabinet. When the study is complete, survey data will be stored in a locked filing cabinet and ultimately destroyed.

*** 1. Please tell us the name of your firm and its principal location (an answer is required for this question).**

Company:

City/Town:

State: 6

ZIP:

Country:

*** 2. Please list the city and state of company offices other than the principal office. If you have no other offices, please write none (an answer is required for this question).**

5

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Green Development Adoption

*** 3. Provide the names and titles of the five most senior executives in your firm (an answer is required for this question, but you do not need to list 5 senior executives, if you do not have that many. Listing 1 is sufficient).**

Person 1 (Name and Title):

Person 2 (Name and Title):

Person 3 (Name and Title):

Person 4 (Name and Title):

Person 5 (Name and Title):

4. Tell us more about these executives by filling out the chart below.

	Age	Gender	Education Level (Check highest level obtained)	Years of Development Experience	Background (If multiple, write in all that apply in comment field below)
Person 1:					
Person 2:					
Person 3:					
Person 4:					
Person 5:					

Write other background in here

Green Development Adoption

2. Company Demographics

This page collects information about the size and focus of the company.

1. How big is your firm, on any or all of the following metrics

	Annual Revenue	Residential Development Annually	Commercial/Industrial Development Annually	Number of Employees	Firm Capitalization
Your firm					

Please provide any clarifying comments

2. Describe the geographic focus of your company

- Single City (please name in comment section below)
- Single State (please name in comment section below)
- Regional (please describe in comment section below)
- Nationwide
- International
- Other (please describe in comment section below)

Comment

3. Tell us more about the type of projects you take on (please check all that apply)

- Single-Family
- Multi-Family
- Commercial/Office
- Industrial
- Retail
- Mixed-Use
- Other (please describe)

Green Development Adoption

4. Tell us more about the services you offer (please check all that apply)

- Own/Develop
- Property Management
- Project Management/Construction Management
- Real Estate Sales/Leasing
- Construction/General Contracting
- Design/Design-Build
- Other (please describe)

5. What is your ownership structure?

- Private-Closely Held (control rests with less than 5 people)
- Private (More than five people have majority control)
- Publicly Traded
- Community Development Corporation/other non-profit
- Other (describe below)

Green Development Adoption

3. Green Building Projects

This page will ask you for information about how your firm decided to undertake green projects and the systems you have used to measure your success.

1. On any green project that your firm has undertaken, have you used a green building guideline or standard? If so, which ones (please mark all that apply)?

- LEED-Homes
- LEED-Core and Shell
- Energy Star
- LEED-Neighborhood Development
- LEED-Operations and Maintenance
- DOE Builder's Challenge
- LEED-Commercial/Major Renovation
- NAHB Green Building Guideline
- Enterprise Green Communities
- LEED-Interiors
- NAHB Green Building Standard (After ANSI adoption in 2008)
- Other (please specify)

2. If you have developed green projects, what were some obstacles you faced in those projects (check all that apply)?

- Lender ignorance/unwillingness related to green building approach
- Increased cost
- It is harder to get a permit or necessary zoning approvals because of green approach
- Builder ignorance/unwillingness related to green building approach
- Lack of material availability
- Our customers are unwilling to pay a premium for a green approach
- My firm has not developed green projects
- Uncertainty and/or limited data about the performance of the project or particular components
- Green approach increases construction time
- Other (please specify)

Green Development Adoption

3. What is the single largest obstacle you have faced to developing green projects?

- My firm has not developed green projects
- Increased cost
- Lack of material availability
- Long-term uncertainty about the performance of the project or particular components
- Increased entitlement risk as a result of green approach
- Our customers won't pay a premium for a green approach
- A green approach increases construction time
- Other (please specify)

4. If you have undertaken green projects, why have you done this? Please check all that apply.

- My firm has not developed green projects
- An investment partner wanted to develop green projects
- A green approach was required by a public agency
- One of our principals wanted to develop green projects
- We believe green projects are more profitable
- Green building is part of our commitment to high quality spaces
- Our customers demand green projects
- We believe green projects are the right thing to do
- Other (please specify)

Green Development Adoption

5. What is the single largest reason you have undertaken green projects? Please select one from the list below.

- My firm has not developed green projects
- An investment partner wanted to develop green projects
- A green approach was required by a public agency
- One of our principals wanted to develop green projects
- We believe green projects are more profitable
- Green building is part of our commitment to high quality spaces
- Our customers demand green projects
- We believe green projects are the right thing to do
- Other (please specify)

Green Development Adoption

4. Specific Green Projects

This page will ask you specifically about a green project (for you to select) that your firm has completed.

1. Has your firm developed a green project? (There is currently much debate about what constitutes a green project, and much research is focused on distinguishing between something that is "truly green" and "green washing". This is not our purpose here. If you believe that you developed a project that was green, then for the purpose of this survey you did. We are going to ask you about the characteristics of that project and how you organized your development team to manage it.)

- We have completed at least one green project
- We have a green project under development, but have not completed it.
- We are planning a green project in the next 2 years.
- We have not developed a green project.

2. What percent of your projects are green?

	All	75-100%	50-75%	25-50%	Less than 25%	zero
Currently						
Expected over the next 5 years						

3. Please tell us about a green building project your firm completed.

Project Name	
Year completed	
Size (# of units or square feet of space)	
Green Building Rating System Used	
Level Achieved in Rating	
Other major goals for project	
Biggest challenges	
Additional comments about the project	

4. What specifically did you do to make this a green project? For example, you might have followed a green building rating system (please state the system and level of performance achieved), focused on energy efficiency, indoor air quality, the use of recycled materials, etc (please provide some examples about materials and systems used).

5

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Green Development Adoption

5. Would you describe this project as a success? Why or why not?

6. After this project, did your firm decide to take on additional green projects? Why or why not?

7. Did you do any of the following on this project (please mark all that apply).

Hire builder or construction manager before the design was complete so they could participate in design decision-making	
Commission an energy model on the existing building or proposed design	
A post-occupancy evaluation of the building	
Obtain performance guarantees from your general/subs that extend beyond the statutory minimums (please describe below in comments section)	
Obtain performance guarantees from someone else on the development team (please describe below in the comments section)	
Contract with any development team members for multiple projects rather than just this one	
Contracts with development team members that include clearly delineated expectations about building performance	

Comments

8. What contract form did you use for project delivery (please check all that apply)?

	This project
Conventional (owner hires architect and builder, architect administers construction process and certifies completion)	é
Multiple primes (owner contracts with various subs for specialized construction)	é
Owner-contractor (where owner acts as the general contractor)	é
Design-build (where architect acts as the contractor)	é
Construction manager (where third-party construction manager delivers the project)	é
Other (please describe below in comments box)	é

Comments

Green Development Adoption

9. Indicate the type of financing you used in this development project (please check all that apply).

	This project
Conventional Debt	é
Developer equity - company funds or funds from principals	é
Investor equity	é
Tax Credit Equity (NMTC, LIHTC, HTC, solar credits, etc)	é
Other public financing (CDBG, HOME, etc)	é
Philanthropic grants	é
Program Related Investments (PRI) - a debt or equity investment made by a philanthropic entity out of its endowment and not funds used for grant-making	é
Other (please describe below in comments section)	é

Comments

10. Indicate the project delivery approach you used on this real estate project (please check all that apply).

	This project
Site-built	é
Modular	é
Panelized (including structural insulated panels)	é
Computer assisted design/computer assisted manufacturing	é
Other (please describe below in comments section)	é

Comments

Initial email to potential respondents

I, Will Bradshaw, am a PhD candidate in Urban Economics and Sustainable Community Development at MIT, and I am doing a study on the capacity for real estate development firms to adopt environmental innovation, looking particularly at the structure of the development process and whether it leads to slower adoption of environmentally related improvements in buildings. One of the participants in the study is my own firm, Green Coast Enterprises, a triple-bottom line developer based in New Orleans. The attached link connects to a survey targeted at real estate developers designed to understand more about their interest in green development, and their efforts to carry out green projects. It should take about 15 minutes to complete, and I would be pleased to have you fill out the survey. I will be happy to share tabulated results with anyone that asks, with identifying information removed of course. The study is scheduled to be complete in summer 2010.

You can access the survey at http://www.surveymonkey.com/s/XFZ28KX. Thank you for your time and consideration. Sincerely,

Will

Follow up email to potential respondents

Recently, I sent you an email requesting that you participate in a survey related to my dissertation research on the capacity for real estate development firms to adopt environmental innovations. I do not believe you have yet responded to the survey, and I wanted to send this follow-up asking again for your participation. I know from a few of the responses I received that there was some question about my identity and whether or not this research is real, especially since the survey asks for some sensitive information. To address that issue, I wanted to send the following:

If you go to the MIT homepage at web.mit.edu, you will see a people search at the top right of the screen. You can search for my full name, William Bradshaw, and it will show you that I am a graduate student in the Department of Urban Studies and Planning and provide my home address in New Orleans. The survey itself also has contact information for MIT's Institutional Review Board (called the Committee on the Use of Humans as Experimental Subjects) which sets standards for research ethics and the treatment of sensitive information. They have approved this research based on protocols that I am following to keep your information private, and you can contact them directly if you have concerns about my activities.

I would greatly appreciate your participation in this survey, which I plan to close on March 19th at midnight CST. Thank you very much for your time and consideration. I could not complete this study without you. The link to the survey is http://www.surveymonkey.com/s/XFZ28KX.

Sincerely,
Will

Bibliography

Anderson, E. and D. C. Schmittlein (1984). "INTEGRATION OF THE SALES FORCE - AN EMPIRICAL-EXAMINATION." Rand Journal of Economics **15**(3): 385-395.

Bradshaw, W. B. (2006). Buying green. Department of Urban Studies and Planning and the Center for Real Estate. Cambridge, MA Massachusetts Institute of Technology. **MSRED and MCP:** 94 p.

DiPasquale, D. and W. C. Wheaton (1995). Urban economics and real estate markets. Englewood Cliffs, NJ, Prentice Hall.

Eccles, R. G. (1981). "THE QUASI-FIRM IN THE CONSTRUCTION-INDUSTRY." Journal of Economic Behavior & Organization **2**(4): 335-357.

Egan, J. (1998). The Egan Report - Rethinking Construction. Report of the Construction Industry Task Force to the Deputy Prime Minister. D. P. M. s. Office. London.

Forum, S. I. (2010). "Socially Responsible Investing Facts." from http://www.socialinvest.org/resources/sriguide/srifacts.cfm.

Geltner, D. and N. G. Miller (2001). Commercial real estate analysis and investments. Australia ; Mason, Ohio, South-Western Publishing.

Gibbons, R. (2005). "Four formal(izable) theories of the firm?" Journal of Economic Behavior & Organization **58**(2): 200-245.

Glicksman, L. (2005). Lecture on the history of Building Technology. W. Bradshaw. Cambridge, MA.

Gordon, C. M. (1994). "CHOOSING APPROPRIATE CONSTRUCTION CONTRACTING METHOD." Journal of Construction Engineering and Management-Asce **120**(1): 196-210.

Kim, W. J., D. Mayers, et al. (1996). "On the choice of insurance distribution systems." Journal of Risk and Insurance **63**(2): 207-227.

Klein, B., R. G. Crawford, et al. (1978). "VERTICAL INTEGRATION, APPROPRIABLE RENTS, AND THE COMPETITIVE CONTRACTING PROCESS." Journal of Law & Economics **21**(2): 297-326.

Koebel, C. T. (1999). "Sustaining Sustainability: Innovation in Housing and the Built Environment." Journal of Urban Technology **6**(3): 75-94.

Koebel, C. T. (2008). "Innovation in Homebuilding and the Future of Housing." Journal of the American Planning Association **74**(1): 45-58.

Koebel, C. T., M. Papadakis, et al. (2004). The Diffusion of Innovation in the Residential Building Industry. Blacksburg, VA, US Department of Housing and Urban Development.

Lennssen and Roodman (1995). A Building Revolution: How Ecology and Health Concerns are Transforming Construction. Worldwatch Paper 124, Worldwatch Institute.

Liles, A. (2010). Lustron Homes. New Orleans, LA.

McDonough, W. and M. Braungart (2002). "Cradle to Cradle: Remaking the Way we Make Things."

Milgrom, P. and J. Roberts (1994). "COMPARING EQUILIBRIA." American Economic Review **84**(3): 441-459.

Oster, S. M. and J. M. Quigley (1977). "REGULATORY BARRIERS TO DIFFUSION OF INNOVATION - SOME EVIDENCE FROM BUILDING CODES." Bell Journal of Economics **8**(2): 361-377.

Pauly, J. T. (2005). Innovation and the big builders : barriers to integrating sustainable design and construction practices into the production homebuilding industry : the case of Pulte Homes. Department of Urban Studies and Planning. Cambridge, MA, Massachussetts Institute of Technology. **MCP:** 176 p.

Poage, W. (1990). Building Professional's Guide to Contract Documents, R.S. Means Company.

Schlosser, A. (2010). Interview for Creative Construction. W. Bradshaw.

Steinbeck, J. (1962). Travels with Charley, Penguin.

Thompson, J. P. (2010). W. Bradshaw. New Orleans, LA.

Williamson, O. E. (1976). Markets and hierarchies, analysis and antitrust implications: a study in the economics of internal organization. New York, Free Press.

Williamson, O. E. (1985). "EMPLOYEE OWNERSHIP AND INTERNAL GOVERNANCE - A PERSPECTIVE." Journal of Economic Behavior & Organization **6**(3): 243-245.