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# Information – The Key to the Real Estate Development Process

Ben Bulloch
*Credit Tenant Capital*

John Sullivan
*Aspinwall Partners, Inc.*



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# Information – The Key to the Real Estate Development Process

**Abstract**
Information generation and sharing is an integral part of the real estate development process, but can this information flow be effectively modeled? Is there a simple yet informationally-rich methodology to detail and understand how it is shared between parties in a complex development process? Because the process is unpredictable, many developers fail to plan accordingly, relying on their past experiences or ability to solve problems as they arise. Practitioners who do attempt to model the development process typically use scheduling and project management software to list out the necessary tasks that occur. While these tools work well when tasks are done in sequence, they are incapable of showing the rework and iteration that occurs as ideas are refined in response to new and unpredictable information. As activities in the development process are completed, other tasks need to be revised and updated. It's a process that is constantly evolving. The Design Structure Matrix (DSM) is a tool that can help us understand and model this iterative process. The DSM has been used successfully in numerous other product development industries (i.e. aerospace, microchips, etc.) to enhance the understanding of information generation and flows. This paper demonstrates the applicability of DSM methodology to the real estate development process and the insights that can be gained from explicating information flows in complex, information-dense processes. Improved understanding of the process can reduce risk and improve project development efficiency.

**Keywords**
Cornell, real estate, information generation, information sharing, design structure matrix (DSM), information flows, development process, cost-benefit analysis, feasibility, asset management, estimate costs, identify land opportunities, back-of- the-envelope proforma, preconstruction, construction, stabilization, sale

# Information – The Key to the Real Estate Development Process

by Ben Bulloch & John Sullivan

## Author

Benjamin Bulloch is Co-founder and Principal of Credit Tenant Capital, a real estate tax advisory firm based in Boston (www.ct-capital.com). Prior to earning a Master's degree from MIT's Center for Real Estate in 2009, Bulloch was the project manager for two large mixed-use centers totaling 1.4 million square feet of retail/office and 1,300 multi-family units in Fresno, CA for Lance-Kashian & Company (Campus Pointe & Fancher Creek). He was responsible for managing land use entitlements, environmental review, infrastructure development, site planning, civil/architectural design review and construction. Before this, Bulloch was a land broker for Fraser Forbes Company in Northern Virginia responsible for negotiating $140 million of land transactions over three years. Bulloch has served in volunteer leadership positions for MIT Center for Real Estate Alumni Association, ULI Young Leaders Group, Greater Merrifield Business Association, Fresno's Leading Young Professionals and Downtown Fresno Redevelopment Taskforce. Mr. Bulloch graduated in 2003 from University of Edinburgh in Scotland where he studied International Business and Anthropology. He has traveled extensively through South-East Asia, Southern Africa and Europe.

## Abstract

Information generation and sharing is an integral part of the real estate development process, but can this information flow be effectively modeled? Is there a simple yet informationally-rich methodology to detail and understand how it is shared between parties in a complex development process? Because the process is unpredictable, many developers fail to plan accordingly, relying on their past experiences or ability to solve problems as they arise. Practitioners who do attempt to model the development process typically use scheduling and project management software to list out the necessary tasks that occur. While these tools work well when tasks are done in sequence, they are incapable of showing the rework and iteration that occurs as ideas are refined in response to new and unpredictable information. As activities in the development process are completed, other tasks need to be revised and updated. It's a process that is constantly evolving. The Design Structure Matrix (DSM) is a tool that can help us understand and model this iterative process. The DSM has been used successfully in numerous other product development industries (i.e. aerospace, microchips, etc.) to enhance the understanding of information generation and flows. This paper demonstrates the applicability of DSM methodology to the real estate development process and the insights that can be gained from explicating information flows in complex, information-dense processes. Improved understanding of the process can reduce risk and improve project development efficiency.

## Introduction

Real estate development is the process of creating value by making tangible improvements to real property. The development process ranges from land speculation and new construction to the renovation of existing buildings. It is the process by which physical places where we live and work are conceptualized, designed, constructed and occupied. Successful implementation of this process is crucial to our economy along with our everyday lives. As Winston Churchill famously stated, "We shape our buildings, and afterwards our buildings shape us."

The development of real estate involves a plethora of disciplines and professions, including architects, engineers, planners, lawyers, bankers, public officials, construction trades and others. Each team member plays an integral part of the real estate product delivery process. The real estate developer is the one who oversees this process and coordinates the information generated by each project participant. A successful developer does this by ensuring that tasks are being completed in a way that allows for information to be generated and shared efficiently. A lack of effective information sharing will require team members to make assumptions which could prove costly or result in a less than ideal outcome. (Geltner, David M., et al, 2007, pp. 758-759); (Peca, 2009, pp. 8-13); (Jarchow, Stephen P., ed. 1991, p. 230); (Miles, Mike E., et al., 2007)

## The Key to it All: Information Flows

For an example of information sharing during the development process, we can look at the design and placement of structural columns in a building. A developer has the architect work together with a structural engineer on column locations and their integration with architectural elements. The architect has a certain floor plan he wants to achieve while the engineer needs to be sure the structure is efficient and built to code. By working together, necessary compromises are made and conflicts are minimized. This design interaction demands the attention of both consultants concurrently in order to minimize errors and miscommunication and the need to rework the design. Working completely independently is highly inefficient. Further, input from a contractor may be desirable. The contractor's advice may provide more cost effective ways to build the desired solution. Alternatively, if the developer were to solicit the contractor's advice later in the process, it may be too late to incorporate his comments. With this information developed upfront, a better, more comprehensive solution is reached.

This is just one example of how efficient information sharing can prove beneficial. While it's easy to say that all this information should be generated collaboratively and early in the process, it should also be noted that it comes at a cost to the developer. Getting the appropriate parties to the table to deliver this information takes both time and money. Therefore, trade-offs must be made. The decision to share and develop information needs to be done as efficiently and effectively as possible. Because of the scarcity of these resources, there comes a point where the process must move on, even if there is a chance of rework down the road.

In the structural column example, one instance of "new information" could be the specific requirements of a tenant whose lease is negotiated towards the end of the design process. The tenant, for example, may require wider spacing between columns for their equipment, sending the design team back to the drawing board. While it would have been best to know this information when the design was first drafted, the developer may not want to wait for this unpredictable information. If he does, he could be waiting so long that the market opportunity passes. At some point, he must proceed and revisit certain issues later, when or if a conflict arises or requirement changes.

A developer and his team must constantly make educated guesses about aspects of the project that are subject to future refinement as more information is obtained. If the assumptions prove correct, the development process can move forward quickly. Often, however, this newly developed information conflicts with previous assumptions and causes rework and iteration. The earlier information is known and shared, the less costly the changes will be. While bringing a tenant in earlier in the process would have helped address this specific example, it could adversely affect other aspects of development. All of these decisions are not made in a vacuum, but rather a complicated web of cause and effect. (Blanchard, 2008, pp. 30-32); (Unger & Eppinger, 2009); (Browing, Fricke, & Negele, 2006); (Eppinger S. , January 2001)

Throughout the process, numerous tasks are being completed in the development process. To organize them, we've grouped them into five distinct functional disciplines, as shown in Figure 1. They include *Market & Competition*, *Physical & Design*, *Legal & Political*, *Financial and Project Management*. As the development process moves forward, the plan is iteratively refined across disciplinary boundaries. As information is gathered from related tasks within and across disciplines, the developer gains more certainty about the project. Designs are finalized based on financial returns; budgets are established based on market conditions; permits are given based on legal evaluation; and so on. The spiral in Figure 1 indicates how the development process iterates through these disciplines, narrowing in towards a final product. The information generated within and between each of these


### Author

John Sullivan is a Founder and Principal of Aspinwall Partners, Inc., an entrepreneurial focused real estate firm that offers outsourcing of a firm's crucial real estate activities. Additionally, Aspinwall focuses on sourcing on and off market investment opportunities (www.aspinwallpartners.com).
Prior to forming AspinWall Partners, John worked for Bovis Lend Lease LMB, Inc. one of the world's largest project and construction management companies. He worked in the Boston office on many urban mixed-use and redevelopment projects. These include residential, hotel, office and laboratory projects, totaling over $1 billion in value. He also has experience working on LEED projects and historic renovations. As a project manager, his responsibilities included permitting, scheduling, budget control, subcontractor buyout, contract administration and construction supervision.
Mr. Sullivan studied Engineering and Economics & Business from Lafayette College, where he graduated with honors. He also received a Masters of Science in Real Estate Development (MSRED) degree from the Massachusetts Institute of Technology. He is a LEED Accredited Professional and is a member of many professional organizations, including Urban Land Institute (ULI), United States Green Building Council (USGBC), National Association of Industrial and Office Properties (NAIOP), and the MIT Center for Real Estate Alumni Association (AACRE).


disciplines is how real estate is developed and a final plan is established. (Geltner, David M., Miller, Norman G., Clayton, Jim, Eichholtz, Piet, 2007)


figure 1

Iterating Through the Disciplines of the Real Estate Development Process

Throughout the process, a developer must carefully weigh the costs and benefits of rework. Iteration often results in a superior work product, but continuously repeating a task rarely results in resource-efficient improvements. There comes a point where the time and costs of information generation, coordination, and rework exceed the diminishing benefits it provides. A developer must understand the costs and benefits of project iteration and encourage rework only when its benefit outweighs its costs. This cost-benefit analysis will vary for each project and task depending on the project specific information and the costs and benefits of additional iterations. (Browing, Fricke, & Negele, 2006, p. 105)

To improve our understanding of the information sharing process in real estate development, we can look outside of real estate to other industries that grapple with similarly complex product development processes. Many complicated products such automobiles, computer chips, and satellites also have a lengthy and expensive development process characterized by uncertainty and resulting in refinement and iteration of tasks towards a finished product. What tools are these industries using to model, understand, and refine their product development processes?

## The Design Structure Matrix

The "Design Structure Matrix" (DSM) is a commonly used product development tool that graphically depicts the relationships between tasks in a product development process. A DSM lists all tasks in the process in sequential order along both the left and top axes of a matrix. Figure 2, below, shows us what a simple six task process looks like in the DSM. An 'X', denoting a dependency for information, is placed in the box where two tasks intersect. By starting with a blank matrix, a project manager can mark the instances from where each task gets its information for proper completion. Once completed, the matrix shows how tasks in the development process are related to each other. By reading across a row, the matrix shows from where that specific task gets its information. In Figure 2, Task 5 is dependent on information received from Task 3 for completion. Alternatively, reading down a column shows where a task sends information. In Figure 2, Task 1 sends information to Tasks 3 and 6. Additionally, because the tasks are listed sequentially, the X's below the black diagonal like indicate forward flowing, or sequential information flows while the X's above the line indicate rework or backward flowing information. Further, by taking a step back, a visually-intuitive and information-rich representation of a process emerges on a single page. (Eppinger, Whitney, Smith, & Gebala, 1994); (Steward, 1981); (Eppinger S. , January 2001)

figure 2

The Design Structure Matrix

| | task 1 | task 2 | task 3 | task 4 | task 5 | task 6 |
|---|---|---|---|---|---|---|
| task 1 | ■ | | | | | |
| task 2 | | ■ | | | X | |
| task 3 | X | | ■ | X | | X |
| task 4 | | X | X | ■ | | |
| task 5 | | | X | | ■ | |
| task 6 | X | | | X | | ■ |

## Applying the DSM to a Real Estate Example

To illustrate how the DSM can be applied to real estate, let's look at an example of how a real estate developer initially evaluates a site for development. We will call it the Idea Inception phase. In this stage of the development project, the developer looks to provide a product that meets a certain demand in the marketplace. This process is initiated based on one of two different scenarios: *a site looking for a use* or a *use looking for a site* (Jarchow, Stephen P., ed., 1991). With a site looking for a use, the developer has a piece of land identified and is trying to maximize value creation by evaluating the *highest and best use* of the site in terms of current and forecasted market conditions. With a use looking for a site, a space user has a demand for a real estate product and needs to identify an appropriate land parcel to satisfy that need.

During the Idea Inception stage, an evaluation of what to develop for one or one of many potential sites is being done. The developer is attempting to get an idea of the major factors that will affect the development and the general parameters that constrain his activities. These include market conditions, design possibilities, zoning and political restrictions, and financial possibilities. These four major issues are evaluated and balanced to determine if the project is feasible. The outcome, which may include multiple possibilities at this point, will also need to match the developer's organizational strategy and capabilities, including timing, location, product, size and complexity.

The tasks in this stage will be repeated and iterated several times as different ideas are proposed and evaluated for a particular parcel of land. The stage ends when an idea (or ideas) for the development of the land is viable enough to invest in an extensive series of feasibility studies and due diligence.

The primary tasks that a developer and his team must accomplish in this initial stage are summarized in Figure 3.

figure 3

Idea Inception

| Idea Inception | |
|---|---|
| Task # | Description |
| 1 | Macroeconomic Analysis |
| 2 | Evaluate Capital Markets |
| 3 | Local Supply & Demand Analysis |
| 4 | Evaluate Zoning/Planning |
| 5 | Evaluate Local Politics |
| 6 | Estimate Rents |
| 7 | Estimate Costs |
| 8 | Identify Land Opportunities |
| 9 | Evaluate Land Control Options |
| 10 | Back of the Envelope Pro Formas |
| 11 | Evaluate Investment Threshold |
| 12 | Evaluate Organization Strategy |
| 13 | Estimate Project Timeline |
| 14 | Estimate Project Scope |
| 15 | Evaluate Programmatic Options |
| 16 | Financial Underwriting & Analysis |

Modeling this stage in the development process is difficult using conventional project management tools or methodologies (Microsoft Project, PERT/CPM analysis or Gantt Charts). These tools display graphical descriptions of task sequencing but are poorly adapted for modeling the development process because they inadequately represent the high amount of iteration and unpredictability that is inherent in the process. The DSM, however, is a tool suited for modeling and graphically representing this iteration and the information shared between tasks. The 16 tasks from Figure 3 are listed sequentially on the left and top axes of the DSM in Figure 4. X's are marked in the boxes within the blank DSM matrix to illustrate where interaction and information sharing between tasks is occurring for a typical development project.

To illustrate the use of the DSM tool, we'll use the *Estimate Project Scope* task (#14) from Figure 4. The objective of the *Estimate Project Scope* task is to try and decipher the overall magnitude of the physical dimensions of the project (number of buildings, height, stories, square footage, etc). By reading across the row, we can easily see that *Estimating Project Scope* requires information from tasks 1 – 8, 10 – 13 and 15 – 16. As expected, estimating figure 4

Idea Inception DSM

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 Macroeconomic Analysis | | X | | | | | | | | | | | | | | |
| 2 Evaluate Capital Markets | X | | | | | | | | | | | | | | | |
| 3 Local Supply & Demand Analysis | X | X | | | | | | | | | | | | | | |
| 4 Evaluate Zoning/Planning | | | | | X | | | X | | | | | | | | |
| 5 Evaluate Local Politics | | | | X | | | | X | | | | X | | | | |
| 6 Estimate Rents | | | X | | | | X | | | X | | | | | X | X |
| 7 Estimate Costs | X | X | X | X | X | X | | X | | X | | X | X | X | X | X |
| 8 Identify Land Opportunities | | X | X | X | X | | | | X | | | X | X | X | X | |
| 9 Evaluate Land Control Options | | X | | X | X | | | | | | | X | X | | | |
| 10 Back of the Envelope Pro Formas | | X | X | | | X | X | | X | | X | | X | X | X | |
| 11 Evaluate Investment Threshold | X | X | | | | | | | | X | | X | | | | X |
| 12 Evaluate Organization Strategy | X | X | X | X | X | | | | X | X | X | | X | X | X | |
| 13 Estimate Project Timeline | X | X | X | X | X | | | | X | | | | | X | X | |
| 14 Estimate Project Scope | X | X | X | X | X | X | X | X | | X | X | X | X | | X | X |
| 15 Evaluate Programmatic Options | X | | X | X | X | X | X | X | | X | X | X | X | X | | X |
| 16 Financial Underwriting - 1st Draft | X | X | X | | | X | X | X | X | X | X | X | X | X | X | |

the scope of what to build is quite comprehensive, requiring information from many tasks.

Because the tasks are listed sequentially, the X's below the black line represent information that comes from previously completed tasks. Alternatively, the X's above the line, represent information that is needed for later tasks. Because the information for these tasks is unknown before they are completed, assumptions need to be made regarding their outcome. Overall, the X's above the line represent planned rework and iteration. In this example, how can a developer *Estimate Scope* without *Evaluating Programmatic Options* (residential vs. office vs. retail vs. industrial etc)? He can't and thus iteration is required as the developer evaluates options and narrows to an optimal project scope based on information from the other tasks in the Idea Inception stage.

By reading down column 14 we can easily see that the *Estimating Project Scope* task provides information to tasks such as *Estimate Costs, Identify Land Opportunities, and Back-of-the-Envelope Proforma* tasks that occurred earlier in the stage. Because these previous tasks now have new information about a potential *Project Scope*, they must be reexamined. For example, the optimal scope for a particular site may be beyond the financial capabilities and development expertise of the developer. The *Identify Land Opportunities* task must be repeated to find a site that more closely matches the developer's criteria.

Overall, the DSM helps us visually identify important information about the development process. It can be used to sequence tasks in an efficient way, highlight relationships between tasks and identify where rework risk might occur. It may seem that an ideal project would have all X's below the line. That would represent a completely sequential process where rework is not planned. As we previously described, however, rework and iteration can be beneficial and result in a better product. The desirable level of rework and iteration is unique for each project, because the information being generated and the associated risks are project specific.

## Expanding the Matrix to Model the Entire Real Estate Development Process

The Idea Inception stage previously discussed is only the first part of the real estate

figure 5

The six stages of the development process.

development process. The entire development process can be organized into six distinct stages, shown in Figure 5.

At the end of each stage, information is collected, synthesized and reviewed to determine whether the developer should:

- *Move forward* and expend further resources on the project
- *Stop* and give up (losing the investment made to date)
- *Go back or reiterate* to an earlier phase and reexamine assumptions and decisions in a effort to create a more viable project
- *Pause* and wait for certain input factors to change

These Decision Gates are crucial steps in the development process and can assume a variety of forms. In many development firms, an internal investment committee will serve this function. Sometimes an independent board of directors is required to approve certain stages of a project or expenditure of resources. At the simplest level, the project's general partner may make the decision completely independently. In many development projects and organizations, the process for reaching the Decision Gate drives the order and relative importance of tasks within a stage. In our framework, we denote this as an explicit *Review and Approve* task that feeds-forward information into the subsequent Stage (if approved).

## Feasibility

If a *Move Forward* decision is made at the end of the Idea Inception stage to further investigate a site, the developer moves into a Feasibility stage. At this point, the developer has most likely narrowed to a particular site and attempts to determine the "highest and best use" within the constraints identified during the earlier stage. To determine the highest and best use, the developer engages feasibility consultants to further develop and iterate the five functional disciplines of the real estate development process (Figure 1). They will work to develop preliminary market studies, massing studies, conceptual designs and an outline of the legal process involved in permitting the project. The developer is gathering the information necessary to settle on a single plan for development. While all the issues have not been resolved, they are being identified, and a plan for development is underway. The specific tasks being completed in this stage (or any stage) will be project specific, based on the costs and benefits of completing them at certain times. The Feasibility stage will come to an end once a single, highest and best use product has been determined. Additionally, the plan must meet all financial and organizational objectives. Once the Feasibility review has been completed, the developer must decide whether to move forward with the preconstruction stage.

## Preconstruction

If a decision is made to proceed, a lengthy and comprehensive Preconstruction stage begins. During this stage, most outstanding uncertainty is resolved in order to give approval to begin construction. Entitlements are negotiated, design iterations completed, cost effective construction solutions are evaluated, market analysis is finalized, and financial resources are committed and acquired. As in prior stages, these decisions are all interactive and will result in frequent iteration and information exchange between tasks and participants in the process. Finalizing the public review process may require design changes; tenant negotiations may affect financial return and capital sources; etc. All of these issues are being raised and addressed.

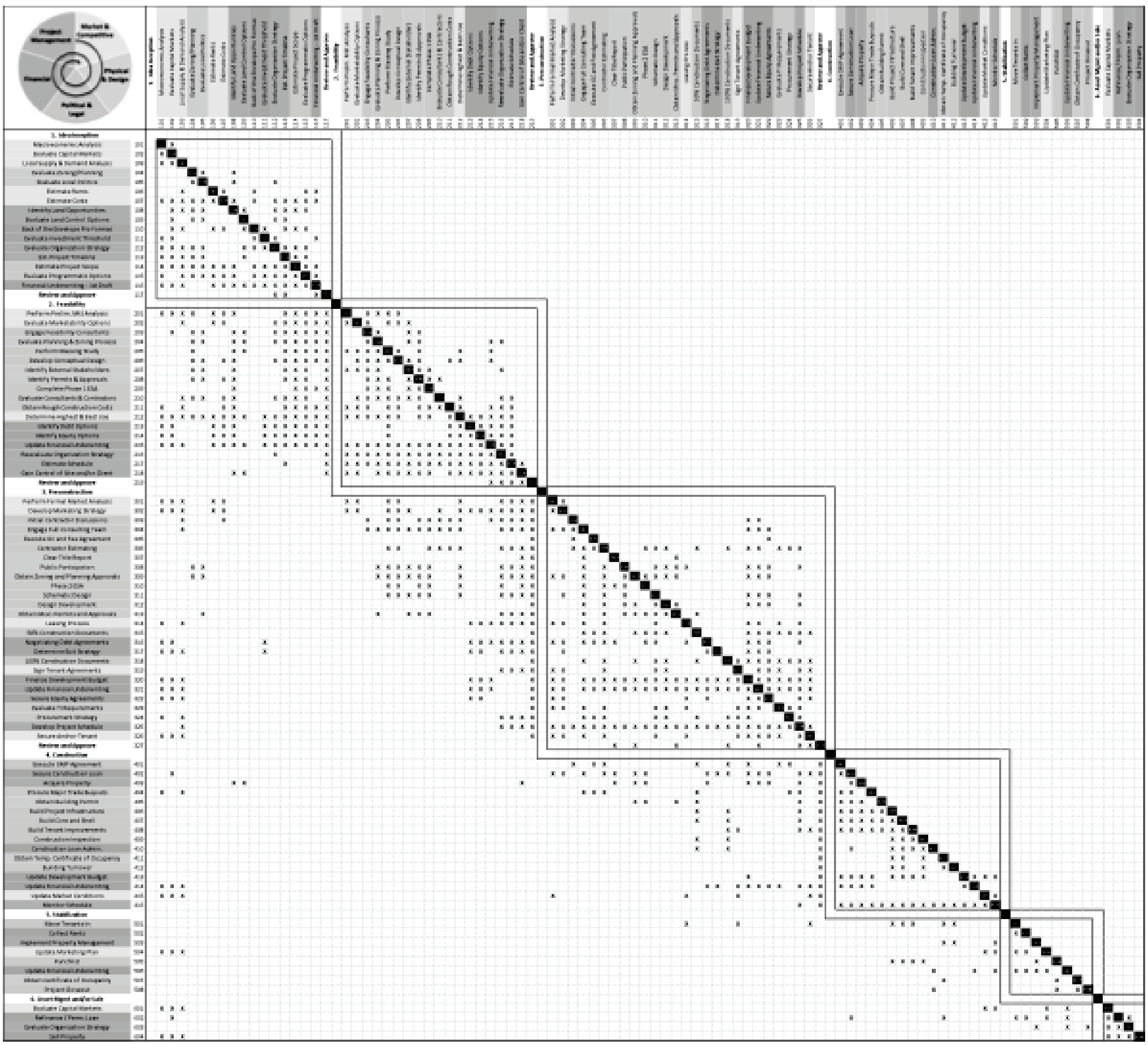
At the end of this stage, the developer will be faced with the biggest decision in the development process: Proceed with construction or wait with the existing plan? Go back and revise the development plan? Or (in an extreme case) cancel the project altogether? In some cases, developers choose to start construction before all tasks in this phase have been completed. To do this, the benefit of expediting the schedule must be compared to (and hopefully outweigh) the cost and risk of starting early. Coming to market sooner minimizes timing risk and carrying costs, but late changes during construction can prove increasingly expensive. The resequencing of tasks within the DSM illustrates the information flows and risks inherent in expediting the process. (Bulloch & Sullivan, 2009)

## Construction/Stabilization/Asset Management

Once the developer fully commits to the project, he has a clear understanding of the project's functional disciplines. While getting to this point has been costly, the **Construction** stage represents the majority of the project's cost. If the decision to initiate construction is made, turning back is rarely an option. Because of this, the *Construction, Stabilization and Asset Management/Sale* stages are more about production and less about the creation and sharing of information. The tasks in the final stages are largely sequential, without the

figure 6

The Real Estate Development DSM



iteration that characterizes the early stages of the development process.

When we apply the DSM methodology to all of the stages and tasks in the real estate development process (categorized by Stage and Discipline), a uniquely comprehensive picture of the interactions between tasks becomes clear (Figure 6). This Real Estate Development DSM model portrays both characteristics of the development process as a whole, as well as informational relationships between individual tasks.

At the project level, the DSM helps explain and visually depict characteristics of the development process. As previously illustrated, the X's below the diagonal line depict sequential interactions where information from a specific task feeds forward to a later task. X's above the diagonal line indicate planned iteration where information from a subsequent task will likely force reexamination or rework of the prior task.

When X's are far away from the diagonal, they represent information that is flowing between tasks not close in their sequential order. If far above the line, iteration and rework may require the developer to repeat tasks that were complete very early in the process. This could then result in many subsequent tasks needing to be revisited as well. If this type of iteration is shown on the DSM, the developer should question its intended result and think about resequencing the tasks.

As a whole, the DSM visually demonstrates the highly iterative and interactive nature of the real estate development process. X's are located both above (iterative information flows) and below (sequential information flows) the black diagonal line within each stage. With a completed DSM, we confirm that the *Idea Inception, Feasibility & Preconstruction* phases are typified by an extraordinary amount of feedback between tasks and iteration as the project moves through the development process. Once the project is fully designed and entitled, the *Construction, Stabilization & Asset Management* phases can be completed entirely sequentially with minimal iteration. Unplanned rework in these later stages is likely to be very expensive, time consuming, and detrimental to project returns. Iteration in these stages is quite rare in practice and the reasons why are clearly displayed in the real estate development DSM.

## Conclusion

Real estate development is a complex, capital-intensive process that generally takes a large team of professionals several years to complete. The DSM tool is widely used in other product development industries and can be useful for analyzing and understanding the real estate development process. The DSM successfully models the entire development process in a matrix configuration that visually portrays the network of information flows between tasks. Only after the information flows and relationships between tasks are understood will the developer be able to manage the development process most effectively. Increased awareness of the relationships between tasks and the iteration inherent in the development process can help us build better, more profitable projects.

## Author's Note

The way we have chosen to sequence and model these information flows in our DSM examples represent a "typical" development and should not be considered to be the only way development is/should be done. This paper, instead, simply illustrates one way of applying the design structure matrix to the real estate development process.

This paper is based on the authors' master thesis completed in 2009 as part of the degree requirements for a Masters in Science in Real Estate Development at the Massachusetts Institute of Technology. The thesis was titled, "Application of the Design Structure Matrix (DSM) to the Real Estate Development Process." John and Ben were advised by Dr. David Geltner, Real Estate Finance Professor from the MIT Center for Real Estate. They also received consultation from Dr. Stephen Eppinger, Professor of Management Science and Engineering Systems from the MIT Sloan School of Management. Information for the thesis was developed in collaboration with Jones Lang LaSalle's Boston office.

John and Ben were awarded the 2009 MIT Center for Real Estate Alumni Association "Outstanding Thesis" Award for this work.

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