Establishing a Commercialization Model for Innovative Products in the Residential Construction Industry.

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ABSTRACT

Throughout the world, innovation is viewed as a critical factor in the future health of the construction industry. There is universal interest in successful commercialization of innovative construction products. This thesis focuses on the US construction industry’s ability to successfully commercialize innovative products. US small, limited-resource innovators will be key players in this success. Recent failures of entrepreneurial business ventures in the commercialization of such products would benefit from a unique model for construction industry commercialization. The general approach is through an identification of accelerators for previously commercialized products, which are incorporated into a generic commercialization model. This process consists of five stages that are presented in this work: defining commercialization and innovation through literature for the residential construction industry; reviewing literature from other-industry commercialization models; establishing a new generic model (or framework) for innovative construction products from such literature; capturing qualitative and quantitative construction data from industry experts regarding actions that facilitate commercialization; populating specific cells of the generic model deemed relevant through this industry data, resulting in the accumulation of important cells, actions, and sequences. This work uses industry cases to present challenges specific to the construction industry and its products. It is limited to five such cases and their important data for residential construction innovation commercialization success.
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CHAPTER ONE: RESEARCH STATEMENT

1.1 Introduction

Advances in innovative technology are widely regarded as major sources of improvement in the competitive position of firms and industries and major factors for increased national economic growth and standards of living (Porter, 1985). Innovation is increasingly becoming a key factor to productivity growth, given changing demographics, intensifying global competition, and accelerating technological change. It is also a generator of social value through production of goods and services that create safer communities, better health care and improved education, for instance (Conference Board of Canada, 2004). At least two key elements are required to achieve national economic growth: technological innovation, which must be transformed into commercially successful products and services that meet customers’ needs, and small technology-based startups, which must grow into medium and large enterprises to become viable receptors (Conference Board of Canada, 2004).

Getting an innovation into the market requires more than just developing something that works. The technical development, or invention, must be matched to an appropriately synchronized, increasingly sophisticated assessment of both the potential market and the channels through which the product may reach it. At the same time, an appropriate business structure must evolve to support the different technical and marketing stages of the invention, while also protecting the inventors’ investment in technology. This coordinated linkage of technical, marketing, and business steps that develop a new technology for a given market comprises the commercialization of the innovation (Rourke, 1999).

Adoption of new innovative products in the residential construction industry is hindered by challenging characteristics unique to the industry (Moavenzadeh, 1991; Slaughter, 1993a; Toole, 1994 and 1998; Toole and Tonyan, 1992). Among others, site variability and one-off nature are characteristics which resist industry adoption (Koebel and McCoy, 2006). Innovative technologies nevertheless offer the potential for competitive advantage through new product and process technologies that can improve effectiveness of designs and efficiency of construction operations. Complexities within
the construction industry also make introducing these innovative technologies difficult. For example, each technology may have to be compatible with numerous parties (Koebel, 1999; Hassell et al, 2003; Toole, 2001). Some commonly accepted factors affecting adoption are firm characteristics; tasks/activities associated with using new products and materials; a firm’s perceived benefits; a firm’s market and competitive strategies; size of builder; competition; business cycles (growth, payback, and downturns); and fragmentation (Koebel, 2003, Hassell et al., 2003). Still, uncertainty could be the main issue (Toole, 1998).

The recently conducted innovation barriers workshop (Koebel, 2004) demonstrates that companies using PATH (Partnership for Advancing Technology in Housing) technologies are faced with heretofore unrecognized difficulty getting products to market. All building product manufacturers must overcome problems inherent in completion of assembly, installation, and integration – “closing the deal” – at the building site. These are magnified for the limited-resource innovator because of diffuse early demand and perceived risk. Many if not all limited-resource innovators, are denied access to traditional homebuilding product supply channels and must create their own.

This thesis describes, in part, ongoing research in response to the National Science Foundation’s (NSF) housing research policy’s findings regarding barriers to technology transfer. The 2004 NSF national housing research found residential technology diffusion as one barrier to current technology transfer (Koebel, 2004). We respond through the development of a unique model for commercializing innovative products in the residential construction industry. I then specify that model through case study data.

The work presented is motivated by recurrent failures of small-sized, resource-limited developers of new homebuilding products in bringing these products to market quickly and effectively. The diffusion of new homebuilding techniques and the growth of new industries in the provision of construction materials are stifled by these failures.

1.2 Problem Statement

This thesis describes the process of identifying important cells, actions within those cells, and sequences among the cells of commercialization. Five interviews further
specify the generic model to one that commercializes innovative products in the residential construction industry.

Commercialization models (e.g. Goldsmith, 2003) describe the sequential decision process of coordinating and optimizing all of the technical, marketing and business decisions required by the successful introduction of a new product or service to the marketplace. A successful commercialization model serves as a process roadmap that promotes “best practices” or optimal actions (accelerators) required to mitigate problems that might arise (barriers) along the path to market. Often, solutions are successful processes experienced by industry innovators. The construction industry nevertheless contains no specific model populated with industry characteristics from previous actions. This thesis investigates such actions from five industry case studies to populate areas along a generic commercialization model, making it specific to the construction industry.

1.3 Objectives & Scope of Work

The general approach to facilitating future innovations is through the identification of important cells, actions and sequences for the commercialization of products in the construction industry. A generic commercialization model is required to reflect any specific barriers and accelerators of commercialization. Performing such a process consists of two phases presented in this work: phase one specifies a generic commercialization model and phase two field tests this model through five innovative product case studies. Chapters Two and Three define the generic model through the following steps:

1) defining commercialization and innovation for the residential construction industry;
2) reviewing literature from other-industry commercialization models;
3) establishing a new generic model (or framework) for innovative construction products from such literature.

Chapters Four through Nine field test the generic model through the following actions:

1) capturing qualitative and quantitative construction data from industry experts through interviews of product commercialization;
2) specifying areas of the generic model deemed relevant through these interviews, resulting in the accumulation of important cells, actions, and sequences.
The process for developing such a model requires a preliminary framework with open architecture to accept multiple forms of data. Once defined through interviews, new case-specific data transform the framework into an increasingly specific adaptation of the generic version. This thesis captures interview data as cells, actions, and sequences of importance for residential construction innovation commercialization success. These data are summarized, and then organized into the cells of commercialization they affect. Examples of further cell detail are also presented as the basis for future work in Chapter Ten.

1.4 Methodology

1.4.1 Generic Commercialization Model Process

Figure 1.4.1 is a visual display of the generic commercialization model process for this thesis. Each item in the diagram is further explained in the text below.

Chapter Two defines commercialization and innovation for the residential construction industry, as separated into two parts. The method for satisfying part one of this process is as follows:

✓ Identifying current construction literature on adoption and diffusion theories for innovation. This work will derive common definitions for the research based on these other works.

✓ Identifying current business literature on commercialization theory for innovation. This work will derive one common definition based on these other works.

Chapter Two also reviews literature from industry commercialization models. The methods for satisfying this process are as follows:

✓ Considering 8 different models as a basis for its definition of the commercialization model: From Invention to Innovation by D.L. Rourke of the US Department of Energy; Randall Goldsmith PhD. Commercialization Website; Commercialization of Innovation by the commercial law firm of Bell Gully; Commercialization of Innovation: Lessons Learned by PATH; Corporate entrepreneurship and innovation part 2: a role-and process-based approach by Elizabeth Shaw; Concept Definition: A New Model by Jane Casto; The R&D/ Production interface: A Case Study of New Product Commercialization by Ginn &
Rubenstein; and S&T Commercialization of Federal Research Laboratories and University Research: Comprehensive Exam Submission by Diane Isabelle.

Figure 1.4.1: Methodology of 8x8 Generic Commercialization Model Process

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Literature Review: Define Innovation, Commercialization, and Acceptance</td>
</tr>
<tr>
<td>1.2</td>
<td>Create generic 3 x 8 commercialization model from literature</td>
</tr>
<tr>
<td>1.3</td>
<td>Further literature review: Create 7 x 8 matrix of generic commercialization model</td>
</tr>
<tr>
<td>1.4</td>
<td>Begin interviews: Create generic 8 x 8 commercialization model (each area has a detailed sheet for findings in case studies)</td>
</tr>
</tbody>
</table>
Chapter Three establishes a new generic model (or framework) for innovative construction products from such literature. The methods for satisfying this process are as follows:

√ Combining and diagram the definitions of part one and two, beginning the creation of a 3 x 8 generic model.
√ Using further literature review from business to expand the 3 x 8 generic model into a 7 x 8 generic model, becoming more specific.
√ Using interview data to create a new model 8 x 8 that serves as a generic representation of the commercialization process required for all innovative products.

1.4.2 Case Study Methodology

Chapters Four through Nine involve capturing qualitative and quantitative construction data from industry experts regarding actions that facilitate the generic commercialization model. Chapter Four serves as an explanation of the process of capturing interviews. The methods for satisfying this process are as follows:

√ Contacting industry innovators who have successfully commercialized a product.
√ Capturing the process of these innovators through interviews.
√ Individually designating the comments of these interviews (actions taken) into cells where these comments might fit on the commercialization model.
√ Expert panel voting of the placement along the generic commercialization model of these interview comments.
√ Placing the cells, actions and sequences of the interview into a timeline diagram (dotted lines denote critical areas for the interviewee, parentheses denote areas where it fits into the generic commercialization model).
√ Note all of the actions mentioned in the interview and their corresponding cells along the generic commercialization model. Create a matrix of these areas mentioned.
√ List the critical actions specifically mentioned by the interviewee and those voted as significant by the expert panel (more than 2 votes).
Place sequences into a generic commercialization model form that might highlight significant relationships.

Figure 1.4.2 is a visual display of the qualitative data process for this thesis. Each item in the diagram is further explained in the text below.

Figure 1.4.2: Methodology for Case Study Findings Process
Once the process is established in chapter three, chapters four through eight use this process to capture five industry-specific products successfully brought to market. The end of each chapter summarizes all of the important areas, actions and sequences into the appropriate areas or individual cells along the generic commercialization model.

Chapter nine redefines the generic model through consistent industry actions which facilitate commercialization, thereby developing a domain-specific commercialization model for the residential industry based on industry inputs that reflect specific challenges facing construction products. The methods for satisfying this process are as follows:

- Assemble the sheets from all five different case studies into one set of the most important areas, actions and sequences experienced by previously commercialized products in the residential construction industry.
- Provide a newly defined Table that relates to the original, generic model presented in Table 3.1.
- Offer modifications of the original, generic model for future use and the conclusions from these modifications.
- Provide one detailed cell example that includes all of the important areas, actions and sequences as a basis for future work.

1.5 Assumptions of the Study

The following definitions are assumed throughout this work:

- Innovation: novel products whose inherent criteria define non-trivial change in an institution’s process;
- Limited-resource innovators: those individuals with little access to the knowledge, markets or finances of corporations;
- Commercialization: Commercialization is the process of developing a product from concept, through feasibility and implementation, to its successful introduction into a given market;
- Acceptance: the point at which a product enters the market;
√ Phases: A period of time within the commercialization model in which similar actions are clustered by function (1 through 8 in Table 3.1);
√ Functional Areas: Different aspects of individual phases within the commercialization model;
√ Cells: The convergence of a row and a column along the commercialization model (Table 3.1);
√ Actions: The processes performed by an individual during commercialization in order to get to the market. Actions are located within a specific cell along the commercialization model;
√ Important Actions (as defined for interviewees): Those actions without which the commercialization process would not be possible;
√ Sequences: The movement between the cells of the commercialization model. This is not to be confused with movement between actions within the cells;
√ Expert: A person with a high degree of skill or knowledge of a subject;
√ Consensus: Agreement by a group of experts as to the location of a case study action within a cell of the commercialization model.

The following additional assumptions were made during this study:
√ The process of successfully getting to market with one product makes an individual an expert.
√ The possibility of these products failing after getting to market is not of importance.
√ Commercialization models are proprietary and therefore not often represented in the literature.

1.6 Contribution to the Body of Knowledge

Chapter Three was achieved by the author as part of NSF research grant #CMS-0533322, Facilitating Supply Chain Support for the Commercialization of Innovative Products in the Residential Construction Market. This first contribution to the body of knowledge is through the development and validation of a generic framework of commercialization that serves as a roadmap for all innovative products or processes.
Most knowledge of commercialization models remains proprietary and therefore inaccessible for small-sized, limited resource product innovators. This framework identifies necessary steps within the technical, marketing and business functions of development. Chapters One, Two and Four through Nine of this thesis are an individual contribution. The second contribution is the use of successful industry case studies to create a specific set of actions for construction industry product development. These cells, actions, and sequences important to successful product commercialization are then organized based on the cells of commercialization. This work then presents a detailed framework for important commercialization processes among these individual cells.

1.7 Limitations of this Study

To offer better details for the proposed construction model in this study, more case studies need to be conducted. Only then can a complete database be created that can be used to compare with other products not yet on the market. This work focuses on creating the generic model, capturing a limited set of knowledge for this model, validating this methodology, and then offering the basis for future work. The following future work is beyond the scope of this study but is needed before full implementation:

- Knowledge from additional successful product commercialization processes;
- Knowledge from individuals without a traditional “business” management training (such as engineers or innovators without business training);
- A set of universal characteristics of these successful products adopted only by the construction industry;
- This universal set of characteristics for other products, not yet in commercialization, that might learn from this work and find success through this process.
- Detailed commercialization cells for all areas of importance listed;

1.8 Organization of the Thesis

This thesis consists of ten chapters, organized as follows:

Chapter One: Research Statement
Chapter One introduces the basis for this research and establishes the methodology for findings.

**Chapter Two: Literature Review**  
Chapter 2 reviews current literature on diffusion and adoption theory for innovation in residential construction and identifies current models published or in use by industry for commercializing innovative products.

**Chapter Three: A Generic Model for the Residential Construction Industry**  
Chapter 3 reviews the process for creating a generic commercialization model that accepts input from residential construction in the following case studies.

**Chapter Four: Individual Case Study Review Process**  
Chapter 4 describes the successful process of all products and corporations getting to market and the actions taken. These actions, where these actions fall within the generic commercialization model and the sequence of these actions are voted on by an expert panel, then plotted onto a timeline for reference. Critical actions of this commercialization process are listed as presented by the interviewee. The number of times an area of commercialization through an action is mentioned in the interview is tabulated. The sequences important to the case study are also diagrammed and discussed. This case study closes with a summary of important areas, important actions taken within those areas, and important sequences.

**Chapter Five: Stair Railing Innovation**  
Chapter 5 describes the successful cells, actions, and sequences for Product 1 and Alpha Corporation getting to market.

**Chapter Six: Composite Siding Innovation**  
Chapter 6 describes the successful cells, actions, and sequences for Product 2 and Beta Corporation getting to market.
**Chapter Seven: Metal Framing Innovation**
Chapter 7 describes the successful cells, actions, and sequences for Product 3 and Charlie Corporation getting to market.

**Chapter Eight: Production Homebuilding Innovation**
Chapter 8 describes the successful cells, actions, and sequences for Product 4 and Delta Corporation getting to market.

**Chapter Nine: Su-Slab Insect Abatement Innovation**
Chapter 9 describes the successful cells, actions, and sequences for Product 5 and Eagle Corporation getting to market.

**Chapter Ten: Findings and Future Work**
Chapter 10 summarizes important areas, important actions taken within those areas, and important sequences. Important findings are drawn from a new commercialization figure that ranks the importance of areas along the generic commercialization model. Possible new model versions are also explored based on the case study findings. One detailed view of the commercialization process for an individual cell is then presented.
CHAPTER TWO: LITERATURE REVIEW

2.1 Innovation, Adoption and Commercialization Definitions

Studies on innovation and commercialization in various industries have created confusion as to separate, universal definitions. Understanding central themes is important, however, as a basis for establishing these definitions. The central themes of innovation are based on diffusion and adoption theories, while commercialization is based on the theories of business. Innovation diffusion theory attempts to explain the characteristics of social groups that affect the acceptance of a product. Innovation adoption theory attempts to further explain the characteristics of individuals within those social groups that affect the acceptance of a product. Industry context also includes factors which affect the adoption of an innovation. Sometimes confused with new product development, commercialization further explains the actions and decisions required in getting the product to a given market.

The addition of construction innovation literature presents further confusion to the already complex industry. Commercialization definitions within the business community are equally complex, depending on the context. Our roadmap requires a strong basis for analysis, an accepted definition of both from the start. Unfortunately, the scholarly literature is not much more consistent in the use of these terms than in popular use (Koebel and McCoy, 2006).

“Innovation and Commercialization are often used in overlapping ways to refer to the processes of discovering knowledge, developing it into technologies, and transforming these into new or adapted products, processes and services to be used or sold in the market place” (Isabelle, 2004). Isabelle provides an integrative definition of commercialization as the “process of translating research knowledge into new or improved products, processes and services, and introducing them into the market place to generate economic benefits.”

Cornford (2004) defines innovation as a “continuous stream of commercially relevant ideas”, and commercialization as “generation of local wealth with them” with success determined by the quality of linkages between the two. More specifically, he defines commercialization as “…having more to do with taking R&D from the lab to the stage where it can find application in an industrial setting. Actually using this know how to
develop a new product would be innovation”. In establishing our own definitions, we first need to look at the concepts separately.

Rogers (2003) develops the most comprehensive look at the diffusion of an innovation. His application, at its basic elements, contains five characteristics that affect an innovation’s diffusion (and thus defines the innovations): *Relative Advantage, Complexity, Compatibility, Trialability, and Observability*. An innovation, for Rogers, is defined by those characteristics that benefit or detract from its market acceptance by a social group. His work does not consider the complexities of the residential construction industry, though.

Sarah Slaughter’s work of the late 1990’s does consider the industry (Slaughter, 1998). She defines innovation through characteristics of innovative products in two settings: the manufacturing process and processes of small builders on-site. For Slaughter, innovative products contain one of the following paths: *System, Modular, Radical, Incremental, and Architectural*. Her general definition is most accepted in construction industry discussions: “Innovation is the actual use of a nontrivial change and improvement in a process, product, or system that is novel to the institution developing the change” (Slaughter, 1998).

Rogers and Slaughter both inform our definition. We see innovation as novel products whose inherent criteria define non-trivial change in an institution’s process. For our study, this broad definition accepts the complexity of the industry.

Still, many others have been identified factors in construction products that might influence innovation (Flood, 2003, Blackley and Shepard, 1996, Toole, 1998). These are common characteristics that accelerate or impede the process of diffusion of innovation. These factors do not necessarily only pertain to the product, but affect a product’s process along commercialization. Examples of these characteristics might be firm characteristics or institutional characteristics. Still, characteristics of diffusion that improve the acceptability of innovations are considered accelerators. Characteristics of diffusion that hinder the acceptability of innovation are considered barriers.

There are many such characteristics that affect innovation in construction. Holmen Enterprises (2001) identify five factors affecting the diffusion of innovations, called “contingent factors”: *Relative Advantage, Complexity, Compatibility, Trialability,
and Observability. Across the population of commercialization cases, each of these factors can be an accelerator or a barrier, depending on its value relative to competing market offerings.

Flood (2003) attributes the difficulty of innovation adoption to the attitudes of the institutions needed for the adoption. Blackley and Shepard (1996) find this resistance to adoption in institutional factors such as local codes or regulations. Toole (1998) finds the variations of the codes to offer the largest barriers.

Others look to firm characteristics as the largest barrier for adoption. While many firms only innovate internally to support existing business strategies, some simply do not have the resources to consider innovation at all (Macomber, 2004, Blackley and Shepard, 1996). Innovations that need a large investment or contain risk will often be tossed out (Sexton and Barrett, 2003). Some contractors don’t even contain the organizational abilities to notice new technology (Mitropoulos and Tatum, 1999). Technology transfer becomes nearly impossible without the necessary organizational structure in targeted firms. New technologies need to understand this barrier and incorporate characteristics that will accelerate adoption (Flood, 2003).

Innovation is often seen as a motivator and an issue of survival (Sexton and Barrett, 2003). For smaller firms, innovation might improve effectiveness and efficiency. For all firms, innovation strengthens capabilities for business strategy and market positioning. These characteristics accelerate adoption of innovation if considered during the product’s commercialization.

A definition of commercialization requires a broad view of business, while specific to the industry. In business, some early studies looked at new product commercialization through the specific lens of R&D/Production. R&D has often been central for technology innovation through knowledge transfer. Due to intense “interface” activity of this stage, R&D confusion can also resist knowledge transfer, becoming a barrier (Ginn and Rubenstein, 1986). Ginn and Rubenstein nevertheless indicate R&D as a crucial part of the commercialization process that needs to be reflected in the broad view of organizational culture.

In manufacturing, 3M Corporation more recently found that “the most problematic pieces of product development involve defining the product;” therefore “the
linear commercialization processes familiar to many businesses are in the throes of revolution” (Casto, 1994). 3M’s commercialization requires that concept definition remains “a separate and ongoing part of the development process.”

While some commercialization literature focuses on R&D/Production for technology-specific industry and concept definition for manufacturing, both are industry specific and neither defines a generic process of commercialization. Generic definitions often offer a broad view. The *Energy Technology Commercialization Help Guide* defines Commercialization as “the full spectrum of activities required for moving a new technology, product, or process from its conceptual stage to the marketplace” (Rourke, 2005). University Technologies International (2001) sees commercialization as the art of taking an invention or a technology and developing a product or service for either consumers or industry. Rourke (1999) calls commercialization “the full spectrum of activities required to move a new technology, product or process, from its conceptual stage to market place.”

We use a broad definition, while limiting the scope to the entrance of a product into a given market. Commercialization, therefore, is the process of developing a product from concept, through feasibility and implementation, to its successful introduction into a given market. This involves understanding product design (PD), production process planning (PP), marketing (M), supply chain management (SCM), financial management (FM), human resources (HR), accounting and IT (AIT), and legal and regulatory management (LM). We further define an innovative product’s acceptance as the point at which it enters the market, while other studies include more of the product’s durability lifecycle after its market acceptance.

Once we establish accepted definitions of innovation and commercialization, building a generic model that reflects these definitions is the next step. The new model must also accept the unusual nature of the residential construction industry.

**2.1 Existing Commercialization Models**

No current model exists for the commercialization of innovative products in residential construction. We assemble our model from other industry current definitions. Isabelle (2004) presents a thorough literature review of various commercialization
models and their differences. Outside of the literature, this work rely on industry-related
publications. It explores all of these influences in the next section of this paper.

Early literature places high importance on the early stages of commercialization; if
early process is sound then major resulting problems may be avoided. Casto (1994)
promotes “concept definition” as an integral part of any model. It happens separately,
concurrently to other operations and is an integral building block for good practice.
Similar to Ginn and Rubenstein’s R&D stage, the concept definition is not only for the
product itself, but for the entire organization surrounding that product. This process
better enables the organization to understand how a product fits its goals, not just the
outside market. Casto’s separation of concurrent activities is achieved through a
reiterative loop process. This loop is necessary for the concept definition to work outside
of the other commercialization processes. Loop diagrams represent an organization’s
ability to continually review the product concept within the larger product development
process.

More recently, Shaw’s (2005) “two-tier model of corporate entrepreneurship and
innovation” furthers the loop diagram. Her strategic framework is similar to other
models through a breakdown of the process into distinct stages: Discovery, Opportunity
Finding, Application, and Adoption and Diffusion. The strategic framework then allows
separate, concurrent actions to happen along the outside of the main framework; a
reiterative loop similar to Casto, offering a corporation the ability to review.

Resulting from industry publications, the United States Department of Energy
(USDOE) innovation process model by D.L. Rourke was created to promote the
commercialization of innovative products in the US energy technology industry (Rourke,
1999). While not written for the construction industry, their model divides the
commercialization process into three major steps: Innovation, Entrepreneurial, and
Managerial. Each major step contains separate stages: Technical, Marketing, and
Business. Table 2.1.1 is a breakdown of the Rourke model with these steps, stages and
the required actions.
Table 2.1.1: Rourke Model Breakdown

<table>
<thead>
<tr>
<th>Stage</th>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td>1</td>
<td>Product Definition</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Working Model</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Engineering Prototype/Test &amp; Refine</td>
</tr>
<tr>
<td>Marketing</td>
<td>1</td>
<td>Preliminary Market Definition</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Market Analysis</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Identify Market Barriers</td>
</tr>
<tr>
<td>Business</td>
<td>1</td>
<td>Define Development and Intellectual Property Strategy</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Find Money, File Patents</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Establish Intellectual Property, License Plan</td>
</tr>
</tbody>
</table>

**Innovation**  
*Product definition to engineering prototype*

<table>
<thead>
<tr>
<th>Stage</th>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical</td>
<td>1</td>
<td>Production Prototype</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Limited Production</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Full Production</td>
</tr>
<tr>
<td>Marketing</td>
<td>1</td>
<td>Full Market Analysis and Plan</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Establish: Customers, Distribution, and Endorsements. Publish</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Expand: Distribution, Competitor Analysis, Response</td>
</tr>
</tbody>
</table>

**Entrepreneurial**  
*Prototype to production*

<table>
<thead>
<tr>
<th>Stage</th>
<th>Step</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business</td>
<td>1</td>
<td>Find Big Money, Complete Business Plan, Form Business, Meet regulations, Arrange Insurance</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Find Big, Big Money, Start-up Business, Build Plant, Buy Equipment, HR Training, Arrange: Record Keeping, Purchasing, Transportation</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Monitor Costs, Finance Cash Flow, Refine Production</td>
</tr>
</tbody>
</table>

**Managerial**  
*Production for major market penetration*
Assuming time to be along the y-axis in Table 2.1.1, the Innovation Stage occurs early in the commercialization process and accomplishes the design of an innovative product or process, market analysis and the strategic business plan. The Entrepreneurial Stage next finalizes all essential elements of the commercialization plan including: product design, the structure of the supply chain, the pricing and promotion plan, the securing of financing and the satisfaction of regulatory requirements. The Managerial Stage is the final stage of the commercialization process and executes the initial production, distribution, sales and installation of the product.

Randall Goldsmith (2003) also produced a commercialization model as part of the Arkansas Small Business Development program at the University of Arkansas. Goldsmith presents a universal solution for the advanced technology industry through his website model.

Table 2.1.2: Goldsmith Model Breakdown

<table>
<thead>
<tr>
<th>Category</th>
<th>Phase</th>
<th>#</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation</td>
<td>Technical</td>
<td>1</td>
<td>Technology Concept Analysis</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>1</td>
<td>Market Needs Assessment</td>
</tr>
<tr>
<td></td>
<td>Business</td>
<td>1</td>
<td>Venture Assessment</td>
</tr>
<tr>
<td>Development</td>
<td>Technical</td>
<td>1</td>
<td>Technology Feasibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Engineering Prototype</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Pre-Production Prototype</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>1</td>
<td>Market Study</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Strategic Marketing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Market Validation</td>
</tr>
<tr>
<td></td>
<td>Business</td>
<td>1</td>
<td>Economic Feasibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Strategic Business Plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>Business Start-up</td>
</tr>
<tr>
<td>Commercial</td>
<td>Technical</td>
<td>1</td>
<td>Production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Production Support</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td>1</td>
<td>Sales &amp; Distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Market Diversification</td>
</tr>
<tr>
<td></td>
<td>Business</td>
<td>1</td>
<td>Business Growth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Business Maturity</td>
</tr>
</tbody>
</table>

Similar to the Rourke model, Goldsmith’s commercialization model shown in Table 2.1.2 comprises three major categories: Investigation, Development and Commercial.
Each phase is broken into three phases: Technical, Marketing, and Business. Unlike the Rourke model, Goldsmith uses distinct actions to define the process. He places details on linked, sequential website pages. Each page’s description provides actions, critical term definitions and milestones for the framework. For example, the web page for Innovation>Technical>Technology Concept Analysis defines the activity as “The process of determining that the physical features of the concept are potentially achievable and operational”; establishes the objective as “to succinctly define the concept, to assess the implementation potential of the technical aspects of the concept, and establish the uniqueness of the technical concept”; then asks the following questions, among others:

a. Have you completed a technology database search?
b. Have you researched related patents or copyrights?
c. Have you researched technical journals and trade magazines?

Once one answers the questions correctly, he can move to the next stage.

Other industry publications on commercialization concentrate on intellectual rights. Gully’s commercialization model is an example of this non-sequential process (Gully, 2004). Its “life cycle” commercialization model offers a breakdown of only the early stage of the commercialization process and no technical side is presented. Like other models, the Gully model uses a reiterative-loop diagram to show the following sequence: Idea, Protection and Development of the Idea, A Decision to Sell or Not, Growing the business, and Beginning the Process again. Gully presents “steps to success” as the consistent elements that can properly be compared with those of other models.

A comprehensive look at all of the literature and industry-based commercialization models offers differing processes for taking a product to market. The next step requires assembly of the different models into a generic one which accepts modification due to the specific characteristics of the residential construction industry.
CHAPTER THREE: A GENERIC COMMERCIALIZATION MODEL FOR THE RESIDENTIAL CONSTRUCTION INDUSTRY

While the vital stages and steps from literature provide a basis for assembling our new commercialization model, case-based industry input and literature will later modify the model’s framework to respond to unique industry characteristics. This section of the thesis discusses assembling the generic model. Table 3.1 is the final 8 x 8 form, a generic commercialization model. Through a description of Table 3.1, this work will explain the layout and literature basis for the model, explain two cells in detail and explain the process of gaining further industry input.

The first diagrammatic representation (figure 3.1) of the literature models shows the movement of the different elements of commercialization along time: Technical, Marketing, and Business. While a basic form, the use of color starts to separate these elements, as compared to the Goldsmith model in Table 2.1.2 above, but as an extension of Rourke’s model in Table 2.1.1. Here, the idea of phases breaks the flow of the elements across an x-axis of time. These phases of the commercialization process are Idea, Innovation, Commercialization, and Acceptance.

Further, the initial diagrams of commercialization attempt to depict the process of an idea along time, trying to gain acceptance. In Figure 3.2, the basic elements of commercialization have been established and these elements move along the x-axis with time and discover barriers that pertain to the innovation, which are illustrated in the literature but not yet discovered in detail. The different elements keep their own color affiliation so that they may later be broken down to see the complexity of their individual paths along commercialization. The verticality of the diagram reflects Goldsmith and Rourke’s models from before. Other literature used as the basis informs our need for looping steps, ones providing the ability to review.

Moreover, Figure 3.3 (below) shows the various levels of barriers that might be associated with one element: Business. Once a barrier is established, the complexities of that barrier must also be mapped along the process and show their relationship to one another. Therefore, Figure 3.3 demonstrates the necessity for each element to have as many phases and stages as possible, as well as detailed deliverables within the phase or
stage. In containing these various levels of definition, the model reflects the complexity of the barriers and the commercialization process.

Figure 3.2: Commercialization Stages Diagram: Technical, Marketing, & Business Along Time
All of these considerations became the basis for the first model matrix. Figure 3.4 is the first version and includes the vertical and horizontal axes and begins to accept the complexities of commercialization. Here, the three elements are still separated and begin to contain deliverables as a solution to barriers. The phases sectionalize the process into distinct periods as well and also contain deliverables for possible barriers. Commercialization follows the x-axis, as the innovation moves across time from its initial IDEA to eventual ACCEPTANCE. The deliverables are detailed in Figure 3.5, where the different model literature is further broken down, compared to one another, and prepared for inclusion into a final, detailed commercialization model.
In order to categorize the commercialization models found in the literature review, a compilation of all information was required by stage or phase. Below is an example of the Goldsmith model, and its deliverables per stage, and the Rourke’s model, with its deliverables by stage, as placed into the same document. Figure 3.5 below demonstrates this comparison process. Here, the Goldsmith description of stage and phase is listed, and then all deliverables per stage or phase are highlighted. The Rourke deliverables are colored blue for contrast. Both will be included as detailed descriptions of actions along commercialization in the generic model.

Figure 3.5: Goldsmith and Rourke Phase Definition

<table>
<thead>
<tr>
<th>DEVELOPMENT/ INNOVATION PHASE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEASIBILITY STAGE</td>
</tr>
<tr>
<td>TECHNICAL FEASIBILITY</td>
</tr>
<tr>
<td><strong>Definition</strong>: The process of proving that the concept is technically possible.</td>
</tr>
<tr>
<td><strong>Objective</strong>: The objective of the technical feasibility step is to confirm that the product will perform and to verify that there are no production barriers.</td>
</tr>
<tr>
<td><strong>Product</strong>: The product of this activity is a working model.</td>
</tr>
<tr>
<td><strong>Technical Activities</strong>: During the technical feasibility step the following must be completed.</td>
</tr>
<tr>
<td>- Test for technical feasibility;</td>
</tr>
<tr>
<td>- Examine the operational requirements;</td>
</tr>
<tr>
<td>- Identify potential safety and environmental hazards;</td>
</tr>
<tr>
<td>- Conduct a preliminary production feasibility assessment;</td>
</tr>
<tr>
<td>- Conduct a preliminary manufacturing assessment;</td>
</tr>
<tr>
<td>- Estimate engineering prototype costs</td>
</tr>
<tr>
<td><strong>Technical Information</strong>: The technical feasibility step generates knowledge about the product or process's design, performance, production requirements, and preliminary production costs.</td>
</tr>
<tr>
<td><strong>Assessment</strong>:</td>
</tr>
<tr>
<td>- Do you have a working model of the product?</td>
</tr>
<tr>
<td>- Have you evaluated the safety factors of the model?</td>
</tr>
<tr>
<td>- Have you evaluated the environmental factors?</td>
</tr>
<tr>
<td>- Have you evaluated the feasibility of producing the product?</td>
</tr>
<tr>
<td>- Have you measured how the product will perform?</td>
</tr>
<tr>
<td>- Do you have a design for the product?</td>
</tr>
<tr>
<td>- Do you have a design for the production process?</td>
</tr>
</tbody>
</table>

PRODUCT DEFINITION: The first step in setting the planning and resource requirements for moving an invention into the commercial innovation process. The product definition brings together knowledge of user needs (market information) with understanding of technical capabilities. The product definition establishes the specific features or functions that need to be developed, enhanced, or emphasized both in creating the product and in designing the marketing plan.

This compilation offers many consistent barriers and accelerators between the different models. For us, a consistent deliverable will be the establishment of a working model which includes all of the information discovered to this point and adheres to a relatively simple process. Figure 3.6 is the first attempt at this deliverable. We placed the major stages and phases identified as important in figure 3.5 along a timeline, defining an x and y axis. The y-axis includes time for the model. An example of this is TECHNICAL FEASIBILITY shown above that appears in figure 3.6 along the timeline. As previously established, the major headings for deliverables along time are Technical,
Marketing, and Business. Figure 3.7 is an extension of the commercialization model that begins as Figure 3.6.

Figure 3.6: Early Commercialization Model

<table>
<thead>
<tr>
<th>TIME</th>
<th>STAGE</th>
<th>TECHNICAL</th>
<th>MARKETING</th>
<th>BUSINESS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>IDEA</strong></td>
<td>Technical Concept Analysis</td>
<td>Market Needs Assessment</td>
<td>Venture Assessment</td>
</tr>
<tr>
<td></td>
<td><strong>INNOVATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Feasibility</td>
<td>Product Definition</td>
<td>Market Study/Preliminary Market Definition</td>
<td>Economic Feasibility/Decision to Develop</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Technical Feasibility</td>
<td>Intellectual Property Strategy</td>
</tr>
<tr>
<td></td>
<td>Planning</td>
<td>Working Model/Engineering Prototype</td>
<td>Market Analysis: define buying keys &amp; 3 points of difference</td>
<td>Find Capital</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Strategic Marketing</td>
<td>File Intellectual Property Documents</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Strategic Business Plan</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
<td>Pre-production Prototype</td>
<td>Identify Market Barriers</td>
<td>More Capital/Business Start-up</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Testing Refined Prototype</td>
<td>Intellectual Property Established</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Market Validation</td>
<td>License or Venture Start?</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Possible License Plan</td>
</tr>
<tr>
<td></td>
<td><strong>ENTREPRENEURIAL/COMMERICAL</strong></td>
<td>(Full-scale) Production</td>
<td>Sales and Distribution</td>
<td>Business Growth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prototype, including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scale Up</td>
<td>Full Market Analysis &amp; Plan, including:</td>
<td>Find Big Money</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Test</td>
<td>Niches</td>
<td>Complete Business Plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Refine</td>
<td>Barriers</td>
<td>Form Business</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production Engineering</td>
<td>Pricing</td>
<td>Meet State &amp; Federal Regulations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product Safety Engineering</td>
<td>Competition</td>
<td>Arrange Insurance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cost Data</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Price Production Facility</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Distribution Method</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Alternative Applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Risk Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sales Projections</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hire/Train Sales Force</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Establish Warranties/Exchanges</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Arrange Customer Financing</td>
</tr>
</tbody>
</table>

25
To better understand time and its role, we then switched the axes. Figure 3.8 shows time running along the x-axis and includes further detail as to the actions that take place as a product progresses. It is an assembling of previous figures 3.5, 3.6, and 3.7 along the new axis. A previous stage or phase (a title for the activity or deliverable) now starts to get detailed actions. The stage requires detailed objectives which lead to activities. These activities are then assessed as to their completion. Once completed, the activities result in a deliverable for the specific stage.
<table>
<thead>
<tr>
<th>FEASIBILITY STAGE</th>
<th>PHASE TASKS</th>
<th>DEFINE PHASE</th>
<th>PHASE OBJECTIVES</th>
<th>PHASE ACTIVITIES</th>
<th>ASSESSMENTS</th>
<th>PHASE DELIVERABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TECHNICAL</strong></td>
<td>Product Definition/Prototype/Service Design/Technical Feasibility</td>
<td>proving that the concept is technically possible</td>
<td>to confirm that the product will perform and to verify that there are no production barriers</td>
<td>Test for technical feasibility, Examine the operational requirements, Identify potential safety and environmental hazards, Conduct a preliminary production feasibility assessment, Conduct a preliminary manufacturing assessment; Estimate engineering, prototype costs</td>
<td>Do you have a working model of the product? Have you evaluated the safety factors of the model? Have you evaluated the environmental factors? Have you evaluated the feasibility of producing the product? Have you measured how the product will perform? Do you have a design for the product? Do you have a design for the production process?</td>
<td>a working model.</td>
</tr>
<tr>
<td><strong>MARKETING</strong></td>
<td>Market Study/Preliminary Market Definition/Target Marketing</td>
<td>identifying the price stage at which a quantified market segment is willing to purchase the product and justifying why the target market will choose the product over the competitive’s</td>
<td>to identify who will buy the product, how many units they will buy, and how much they will pay.</td>
<td>Describe the market environment, Identify economic and industry trends, Quantify the size of the market, Identify the market segments, Analyze market segment size, growth rate, competitive environment, Analyze business capabilities for market share, competitive position, product capabilities, resource capabilities</td>
<td>Have you conducted a market study? Have you identified factors critical to the market environment? Have you identified the economic and industry trends? Have you quantified the market size? Have you identified the market segments? Have you identified the size, growth rate, and competition of the market segments? Have you analyzed business capability for market share, competitive position, product capabilities, and resource capabilities</td>
<td>a market study that follows the marketing section of a standard business outline format.</td>
</tr>
<tr>
<td><strong>BUSINESS</strong></td>
<td>Economic Feasibility/Decision to Develop/Intellectual Property Strategy/Capabilities Sourcing</td>
<td>that period during which a break-even financial model of the business venture is developed based on all costs associated with taking the product from idea to market and achieving sales sufficient to satisfy debt or investment requirements</td>
<td>to develop a financial model of the business venture</td>
<td>Develop a financial analysis that identifies break-even parameters based on unit prices, volume of sales, and costs, Determine whether the business opportunity presents sufficient profit margins to justify a business venture, Assess the merits of licensing the opportunity compared to venturing</td>
<td>Does the venture demonstrate a positive economic feasibility? Have you developed a break-even financial analysis for the venture? Does the venture offer financial returns that justify investment? Have you compared the merits of licensing to venturing?</td>
<td>a complete integration of the technical product information and the market study into one or more break-even financial models.</td>
</tr>
</tbody>
</table>
The commercialization model concept (figure 3.9) consists of several phases that were consistent among all industry models studied: a beginning idea phase, a second investigatory stage, a third production stage, and a fourth stage of acceptance into the market. Each phase has specific characteristics and some phases require more detail, which becomes a sub-phase called a stage. Each phase or stage represents a period of time from 1-8, 1 being the beginning of the process.

Again, the literature diagramming shows that every commercialization process can be broken down into three components or “functional areas:” Technical, Marketing and Business. For this level of description, marketing still is considered a part of the business side, though, and separate from technical operations. Later models will become more detailed into the functions required on the business side.

As shown in the literature, the Technical, Marketing, and Business functions move across time through the phases of Idea, Innovation, Commercial and Acceptance. The Idea phase requires analysis and research of the products concept in regard to technical, marketing, and business functions. The Innovation Phase requires feasibility studies and initial production runs across all functions. The Commercial phase refers to the production and standardization functions. The Acceptance phase requires product support and diversification of markets.

In Figure 3.9’s concept model, only a basic description is used to name the phase or stage. In the following figure 3.9, the phases and stages will reflect desired outcomes, or deliverables based on the literature concepts of concurrent engineering.

Casto (1994) discusses the importance of concurrent engineering within the commercialization process. Concurrent engineering looks at all elements of the new product development process occurring at once. Figure 3.10’s commercialization model is an expansion of Figure 3.9 which allows for all of the possible business actions required through concurrent engineering. Each cell in this model reflects a broader view of the same previous model cell. One obvious difference here is that the cells called “business” before have been expanded to reflect the large amount of different tasks that cannot be easily grouped under one description.
The previous 3 x 8 matrix is now 7 x 8 to resolves all of the functions required for product development. Therefore, a cell like “accounting and legal” has its own separate set of deliverables through the process of innovation. The literature discussed in previous chapters was then used to add better descriptions of the individual cell functions.
### Figure 3.10: Commercialization Model Deliverables by Stage

<table>
<thead>
<tr>
<th>GENERAL DELIVERABLES BY PHASE OR STAGE: BEGINNING TO END</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPLY CONCURRENT ENGINEERING PRINCIPLES</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TECHNICAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>The innovation is defined in a succinct statement</td>
<td>Mockup, demonstrates relationships of parts, physical and illustrated</td>
<td>Working Model; demonstrates the connections and motions of the parts, physical</td>
<td>Engineering Prototype; demonstrates important design parameters (CT, reliability, speed, and accuracy)</td>
<td>Production Prototype; meets performance standards, resolves production problems, illustrates quality control standards</td>
<td>Verifies that product is ready for full scale production</td>
<td>Innovation production and all the related processes necessary is up and running</td>
<td>Field and innovation production support, looking for new or supporting innovations to commercialize</td>
</tr>
<tr>
<td>M</td>
<td>Identify a potential market for the idea; Succinct investigation of market acceptability</td>
<td>Perform market research; market segmentation &amp; product definition</td>
<td>Forecasting &amp; diffusion planning, Advertising &amp; promotion planning</td>
<td>Test marketing plan</td>
<td>Initial sales, promotion &amp; advertising management</td>
<td>Revise marketing plan, product definition &amp; diffusion plan</td>
<td>Sales, promotion &amp; advertising management</td>
<td>Marketing Support; Look for new or supporting innovations in the field</td>
</tr>
<tr>
<td>Fin</td>
<td>Succinct description of financing options</td>
<td>Capital sourcing analysis</td>
<td>Determine capital configuration, Develop capital plan, Perform capital costing &amp; risk analysis</td>
<td>Test capital plan, Develop working capital management plan</td>
<td>Capital acquisition, Working capital management</td>
<td>Revise capital configuration, Revise capital plan</td>
<td>Manage financial resources</td>
<td></td>
</tr>
<tr>
<td>Ops</td>
<td>Succinct description of operations models &amp; options</td>
<td>Capability sourcing &amp; Supply-chain analysis</td>
<td>Supply-Chain Design, Capacity &amp; operations planning</td>
<td>Pre-production run</td>
<td>Initial operations management, Measure supply-chain performance</td>
<td>Revise supply-chain design, Revise capacity &amp; operations plan</td>
<td>Operations management</td>
<td></td>
</tr>
<tr>
<td>HR</td>
<td>Succinct description of human resource options</td>
<td>Labor sourcing analysis</td>
<td>Staff planning, Develop hiring/development/promotion plan, Perform labor costing &amp; HR timing</td>
<td>Test staffing &amp; HR plans</td>
<td>HR recruitment &amp; development, Initial HR management</td>
<td>Revise staffing &amp; HR plans</td>
<td>HR management</td>
<td></td>
</tr>
<tr>
<td>IT</td>
<td>Succinct description of information technology options</td>
<td>IT research</td>
<td>IS design, Develop IS implementation plan</td>
<td>System testing</td>
<td>Initial IS implementation &amp; supervision, Measure system performance</td>
<td>Revise IS design, Revise IS implementation plan</td>
<td>IS management &amp; supervision</td>
<td></td>
</tr>
</tbody>
</table>
Our generic commercialization model is an 8x8 matrix. The x-axis items of the matrix are phases in time; actions performed in taking a product to market. Each phase number, indicated by numbers 1-8, represents a sequential order from concept to market. All phase definitions are listed across the top of Table 3.1 in the same column as the corresponding cell. The “Concept” phase is mostly a research step. “Feasibility” actions are early actions needed for proper product development, while the “Planning” phase requires figuring out the resources for these actions. Two “Review” phases (4 and 6) test and adjust the product accordingly. A review is required of the planning and early production stages. “Early Production” is the first product release and all of the actions surrounding this production. After review and adjustment, the new product and it surrounding actions become standardized. Finally, the new product reaches a market.

The y-axis items of Table 3.1 include technical, marketing, and other business-related functional areas encountered when taking a product to market. Functional areas are unconstrained in their order, not necessarily representing a sequence as the product moves from concept to market. All functional areas definitions are listed down the table in the same row as the corresponding cell. “Product Design” is the technical design of the product, including concept design, prototype, production, standardization and supplemental product design. “Process Planning” establishes the needed production capabilities and capacities of the product and might include plant design and production line mechanics. “Marketing” understands a product’s unique market, including forecasting, planning and revisions of the plan. “Supply Chain Management” coordinates the suppliers and distributors needed for a product. Any portion of supply or distribution coordinated outside of the company is considered out-sourcing, while most internal work is covered by process planning. “Human Resources” deals with all personnel needs, including hiring, firing, the decision to subcontract, reassigning and promoting. “Accounting and Information Systems” organize knowledge for a product’s development, including communication systems, internal auditing processes, software designs, and standards of access to knowledge. “Financial Management” pertains to all actions associated with product capital management, including financing rates and options, securing financing, estimating and planning. “Legal Management” deals with the legal entities, contracts, agreements, or regulations surrounding a product’s path to market.
While not specifically shown in Table 3.1, the phases are consistent with generic industry models: a beginning idea/investigation phase relates to phases 1&2, a second innovation phase relates to phases 3 & 4, a third commercial phase relates to phases 5 through 7, and a fourth phase of acceptance into the market relates to phase 8. Industry literature also has the commercialization process or step broken down into three main components: Technical, Marketing and Business. Our technical areas are product design and process planning. Marketing is the same, while business is much more diverse than previous models. The “review” phases of the model allow for the literature concept of the “reiterative loop.” In reviewing the phases at critical points along the path to market, the product can learn from its own development and improve. The phase 4 planning review reflects the literature’s insistence on getting early concepts correct.

Individual cells of Table 3.1 could become separate, detailed pages within the commercialization model. Separate pages contain objectives and the actions required to complete these objectives, similar to Goldsmith. The total possibilities of detailed sheets is 64 (8 x 8), but we will probably focus on fewer areas of critical value. For example, a detailed page of “M2: Marketing Feasibility” would include objectives of: understanding the market fit and segmentation for the given product. Recognizing the market fit might require researching competition, initial testing of the current market and identifying niches within a market. A detailed page of “LM3: Legal Management Planning” includes designing contracts and procedures. This step probably requires subcontracting a partnering license to a lawyer, identifying partners for the contract design and outlining legal procedures for the new corporation. Many other objectives and actions are possible in a product’s development; all contained in the detailed pages of the model. The detailed model pages need to be populated by case-based actions and decisions, though. While this is a generic outline and various detailed objectives, case-based data validate critical cells, actions and sequences.

The case study process, beginning with Chapter Four, will capture qualitative data through industry interviews with individuals who have participated in commercializing a product for the residential construction industry. Future work will also incorporate existing case study literature which examines the process of introducing a product into
<table>
<thead>
<tr>
<th>Functional Areas</th>
<th>Definitions</th>
<th>Phases</th>
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<th>Phases</th>
<th>Phases</th>
<th>Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supply Chain Management</strong></td>
<td>Establishing the chain of business entities for manufacture and distribution</td>
<td>SCM1: Identify Sourcing &amp; Outsourcing Options</td>
<td>SCM2: Configure Supply Chain</td>
<td>SCM3: Detailed Design of Supply Chain</td>
<td>SCM4: Model Supply Chain Performance</td>
<td>SCM5: Execute Production Run</td>
<td>SCM6: Adjust Supply Chain</td>
<td>SCM7: Standardize Sourcing &amp; Outsourcing</td>
</tr>
<tr>
<td><strong>Human Resources</strong></td>
<td>Defining the personnel requirements for the supply chain and acquiring human resources</td>
<td>HR1: Identify Project Leaders &amp; Responsibilities</td>
<td>HR2: Create Leader Positions, Other Labor Roles &amp; Responsibilities</td>
<td>HR3: Create Hiring, Firing, &amp; Promotion Plan</td>
<td>HR4: Review Labor Costs, Reassign or Dissolve Labor. Decide to Outsource?</td>
<td>HR5: Recruit, Create, Train, &amp; Supervise for Production Run</td>
<td>HR6: Review Staff Costs, Reassign or Dissolve Labor. Decide to Outsource?</td>
<td>HR7: Manage Human Resources.</td>
</tr>
<tr>
<td><strong>Accounting &amp; Information Systems</strong></td>
<td>Implementing the AIS system for all business functions</td>
<td>AIS1: Includes: Research Information Technology</td>
<td>AIS2: Includes: Design Accounting &amp; Other Information Systems</td>
<td>AIS3: Includes: Plan &amp; Acquire IS Implementation</td>
<td>AIS4: Includes: Install &amp; Test IS</td>
<td>AIS5: Includes: Audit IS through Production Run</td>
<td>AIS6: Includes: Revise from Audit</td>
<td>AIS7: Includes: Support &amp; Standardize IS</td>
</tr>
</tbody>
</table>
the market. Once these data are captured, a series of filters that relate the information to our framework is used. The templates are filters designed to accept critical cells, actions and sequences, some of which are used in the findings.
CHAPTER FOUR: CASE STUDY REVIEW PROCESS

This next portion of the research specifies our generic commercialization model by introducing data from product case studies in residential construction. The typical collection process has seven main components: an initial phone contact, a follow-up phone or in-person interview, a dictation of the interviewee’s actions for distribution to an expert panel, expert consensus as to each action’s location on the generic commercialization model, a timeline representation of the interview data and expert consensus, a table representing the expert panel consensus and a final mapping of the sequence along the generic commercialization model. Each case study relies on this consistent process to present its separate data. The following describes individual case study format and presentation of data.

I begin each case study with naming the product and corporation developing the product. Since all interviews are confidential, I give each product and corporation a fake name for reference throughout the thesis. Once identified, I offer important firm characteristics and a thorough description of the product itself. The product description often places it into a larger context that shows its importance within the industry at large.

The context of a product’s location along the construction supply path is the next important description. Figure 4.1 offers a typical supply path for products in the construction industry as well as the different players possibly needed to touch the product from concept to acceptance in the market. A typical corporation might serve as both “Fabrication Manufacturer” and “Assembly Manufacturer” along the supply path of Figure 4.1. As a result of a corporation’s position in the supply path, the product’s commercialization process must therefore consider its supply of raw materials and the role of an assembly manufacturer. Each case study contains a description of this important placement for the product.

Since the research team previously defined acceptance for these studies as the point in which a product has reached the market and has full production, Figure 4.2 is an example of this process through a product timeline. The timeline illustrates actions performed and the sequence between cells of commercialization in gaining market acceptance. At this point in the case study process, the interview has been captured, the dictation digitized and distributed and the expert
panel has reached consensus as to each quotation’s location on the generic commercialization model. I use the timeline to better visualize the commercialization process for each product, such as the one above. The beginning of the timeline process is labeled as “Start.” I denote critical cells, according to the subject, in the boxes with dotted lines. Sequences are implied through their placement along the timeline. Expert panel voting (shown in parentheses) ties all actions to the commercialization model cells. For example, this product’s “Finance (FM1)” was a critical action which needed to come before looking into initial Marketing. This is an action that would take place during the cell “FM1: Identify Sources of Capital, Financing Rates.”

When compared, similar timeline diagrams reflect specific tendencies across all five residential construction products and processes. While this example is a generic product version, the case study writings discuss more details of the individual products and processes, further define product characteristics, players involved and the commercialization process followed.
Still, the goal of this research is to create a domain-specific commercialization framework. Since all case studies are used to refine the framework, the validation process must relate the timeline with our generic model. Table 4.1, showing the panel consensus, better explains this relationship. The expert panel consists of two business school representatives and three Building Construction department representatives from Virginia Polytechnic Institute and State University. Each panel member is asked to review the interview dictation and note a cell where the interview quotation might fit into the generic model. For example, the action of attending a conference for initial product research might correspond to cell “PD1: Technical Research” in Table 1. The panel then convenes and reaches a group consensus as to the model location for each interview quote. Table 4.1 contains the same basic structure as Table 3.1 with functional areas along the y-axis and phases along the x-axis. It contains individual consensus per cell and then totals the amount of consensus achieved per row and column. While the group found that M2 was mentioned seven times, marketing as a functional area is by far the most
active in commercialization. Likewise, this generic product would signify phases 2, 3 and 4 as most active. Based on these tables, our conclusions flag individual cells, not the totaled rows or columns, with the number two or higher as important to our findings. This number of significance was chosen as a way to distinguish between a cell being mentioned versus a cell being mentioned often. I feel a cell being mentioned often relates to its significance.

Like the timeline, Figure 4.3 offers cells, actions, and sequences of importance for an innovative construction product. It differs by incorporating the backdrop of our generic commercialization model, though. Again, important cells are dotted as specifically named by the interviewee. Any cell along commercialization specifically mentioned during the interview remains, while we removed all unmentioned cells. All sequence diagrams are also presented in the appendix due to the length of this article.

The significance of sequences in Figure 4.3 is still unclear simply looking at the arrows between cells. I therefore consider any relationship between cells with a double-sided arrow to be significant. These double arrows indicate a back-and-forth relationship of two cells on the process of commercialization, which I feel implies importance. Figure 4.3 offers such a relationship between the cells M2 and PD2 in this generic example. A conclusion from this sequence might be that all second stage marketing work must be integrated with second stage technical development decisions.
The final part of each case study capture summarizes the cells, actions, and sequences into a list. The list is labeled with the important areas (as voted on or explained by the interviewee), and then offers important actions described within the cells and lastly offers possibly important sequences or links to other areas. All individual case study findings are later grouped into common findings in Chapter Ten.
CHAPTER FIVE: STAIR RAILING INNOVATION

Product 1 is an innovative product and process for stair parts in the construction industry. While Product 1 might have commercial construction applications, it is mostly marketed towards home builders. In our description, we refer to the company who developed Product 1 as Alpha Corporation.

Alpha Corporation is part of a larger corporation that makes stair parts for the residential construction industry. While the parent company is in the business of making individual stair pieces and performing some stair parts assembly, Alpha’s purpose is to further innovative systems for stairs. Alpha’s president is the champion of its innovation. Their company is approximately 75 individuals, compared to similar companies that might have 150 employees. They see this as a result of their innovation in process management. Alpha’s parent company, at the time of the interviews, controlled approximately 65% of the stair parts industry in the US Southeast region. They are looking to expand their market and see new innovation as a solution.

Historically, stair railings have used a series of bolts and nuts that tighten to secure different railing pieces together. Due to the unsightly nature of these connections, they are usually hidden beneath the railing and “patched” or “plugged” with another piece of material that is similar in texture and nature. For wooden railings, this process has always been difficult, requiring a large amount of time from a highly skilled worker, and therefore someone who is highly paid. While many within the industry have been looking for a solution to this expensive detail, Alpha Corporation already understands the existing problems inherent in railing installation and are also in a good position to see existing products on the market that are meant to solve the railing problem.

While containing its own innovative product, Product 1 is mostly an innovative process that includes a device from another company, which was developed for other applications. This device is placed within the railing and used to tighten separate railing pieces through a magnetic field, which powers the hidden device. Product 1 is not the hidden device, however, but the innovative process required to adapt this hidden device for stair parts.

The process of uniting stair railings is not easy. Each piece of railing might contain various twists or radiuses needed to create separate looks desired from the client. Often, the client asks for a certain style and expects the contractor to provide the solution. Alpha Corporation
developed Product 1 as a solution to the high cost of assembling these various pieces with multiple styles and radiuses. As the solution, Product 1 needed to adjust for all styles and accommodate the radius of the individual stair railing. Product 1 also needed to adapt for "valutes," or end sections of the railing that were not straight. The product is a collar that fits all railing sizes and curves, forcing the railing to line up precisely. Once lined up precisely, the hidden device can lock the two pieces together.

Still, Alpha Corporation was not able to insert the hidden device easily into certain species of wood. They therefore developed a complementary product that made insertion of the hidden device possible. This additional product is included in Product 1’s total package, making it both an innovative product and process.

Alpha Corporation serves as both “Fabrication Manufacturer” and “Assembly Manufacturer” along the supply path of Figure 4.1. Alpha fabricates stair parts for the construction industry for others to assemble and it assembles sections of stairs for installers to use. Product 1 is an example of an assembly process innovation that includes an innovative complementary product to aid in this assembly. As a result of Alpha’s position in the supply path, Product 1 must therefore consider its supply of raw materials and the role of an assembly manufacturer. This did not pose a problem for Alpha, as it already had products that required the same coordination. Alpha did experience problems with identifying the market for their product, an issue with their stair parts as well. Product 1 is geared towards installers mostly. Alpha’s other products are mostly geared towards the end user, through style or cost or various other benefits, or the developers, through similar attributes. As a corporation, Alpha had much experience in bringing products to market. Product 1 nevertheless required a different commercialization with new areas, actions, and sequences of importance.

Figures 5.1 and 5.2 illustrate Product 1’s interview as a timeline of commercialization that contains areas, actions, and sequences of importance. The timeline shown was only a portion of the longer dictation timeline, but still illustrates the process of capturing the important information. Figures 5.1 and 5.2 illustrate sequence among the important actions and areas for Alpha’s commercialization process as well.
Figure 5.1: Product 1 Timeline

Product #1 Commercialization Process

- Patent investigation of other products on the market: Third party lawyer (LM1)
- AIA Show: Approached by other manufacturer who needs industry application (SCM1)
- Previous Product Introduced into industry (M1)
- Looks for supplemental Product (PD1)
- Partnering contract: 8 months (LM2)
- START

1991

2002

2003

2004

2005

2006

Prototype #1: Metal, in-house, & profile specific: 2 months (PD2)
Prototype #2: Metal, in-house, & non-profile specific: 2 months (PD2)
Prototype #3: Third party product designer, plastic product (PD3)
Prototype #4: Third party product designer, New handle produced (PD5)

Pricing (M3)

Looks for manufacturers to do plastic product (SCM3)
Sales Meeting to test plastic product: New handle needed (PD4)

Pricing (M2)

Looks for manufacturers to do plastic product (SCM3)
Interview product designers to do plastic product (PD3)

Pricing (M2)

Interview manufacturers to do plastic product (SCM3)

Pricing (M5)

Packaging Design by product designer (PD7)

Magazine & television advertising: PR in full operation (M6)
Figure 5.2: Product 1 Timeline Part 2

Product #1 Timeline, Part 2

- Begin trade show demonstrations & dealer demonstrations (M7)
- Salesmen ready to go into field to support proper product installation (M7)
- New product concept: need post-to-post connector system (M7)

- Full Production in Taiwan & China (SCM7)
- Support in place for replacement parts supply (SCM7)
- Registration cards placed into kits (M7)

KEY: □ = CRITICAL
Alpha’s commercialization process for Product 1 began with a long period of time devoted to research and development before getting to any manufacturing processes. This product was developed through legal management of patents, early market identification by looking for others on the market, understanding how the new product might improve on the current products and finding another industry partner for supplemental parts. This process lasted from 1991 to 2002 and was considered critical by the interview subject. The product next went through a series of prototypes and market pricing, all followed by testing. The testing for this product identified the complementary product, mentioned earlier, that required development for this product to be successful on the market. Finally, Product 1 was ready for supply chain management, marketing plan revisions and initial production lines, which lead to the market. Noticeably missing in this product’s process is the financing. Product 1’s financing was mostly through its parent organization, which budgets the amount of investment risk throughout the process and has knowledge from previous product development.

When asked, Alpha listed only the following critical cells of importance during commercialization for Product 1: Technical research (PD1); Market research (M1); Identifying sourcing options (SCM1); Identifying liabilities, regulatory requirements, and partners (LM1); and Designing liability protections (LM2). This list does not, however, show the total amount of cells along commercialization mentioned by alpha during the entire interview. Table 5.1 provides this total number of times Alpha Corporation mentioned specific actions for cells along their commercialization process for Product 1.

According to these numbers, many

<table>
<thead>
<tr>
<th>Functional Area</th>
<th>Phases</th>
<th>TOTAL</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Product Development</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Process Planning</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Marketing</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Financial Management</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Human Resources</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Accounting &amp; Information Tech.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Legal Management</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>7</td>
<td>12</td>
</tr>
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</table>
other areas along commercialization hold importance for Alpha. For these purposes, if a cell mentioned more than 2 times is deemed important, then the previous list would change to the following: Product Development (PD1); Detailed Design (PD3); and Managing Sales (M7). The importance of the information provided by Alpha changes based on this different view. Since Alpha mentioned product design, process planning, and marketing the most, it seems to show the critical nature of this part of the commercialization process.

The sequence of events along commercialization offers a final view into the importance of certain areas and actions for Alpha’s commercialization of Product 1. Figure 5.3 offers a visual account of the amount of times an area was mentioned as part of Product 1’s sequence. This order in which Alpha chose to commercialize for Product 1 might be important for similar products. Figure 5.3 suggests that prototyping, marketing and then understanding the supply path is the important sequence for this type of innovation. The importance of these areas within Product 1’s commercialization is delineated in the sequence through the use if the line with arrows at both ends. These arrows refer to the symbiotic relationship these areas experience when the product attempts to get to the market. For Alpha, each new prototype required that a new marketing fit or plan was investigated to assure success. If the price for the prototype was not good to the market requirements, a new prototype was required. This back-and-forth process continued for Product 1 until the price was good for market fit.

All of the different views of Alpha’s commercialization offer critical cells along commercialization. All mentioned include:

- Technical research (PD1);
- Conceptual design (PD2);
- Detailed Design (PD3);
- Selecting processes (PP2);
- Market research (M1);
- Managing Sales (M7);
- Identifying sourcing options (SCM1);
- Identifying liabilities, regulatory requirements, and partners (LM1);
- Designing liability protections (LM2);
Figure 5.3: Product 1 Commercialization Sequence

**Phases**

<table>
<thead>
<tr>
<th>Functional Areas</th>
<th>Concept</th>
<th>Feasibility</th>
<th>Planning</th>
<th>Review Planning</th>
<th>Early Production</th>
<th>Review Early Production</th>
<th>Standardization</th>
<th>Market Release</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Design</strong></td>
<td>Specifying conceptual design of product &amp; business</td>
<td>Assessing feasibility of product &amp; viability of business</td>
<td>Designing the product and the business plan</td>
<td>Testing product design and business plan</td>
<td>Initial product release</td>
<td>Evaluate initial release and revise product design and business plan</td>
<td>Standardize product design and business plan</td>
<td>Ongoing product/process improvement</td>
</tr>
<tr>
<td>Functional Areas</td>
<td>Definitions</td>
<td></td>
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</tr>
<tr>
<td><strong>Process Planning</strong></td>
<td>Specifying the technical design of a product.</td>
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<tr>
<td><strong>Marketing</strong></td>
<td>Establishing the needed production capability and capacity</td>
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</tr>
<tr>
<td><strong>Supply Chain Management</strong></td>
<td>Identifying the requirements of available markets for a product.</td>
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</tr>
<tr>
<td><strong>Human Resources</strong></td>
<td>Establishing the chain of business entities for manufacture and distribution</td>
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<tr>
<td><strong>Accounting &amp; Information Systems</strong></td>
<td>Defining the personnel requirements for the supply chain and acquiring human resources</td>
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<tr>
<td><strong>Financial Management</strong></td>
<td>Implementing the AIS system for all business functions</td>
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<tr>
<td><strong>Legal Management</strong></td>
<td>Acquiring capital for the commercialization project</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Satisfying legal &amp; regulatory requirements</td>
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</table>
The actions performed within these cells for Product 1 become important in overcoming barriers to the process of commercialization for products with similar characteristics. According to the interview, the actions performed in the above cells include:

- **PD1**: Finding websites that will aid your technical research; Attending conferences that will aid your technical research. Sequence note: Have the marketing and supply chain issues been discovered for this stage?
- **PD2**: Creating a design competition among firms to understand who best identifies with your concept. Sequence note: Have the marketing and supply chain issues been discovered for this stage?
- **PD3**: Identifying the third party designer for your product via personal interviews. Sequence note: Have the marketing and supply chain issues been discovered for this stage?
- **PP2**: Identify the local possibilities for manufacturing your product or the need to outsource;
- **M1**: Attending industry shows that will aid in marketing ideas for the product; looking through industry publications for marketing ideas. Sequence note: Have the product development and supply chain issues been discovered for this stage?
- **M7**: Design and insert a feedback form for field operations to let you know where you are not succeeding with your product. Sequence note: Have the product development and supply chain issues been discovered for this stage?
- **SCM1**: Identifying the facilities needed for your product and whether they will be overseas; Looking for complementary products required for your product and their supply path. Sequence note: Have the marketing and product development issues been discovered for this stage?
- **LM1**: Identify confidentiality agreements needed; Identifying possible partners and their requirements legally; Identifying the regulations regarding the product; Finding a lawyer to perform patent searches;
- **LM2**: Paying a lawyer to draft partnership agreements; Paying a lawyer to file a patent.
Product 2 is an innovative product for siding in the construction industry. While Product 2 also might have commercial construction applications, it is mostly marketed towards home builders. In our description, we refer to the company who developed Product 2 as Beta Corporation.

Beta Corporation is a new company that was formed to produce Product 2. The president of the company has formed various other corporations for the purpose of producing other innovations. At the time of the interviews, Beta was a small company with only four employees: a president, a general manager, a production manager, and an assistant. Beta’s president is the champion of its innovation. They run their finances on a weekly basis, constantly contacting investors to gain new financing for the next phase of their innovation’s development. Still, the president has developed innovations for 25 years and knows the process. Some past innovations have been successful and some have failed.

Plastic composite siding is a relatively newer product in the residential construction industry. What was historically a wood, cementitious (stucco) or masonry option is combined in the composite product. Previous attempts at creating better and longer-lasting siding have often failed to make a large impression on the market: asbestos and EIFS would be good examples of this failure. Newer composites combine the strengths of wood, cement, or masonry for these better products currently on the market. Hardie Board is a newer product that combines cement and the form of wood clapboard siding to offer fire and insect protection like masonry, the look of wood, and the impermeability of cement. Still, Hardie is heavy and requires plastic composite trim or wood trim.

Until Product 2, plastic composite technology was only used in decking. These decks often weather poorly from their viscosity and application. Taking this technology and combining it properly with the market of the Hardie Board system could offer many opportunities. This is the basis for Product 2.

While an innovative product, Product 2 also needs an innovative process for its production. Since it is a leader in composite technology, Beta Corporation must ensure the best quality for this new product that will compete with existing successful products.
like Hardie. Therefore, Beta contacted the marketing companies for other siding products on the market and researched the need for this new technology. Once Beta found it to be a viable technology, they began the technical process of understanding the specifications for the new product. They found six items of necessity from a technical and marketing standpoint: Price point; Nailability; Paintability; Screwability; Waetherability; and Abrasion resistance. Beta had previously looked into producing composite decking, but the market had changed quickly. They put their previous knowledge from decking along with their new research for siding products and designed Product 2.

Product 2 takes wood sawdust and combines it with Polypropylene fibers in an extrusion process that finally yields a siding board of specific dimensions. Beta’s system can add a wood graining to the siding if the market desires that specific look. Product 2 has a sustainable element, if using recycled wood, which is popular in today’s market. It also has insect and fire resistance, as the Polypropylene accounts for approximately 80% of the product’s mass. As opposed to Hardie’s cement board, Product 2 is easily nailable, screwable, and weighs less. Beta plans on producing plastic composite trim that will complement their siding as a future product development.

Like Alpha Corporation in Case 1, Beta also serves as the “Fabrication Manufacturer” along the supply path of Figure 4.1. Beta fabricates the composite siding product from raw materials supplied to it and then sends them on to a distributor. Siding is not the type of product that would continue on to an assembly manufacturer. As a result of Beta’s position in the supply path, Product 2 must therefore consider its supply of raw materials and the role of a distributor. This does not pose a problem for Beta, as it already developed products that required the same coordination. Beta does see limitations in the period of time for which the product will contain a good market. Also, partnering becomes a serious issue for Beta, as it needs a distributor who can reliably place it onto the market with the proper fit. Product 2 therefore has specific barriers and accelerators for its commercialization as well with new cells, actions, and sequences of importance.

Beta’s commercialization process (figures 6.1 & 6.2) for Product 2 begins with a search for financing that would allow for the initial product research. Beta’s initial
Figure 6.1: Product 2 Timeline

Product #2 Timeline

MARKET RESEARCH: (M1)
1. Understand attributes needed in the product from a marketing company, including:
   A. Pricing
   B. Weathering
   C. Nailability
   D. Current Products & their limits
2. Develop a team & identify its weaknesses
3. Find the right people with the right skills

MARKET RESEARCH: (M1)
1. Understand attributes needed in the product from a marketing company, including:
   A. Pricing
   B. Weathering
   C. Nailability
   D. Current Products & their limits
2. Develop a team & identify its weaknesses
3. Find the right people with the right skills

PLAN FOR MARKET CHANGES: (M2)
A. Availability
B. Costs
C. Natural Disaster
D. Reflect back into market and technical research

MARKETING WORK: (M3)
1. Identify problems
2. Capitalize on problems
3. Does product have ability to change with market?
4. Does market still support business plan?
5. Will financing last?
6. Look for distribution options
7. Determine partnering options

FINANCE: (FM1) Figure out how to pay for the initial research on the product

FINANCE: (FM3) Figure out how to pay for the prototype of the product

TECHNICAL RESEARCH: (PD1)
1. Look at decking polymers and their material quality
2. Establish the product’s market limits:
   A. Durability
   B. “Creep”
   C. Strength
   D. Nail-ability: Aesthetics, reduce density, better handling

TECHNICAL WORK: (PD3)
1. Facility Acquisition
2. Identify problems
3. Capitalize on problems
4. Does equipment support business plan?
5. Will financing last?
6. Do product specs. work with other product specs.?
7. Resolve issues

TECHNICAL RESEARCH: (PD1)
1. Look at decking polymers and their material quality
2. Establish the product’s market limits:
   A. Durability
   B. “Creep”
   C. Strength
   D. Nail-ability: Aesthetics, reduce density, better handling

START

FINANCE: (FM1) Figure out how to pay for the initial research on the product

FINANCE: (FM3) Figure out how to pay for the prototype of the product

MARKETING WORK: (M3)
1. Identify problems
2. Capitalize on problems
3. Does product have ability to change with market?
4. Does market still support business plan?
5. Will financing last?
6. Look for distribution options
7. Determine partnering options

PARTNERING for DISTRIBUTION: (SCM2)
A. Interview potential brands
B. Negotiate “adaptive” relationship
C. Does it require a new version of the product?
D. Establish similar views of product for the market (critical)

KEY
- CRITICAL
**Product #2 Timeline: Part 2**

**REVIEW ITEMS: (M4/PD4)**
1. Review design
2. Review branding & market needs
3. Establish new and pending products
4. Possible return to prototype development

**FINANCE: (FM4)**
Figure out how to pay for changes & review of the product

**FINANCE: (FM5)**
Figure out how to pay for production of the product

**TECHNICAL/ MARKETING ITEMS: (M3/PD3)**
1. If contract negotiations produce a new product idea, make sure to capture it first
2. Before negotiating, make sure product has a market need

**TECHNICAL WORK: (PD5)**
1. Meet product specs.
2. Continue to know the nature of the product
3. Establish flexibility to try new product changes & not argue the merits of one over another (waste of time & resources)
4. Establish lessons learned: learn quickly

**HUMAN RESOURCES: (HR2)**
1. Establish human resources expectations
2. Establish cross-training techniques: all personnel must know multiple tasks
3. Develop leadership skills of team members
4. Develop roles of champions
5. Establish lessons learned: learn quickly

**PATENT PENDING: (LM2)**
Establish a patent pending process and apply to all versions of the product

**REVIEW: PATENT PENDING**
(PLM2)
A. Establish a patent pending process and apply to all versions of the product
B. Negotiate "adaptive" relationship
C. Does it require a new version of the product?
D. Establish similar views of product for the market (critical)

**CONTRACT ITEMS: (LM3)**
1. Include language offering a way out
2. Establish rights to the market without the brand
3. Establish "working document" outline
4. Series of negotiations
5. Establish a back door (person)

**MARKETING WORK: (M6)**
1. Determine sales possible
2. Establish lessons learned: learn quickly

**FINANCE: (FM4)**
Figure out how to pay for changes & review of the product

**FINANCE: (FM5)**
Figure out how to pay for production of the product

**FINANCE: (FM6)**
Figure out how to pay for more production of the product

**TECHNICAL WORK: (PD5)**
1. Meet product specs.
2. Continue to know the nature of the product
3. Establish flexibility to try new product changes & not argue the merits of one over another (waste of time & resources)
4. Establish lessons learned: learn quickly

**HUMAN RESOURCES: (HR2)**
1. Establish human resources expectations
2. Establish cross-training techniques: all personnel must know multiple tasks
3. Develop leadership skills of team members
4. Develop roles of champions
5. Establish lessons learned: learn quickly

**SUPPLY CHAIN: (SCM7)**
1. Establish material necessary for product
2. Establish limits of supply for material
3. Adapt to these supply limits
4. Establish quality limits & adapt
5. Establish constituent parts of product & their chain of distribution
6. Establish distribution channels (from partner in this case)

**SUPPLY CHAIN: (SCM6)**
1. Determine output necessary
2. Establish flexible architecture for production system with branding company
3. Research systems for proper production: be flexible!
4. Establish lessons learned: learn quickly
research process consists of a switching process back and forth between marketing and technical research. Beta considers these two steps to almost be the same and they call it “R&D.” This switching back and forth continues for Beta until they need additional financing. Additional financing usually is required when going from a research step into a step of prototyping or facility acquisition. Once a successful product is defined, legal management becomes important for patent protection. Then, Beta looks to find a partner in supply chain management, or distribution of their product. Human resources become an issue after the product needs standardization and requires a production run or goes into full production. Beta again finds financing at these crucial times.

When asked, Beta listed the following critical cells of importance during commercialization for Product 2: Market research (M1); Market Fit & Segmentation (M2); Configure Supply Chain (SCM2); Designing liability protections (LM2); and Design Contracts & Procedures (LM3). This list does not, however, show the total amount of areas along commercialization mentioned by Beta during the entire interview. The matrix presented in Table 6.1 provides this total number of times Beta Corporation mentioned specific actions for areas along their commercialization process for Product 2. According to these numbers, other cells along commercialization hold importance for Beta. A cell mentioned more than 2 times would also include the following: Product Development (PD1); Concept Design (PD2); Detailed Design (PD3); Select Processes (PP2); Design Processes (PP3); Test, Review Processes (PP4); Forecast Demand & Marketing Plan (M3); Review Marketing Plan (M4); Prepare Capital Plan (FM3); Estimate Capital Costs & Risks (FM4); Model Supply Chain Performance (SCM4);
Create Leader Positions, Other labor Roles & Responsibilities (HR2); Create Hiring, Firing, & Promotion Plan (HR3); and Review Standards & Protections from External Certifiers (LM4). The importance of the information provided by Beta changes based in this view. Product and process design here gets much more importance than before and the human resources side of commercialization is emphasized.

The sequence of events along commercialization offers a final view into the importance of certain cells and actions for Beta’s commercialization of Product 2. Figure 6.3 offers a visual account of the amount of times an area was mentioned as part of Product 2’s sequence. The figure suggests the importance of directly linked stages between marketing and product research in the early stages of product development. Further, finance steps directly follow marketing and technical product development at critical stages in the process. These actions should therefore be referenced in the detailed sheets of the appropriate cells in the commercialization matrix.

All of the different views of Beta’s commercialization offer critical cells along commercialization. All mentioned include:

- Technical research (PD1)
- Conceptual design (PD2)
- Detailed Design (PD3)
- Select Processes (PP2)
- Design Processes (PP3)
- Test, Review Processes (PP4)
- Market research (M1)
- Market Fit & Segmentation (M2)
- Forecast Demand & Marketing Plan (M3)
- Review Marketing Plan (M4)
- Configure Supply Chain (SCM2)
- Model Supply Chain Performance (SCM4)
- Create Leader Positions, Other labor Roles & Responsibilities (HR2)
- Create Hiring, Firing, & Promotion Plan (HR3)
- Prepare Capital Plan (FM3)
### Figure 6.3: Product 2 Commercialization Sequence

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<thead>
<tr>
<th>Phases</th>
<th>Concept</th>
<th>Feasibility</th>
<th>Planning</th>
<th>Review Planning</th>
<th>Early Production</th>
<th>Review Early Production</th>
<th>Standardization</th>
<th>Market Release</th>
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<td>Definitions</td>
<td>Concept Feasibility Planning</td>
<td>Planning Early Production Standardization</td>
<td>Market Release</td>
<td>Evaluate initial release and revise product design and business plan</td>
<td>Standardize product design and business plan</td>
<td>Ongoing product/process improvement</td>
<td></td>
</tr>
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<td>Product Design</td>
<td>Specifying conceptual design of product &amp; business</td>
<td>Assessing feasibility of product &amp; viability of business</td>
<td>Designing the product and the business plan</td>
<td>Testing product design and business plan</td>
<td>Initial product release</td>
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<tr>
<td>Process Planning</td>
<td>Establishing the needed production capability and capacity</td>
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<td>Marketing</td>
<td>Identifying the requirements of available markets for a product</td>
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<td>Supply Chain Management</td>
<td>Establishing the chain of business entities for manufacture and distribution</td>
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<td>Human Resources</td>
<td>Defining the personnel requirements for the supply chain and acquiring human resources</td>
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<tr>
<td>Accounting &amp; Information Systems</td>
<td>Implementing the AIS system for all business functions</td>
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<tr>
<td>Financial Management</td>
<td>Acquiring capital for the commercialization project</td>
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<tr>
<td>Legal Management</td>
<td>Satisfying legal &amp; regulatory requirements</td>
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</table>

**Product Design**
- PD1: Includes: Technical Research
- PD2: Includes: Detailed Design
- PD3: Includes: Test Prototype
- PD4: Includes: Initial Product Release, Test in Field

**Process Planning**
- PPI: Includes: Forecast Supply Chain
- PPI: Includes: Review Marketing Plan

**Marketing**
- M1: Includes: Market Research
- M2: Includes: Market Fit & Segmentation
- M3: Includes: Forecast Demand & Marketing Plan
- M4: Includes: Review Marketing Plan
- M5: Includes: Revise Marketing Plan
- M6: Includes: Revise Marketing Plan
- M6: Includes: Adjust Supply Chain

**Supply Chain Management**
- SCM1: Includes: Detailed Design of Supply Chain
- SCM2: Includes: Standardize Sourcing & Outsourcing

**Human Resources**
- HR1: Includes: Create Leader Positions, Other Labor Roles & Responsibilities

**Accounting & Information Systems**
- AIS: Includes: Business Intelligence

**Financial Management**
- FM1: Includes: Identify Sources of Capital, Financing Rates
- FM3: Includes: Prepare Capital Plan
- FM4: Includes: Estimate Capital Costs & Risks
- FM5: Includes: Acquire Capital
- FM6: Includes: Revise Estimates & Capital Plan

**Legal Management**
- LM1: Includes: Design Contracts & Statements
• Estimate Capital Costs & Risks (FM4)
• Identifying liabilities, regulatory requirements, and partners (LM1)
• Designing liability protections (LM2)
• Design Contracts & Procedures (LM3)
• Review Standards & Protections from External Certifiers (LM4).

The actions performed within these cells for Product 2 become important in overcoming barriers to the process of commercialization for products with similar characteristics. According to the interview, some of the actions performed in the above cells include:

• Technical research (PD1): Look at current technology and its quality; Sequence note: Have the marketing and financing issues been discovered for this stage?
• Conceptual design (PD2): Establish the technical market limits for the product; Sequence note: Have the marketing and financing issues been discovered for this stage?
• Detailed Design (PD3): Identify & capitalize on problems; Will financing last?; Resolve technical issues; If negotiations produce a new product idea, be sure to capture it first; Sequence note: Have the marketing and financing issues been discovered for this stage?
• Select Processes (PP2): Research facility acquisition; Does equipment support the business plan?;
• Design Processes (PP3): Does equipment support the business plan?; Acquire facilities that support the business plan;
• Test, Review Processes (PP4): Do the facilities support the business plan?; Does the process requirement need a change in the technical design?;
• Market research (M1): Understand the attributes needed in the product from a marketing company perspective, including: Pricing, weathering, Nailability, Current products and their limits; Sequence note: Have the product design and financing issues been discovered for this stage?
• Market Fit & Segmentation (M2): Plan for market changes: availability, costs, natural disasters, and reflect this back into market and technical research;
Sequence note: Have the product design and financing issues been discovered for this stage?

- Forecast Demand & Marketing Plan (M3): Identify problems; capitalize on problems; Will product change the market?; Does the market still support the business plan?; Sequence note: Have the product design and financing issues been discovered for this stage?

- Review Marketing Plan (M4): Have you established similar views of the product for the market?; Review branding and market needs; Establish other new or pending products; Possible return to prototype development; Sequence note: Have the product design and financing issues been discovered for this stage?

- Configure Supply Chain (SCM2): Look for distribution options; Determine partnering options;

- Model Supply Chain Performance (SCM4): Does the supply chain require a new version of the product?; Have

- Create Leader Positions, Other labor Roles & Responsibilities (HR2): Find the right people with the right skills; Develop a team and identify its weaknesses; Develop roles of champions; Develop leadership skills of the team members; Establish human resources expectations;

- Create Hiring, Firing, & Promotion Plan (HR3): Establish cross-training techniques: all personnel must know multiple tasks; Establish lessons learned & incentives to learn quickly;

- Prepare Capital Plan (FM3): Figure out how to pay for this stage of the development; Sequence note: Does the financing reflect the product design and technical issues been discovered for this stage?

- Estimate Capital Costs & Risks (FM4): Figure out how to pay for this stage of the development; Sequence note: Does the financing reflect the product design and technical issues been discovered for this stage?

- Identifying liabilities, regulatory requirements, and partners (LM1): Determine partnering options; Determine regulatory barriers for product;

- Designing liability protections (LM2): Design partnering agreements; Establish a patent pending process and apply to all versions of the product;
• Design Contracts & Procedures (LM3): Always include language that offers a way out; Establish rights to the market without the brand;

• Review Standards & Protections from External Certifiers (LM4): Establish a “back door” person for negotiations; Conduct negotiations for rights; Establish “working document” outline.
CHAPTER SEVEN: METAL FRAMING INNOVATION

Product 3 is an innovative product for framing in the construction industry. While Product 3 also might have commercial applications, it is mostly meant for homebuilding. In our description, we refer to the company who developed Product 3 as Charlie Corporation.

Charlie Corporation is similar to Alpha in that it is also a sub-set of a larger corporation. Therefore, all actions performed by Charlie are managed by its parent company and often financed as well. Charlie employs approximately 20 people full-time. They have a current business that manufactures sheet metal for various industry applications. Charlie itself is approximately a 2 million dollar company. The parent company’s experience in the construction industry allowed it a view into the need for Product 3 within the residential construction industry.

Typically, arched doorways in the construction industry require a labor-intensive process. A carpenter needs to make two separate templates per opening, often out of plywood, that allows for the archway’s framing. Once the templates are cut, numerous framing members are placed between the two and then screwed into place at the top of the door. Once in place, additional framing members are screwed between the templates for added stability and strength. Product 3 serves as a solution to this long process.

Product 3 is an extruded, cold-formed metal archway that comes pre-assembled to a desired arch shape. The metal adjusts to fit most doorways and screws into place at the top of the doorway framing. Once in place, the metal’s thickness easily allows for any finish material to be screwed directly into it. It also acts as a sturdy framing element that has the strength to support most types of finish materials. It is metal and therefore will not contain issues that a wood framing might have, like water damage for example.

Charlie Corporation supplies its own materials in the form of steel sheeting. It takes the steel sheeting and manufactures the curved pieces of the archways, then assembles the entire archway system. Beta also acts as its own distributor since it already distributes its other products. According to Figure 13, Charlie therefore, needs to consider the
Figure 7.1: Product 3 Timeline

Product #3 Timeline

START

TECHNICAL RESEARCH: (PDI/PP1)
1. Research requirements of new product in manufacturing process and design
2. Research ability to improve existing product

MARKET RESEARCH: (M1)
1. Idea for product given to them by others based on their current product

MARKETING: (M2)
A. Define Market
B. Begin Advertising

HUMAN RESOURCES:
(1HR1)
A. Define Product Champions

FINANCE: (FM1)
Research possibilities for financing new product

HUMAN RESOURCES:
(1HR2)
A. Hire outside salesmen

TECHNICAL DESIGN:
(PDI)
A. Define Technical Side of Product in Drawings

HUMAN RESOURCES:
(1HR3)
A. Hire Technical Talent

MARKETING: (M4)
A. Review & Revise Marketing Plan

ACCOUNTING: (AT1)
A. Establish Accounting System for Product

MARKETING: (M3)
A. Begin outside sales by visiting builders

2006

2007
downstream players such as: developers and installers, and end-users. This side of the
supply path has proven to be difficult for Charlie. While they understand the costs and
process of manufacturing and distributing, they did not understand the needs of a
distributor, an installer, and an end-user. In other words, they did not completely identify
their market. As a result, Charlie hired an outside salesman to directly market the
product through site visits in different regions of the US. This direct marketing has
proven quite successful. Product 3 has also needed a different commercialization with
new cells, actions, and sequences of importance.

Charlie Corporation’s commercialization process for Product 3 (Figure 7.1) began
with marketing and technical research. Because they had a larger parent company to rely
on, the human resources issues and financing that came early were already in place for
successful product and process development. Charlie also had knowledge of proper
processes due to its manufacturing experience. This new process would simply change
the existing system slightly, a financial advantage for them. Still, Charlie was not so
aware of the market early on in their commercialization. The timeline shows that they
did perform early market tasks, but not thoroughly enough that the product had successful
initial sales. Charlie did perform the typical marketing processes of attending shows and
advertising, but they did not have good sales. Eventually, they realized the vital step of
hiring an outside sales manager who could make personal visits to the builders they
wished to target. This improved sales and helped with the commercialization success of
their product. Charlie also felt that their accounting systems were not well established for
the new product. This seemingly small problem made it difficult for them to know where

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the commercialization process was failing for them. They would have a better accounting system on the future. According to Charlie’s hierarchy, the critical cells of importance during commercialization for Product 1 are the following: Marketing Plan (M3); Create leader positions, other labor roles (HR2); and Establish accounting system for product (AIT2). This list does not, however, show the total amount of areas along commercialization mentioned by Charlie during the entire interview. The matrix presented in Table 7.1 provides this total number of times Charlie Corporation mentioned specific actions for cells along their commercialization process for Product 3. According to these numbers, other cells along commercialization hold importance for Alpha. Cells mentioned more than 2 times change the previous list e to the following: Conceptual Design (PD2) and Market Fit & Segmentation (M2). Charlie Corporation spent much of its process in commercialization on market fit and the product concept, making them the most important areas for them.

Charlie’s sequence along the timeline in figure 7.1 shows a process of defining the technical side of the product, then figuring out its market, then finding the human resources needed to get it into the marketplace. As they said in their interview, this sequence caused problems for Product 3 and the human resources sequence should have come earlier in their process. No areas of commercialization had an especially close relationship. This sequence needs to be noted in a similar product’s commercialization.

All of the different views of Charlie’s commercialization offer critical cells along commercialization. All mentioned include:

- Conceptual Design (PD2)
- Market Fit & Segmentation (M2)
- Marketing Plan (M3)
- Create leader positions, other labor roles (HR2)
- Design Accounting and Information Systems (AIS2)
**Figure 7.3: Product 3 Commercialization Sequence**

<table>
<thead>
<tr>
<th>Phases</th>
<th>Functional Areas</th>
<th>Definitions</th>
<th>Phases</th>
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<th>Definitions</th>
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<td>Concept</td>
<td>Product Design</td>
<td>Specifying conceptual design of product &amp; business</td>
<td>Feasibility</td>
<td>Process Planning</td>
<td>Establishing the needed production capability and capacity</td>
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<td></td>
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<td>PD1: Includes: Technical Research</td>
<td>Planning</td>
<td>Marketing</td>
<td>Identifying the requirements of available markets for a product.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PD2: Includes: Feasibility Review</td>
<td>Review Planning</td>
<td>Supply Chain</td>
<td>Establishing the chain of business entities for manufacture and distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PD3: Includes: Detailed Design</td>
<td>Early Production</td>
<td>Human Resources</td>
<td>Defining the personnel requirements for the supply chain and acquiring human resources</td>
</tr>
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<td></td>
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<td></td>
<td>Review Early Production</td>
<td>Accounting &amp; Information Systems</td>
<td>Implementing the AIS system for all business functions</td>
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<td></td>
<td></td>
<td></td>
<td>Standardization</td>
<td>Financial Management</td>
<td>Acquiring capital for the commercialization project</td>
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<td></td>
<td></td>
<td></td>
<td>Market Release</td>
<td>Legal Management</td>
<td>Satisfying legal &amp; regulatory requirements</td>
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**Definitions**
- Specifying conceptual design of product & business
- Assessing feasibility of product & viability of business
- Designing the product and the business plan
- Testing product design and business plan
- Initial product release
- Evaluate initial release and revise product design and business plan
- Standardize product design and business plan
- Ongoing product/process improvement

**Activities**
- PD1: Includes: Technical Research
- PD2: Includes: Feasibility Review
- PD3: Includes: Detailed Design
- PP1: Includes: Process Research
- M1: Includes: Market Research
- M2: Includes: Market Fit & Segmentation
- M3: Includes: Forecast Demand & Marketing Plan
- M4: Includes: Review Marketing Plan
- HR1: Includes: Identify Project Leaders & Responsibilities
- HR2: Includes: Create Leader Positions, Other Labor Roles & Responsibilities
- AIS1: Includes: Design Accounting & Other Information Systems
- FM1: Includes: Identify Sources of Capital, Financing Rates
The actions performed within these cells for Product 3 become important in overcoming barriers to the process of commercialization for products with similar characteristics. According to the interview, the actions performed in the above cells include:

- Conceptual Design (PD2): Allowing for the ability to improve the product; Defining the technical side of the product in drawings;
- Market Fit & Segmentation (M2): Defining the Market; Advertising for the market; Sequence Note: Has the market fit been satisfied early and have the human resources steps been satisfied?;
- Marketing Plan (M3): Begin outside sales by visiting builders;
- Create leader positions, other labor roles (HR2): Hire technical talent; Hire outside salesman;
CHAPTER EIGHT: PRODUCTION HOMEBUILDING
INNOVATION

Product 4 is an innovative process used for the innovative production of homes in residential construction. Product 4 has historically pertained to residential applications, while a future application might enter the commercial market. In our description, we refer to the company who developed Product 4 as Delta Corporation.

Delta Corporation is a production home builder and developer in the South and Mid-Atlantic United States. While they have over 30 years of experience building homes and developing properties, they have more recently started the innovative process of manufacturing homes. Now, they primarily supply other builders in the same region with pre-manufactured sections of homes. They are a division of a larger corporation that still builds and develops homes in a traditional manner. As a division, Delta manufactures approximately 500 homes per year or approximately $600 K per month.

The traditional process of building a home is most commonly referred to as “stick-built.” Delta’s parent company has a long history of producing developments with these types of homes. Today’s market requires ever faster processes of construction, though, and increasingly reduced bottom lines for the contractor. Adding to this situation, clients and regulatory bodies also expect better quality than before, which is often difficult to achieve from various trades and products included in the home building process. One solution to better quality, cost and schedule control is pre-manufacturing homes. In other words, homes are now being built in a factory and contractors are applying the rules of manufacturing in a controlled environment. In many cases, this manufacturing process successfully provides better quality, cost, and control of all aspects of the product. Product 4 is one such process that results in an innovative total product.

While an innovative product, Product 4 is mostly significant as an innovative process. This process requires Delta Corporation to coordinate the complex system of homebuilding within a controlled environment and then translate that environment to one they cannot control out on the site. Delta considers its product to include approximately 75% of the entire building process in its pre-manufactured sections. They construct the framing, interior and exterior sub-surfaces, plumbing, electrical, mechanical, interior and
exterior finishes, windows, and finish carpentry. They do not construct the foundation, deal with site conditions, or paint. Once assembled in their factory in sections, Product 4 is also assembled by Delta’s crews on the foundation provided by the site contractor or developer. Delta is responsible for understanding all elements of its product that do not properly work or assemble, including the various products purchased from product manufacturers.

While Delta does not produce its own raw materials, it fits differently than others in the supply path of the construction project. Delta Fabricates and assembles many of its products from the raw materials of others. Delta also acts as a distributor and installer for its homes. The inspection process for Delta takes place in the manufacturing plant, and the product arrives on-site inspected and ready for installation. According to Figure 4.1, this places Delta in different areas of the supply path with different responsibilities. As a division of a larger corporation, Delta understands many of the needs of the developer and installer. Delta must still recognize the needs of the end-user and use products within their homes that satisfy this market. Outside of these responsibilities, Delta is also fighting an uphill battle, as many clients associate manufactured housing with trailers and therefore a lesser product. Delta, as a promoter of innovation, will therefore commonly consider innovative products within their homes. Our interview largely focuses on the process of getting an innovation through Delta’s process.

Delta’s commercialization process (Figures 8.1 & 8.2) for innovative products is the reverse view of the other case studies: it demonstrates the actions an innovative product might need to take to be included in the final, innovative pre-manufactured home product. Delta has many points of introduction for a product into its manufacturing system: the purchasing department, the end-user, a salesman, a field crew, office personnel, or a distributor. No matter where the product is introduced, it is automatically placed in front of all parts of the company in a feasibility meeting. Therefore, all cells of commercialization for the product must be performed for all members of the feasibility meeting to sign off on a new product’s use. Typically, though, the meeting, a process
Figure 8.1: Product 4 Timeline

Product #4 Timeline

START

1. Distributor Marketing (M1)
   - Establish the need for a new product from demand/field/clients/distributor

2. Process Planning (PPI)
   - Issue Product Change Request

3. Research Product Technology (PDI)
4. Research Process Technology (PPI)
5. Perform Basic Market Research (M1)

6. Distributor Marketing (M2)
   - Distributors Must be Prepared to Address Problems

7. Define Product-Market Fit & Segmentation (M2)
8. Prepare Conceptual Design (P1D2)

6 MONTHS

9. Identify Sources of Capabilities (SCM1)
10. Configure Supply Chain (SCM2)

11. Identify Project Leaders (HR1)
12. Source Labor Roles & Responsibilities (HR2)
13. Design Accounting & Information System (A1T2)
14. Define Capital Configuration (FM2)
15. Design Liability Protections & Standards (M2)

16. Prepare Detailed Design (P1D3)
17. Forecast Demand & Prepare Marketing Plan (M3)
18. Prepare Detailed Design of Supply Chain (SCM3)
19. Prepare Hiring/Development/Promotion Plan (HR3)
20. Plan IS Implementation (A1T3)
21. Prepare Capital Plan (FM3)
22. Design Contracts & Procedures (LMT1)

HUMAN RESOURCES
   - (HR1) Champion
     - Introduces the Product

KEY:
   - CRITICAL
Figure 8.2: Product 4 Timeline Part 2

**Product #4 Timeline: Part 2**

- **Process Planning: (PP1)**
  - **Review Product**
  - **Perform Field Testing**

- **Distributor Marketing: (M5)**
  - Representative for product must be present for testing

- **Market Research: (M6)**
  - Distributors Must be Prepared to Address Problems

- **Process Planning: (PP1)**
  - Review Product
  - Execute the Pre-production Run

- **Supply Chain: (SCM5)**
  - Standardize Supply Chain Procedures
  - Review Supply Chain Design

- **Supply Chain: (SCM6)**
  - Review Supply Chain Design

- **Human Resources: (HR5)**
  - Recruit, Train, & Supervise Pre-production Workforce

- **Human Resources: (HR6)**
  - Revise Staffing Plan

- **Information Technology: (AIT5)**
  - Audit Accounting & IS Performance during Pre-production

- **Information Technology: (AIT6)**
  - Revise IS Design

- **Finance: (FM5)**
  - Acquire Capital

- **Finance: (FM6)**
  - Revise Capital Plan

- **Logistics: (LM5)**
  - Monitor & Control Pre-production

- **Logistics: (LM6)**
  - Revise Contracts & Standards

- **KEY**
  - CRITICAL

1 YEAR

- **Distributor Marketing: (M7)**
  - Manage Sales

- **Supply Chain: (SCM7)**
  - Standardize Supply Chain Procedures

- **Human Resources: (HR7)**
  - Manage Human Resources

- **Information Technology: (AIT7)**
  - Support IS

- **Finance: (FM7)**
  - Manage Capital Resources

- **Logistics: (LM7)**
  - Monitor & Control Claims

1 YEAR
planning type of review, brings all limits of the product to the attention of the group. Then, the person responsible for investigating each limit is required to do more research. The group acts as a champion and meets after another period of time to again review the problems with the product and continues to meet until the product’s issues are solved. The group also allows the attendance of marketers for the product to solve issues. This is an important aspect of the commercialization process, as it typically gets the product accepted faster. Delta requires the product’s salesman to be present for the initial installation of the product into the manufactured home also, which aids in its acceptance. This is part of Delta’s strategy to promote innovative process and to produce its innovative home product that contains innovations as well. In the commercialization timelines of figures 8.1 & 8.2, the process research steps are the feasibility meetings that our generic model suggests happens early in the process. Delta continues to use this meeting throughout its process. Also, the step of the outside product’s salesman being in the meeting happens simultaneously.

According to Delta’s hierarchy, the cells of importance during commercialization for Product 4 are the following: Process Research (PP1); Market research (M1); Market Fit & Segmentation (M2); Forecast Demand & Marketing Plan (M3); Test Marketing through Production Run (M5); Revise Marketing Plan (M6); and Identify Project Leaders (HR1). Table 8.1 provides the total number of times Delta Corporation mentioned specific actions for cells along their commercialization process for Product 4.

Table 8.1: Expert Consensus for Product 4

<table>
<thead>
<tr>
<th>Functional Area</th>
<th>Phases</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8</td>
<td></td>
</tr>
<tr>
<td>Product Development</td>
<td>1 1 0 2 0 0 0 0</td>
<td>4</td>
</tr>
<tr>
<td>Process Planning</td>
<td>0 0 0 2 0 0 4 0</td>
<td>6</td>
</tr>
<tr>
<td>Marketing</td>
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</tr>
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<td>Supply Chain Management</td>
<td>0 4 0 0 0 4 0 0</td>
<td>8</td>
</tr>
<tr>
<td>Human Resources</td>
<td>4 2 0 0 0 2 0 0</td>
<td>8</td>
</tr>
<tr>
<td>Accounting &amp; Information Tech.</td>
<td>0 0 0 0 0 0 0 0</td>
<td>0</td>
</tr>
<tr>
<td>Legal Management</td>
<td>0 0 0 0 1 4 0 0</td>
<td>5</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6 14 0 4 2 15 0 0</td>
<td></td>
</tr>
</tbody>
</table>
According to these numbers, the following also were mentioned more than 2 times: Standardized Processes (PP7); Configure Supply Chain (SCM2); and Monitor and Control Claims (LM7). Since Delta mentioned standardization of process and legal matters, as well as supply chain configuration the most, these seem to add to the important nature of these parts of the commercialization process.

Figure 8.3 offers another visual account of the amount of times a cell was mentioned as part of Product 4’s sequence. This order in which Delta chose to commercialize for Product 4 might be important for similar products. According to its sequence, all areas of the company seem to have equal weight in matters of introducing a new product. Therefore, all cells of commercialization must be considered when commercializing products. If one sequence were to stand out, it would be the process research section of commercialization, where Delta consistently uses the group to understand the best process for placing a new product into the market with success. While the process design is critical in their process, the constant back-and-forth of the arrows from each area along commercialization with process planning steps suggest that the ability for each section of the company to affect the path of the product is great. Similarly, the ability for individual areas of the company to restrict acceptance of the new product might be great. This could be seen as a good system of balances to ensure quality and control costs along the entire commercialization process. As an outside marketer, one wants to have his product alleviate the resistance of each part of the group as much as possible and therefore make it through to the market faster.

All of the different views of Delta’s commercialization offer critical cells along commercialization. All mentioned include:

- Process Research (PP1)
- Standardized Processes (PP7)
- Market research (M1)
- Market Fit & Segmentation (M2)
- Forecast Demand & Marketing Plan (M3)
- Test Marketing through Production Run (M5)
- Revise Marketing Plan (M6)
Figure 8.3: Product 4 Commercialization Sequence

<table>
<thead>
<tr>
<th>Phases</th>
<th>Functional Areas</th>
<th>Definitions</th>
<th>Concept</th>
<th>Feasibility</th>
<th>Planning</th>
<th>Review Planning</th>
<th>Early Production</th>
<th>Review Early Production</th>
<th>Standardization</th>
<th>Market Release</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Product Design</td>
<td>Specifying the technical design of a product.</td>
<td><strong>PD1:</strong> Includes: Technical Research</td>
<td><strong>PD2:</strong> Includes: Conceptual Design</td>
<td><strong>PD3:</strong> Includes: Detailed Design</td>
<td><strong>PD4:</strong> Includes: Test Prototype</td>
<td><strong>PD5:</strong> Includes: Initial Product Release, Test in Field</td>
<td><strong>PD6:</strong> Includes: Field Testing Results, Redesign</td>
<td><strong>PD7:</strong> Includes: Standardized Product</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Process Planning</td>
<td>Establishing the needed production capability and capacity</td>
<td><strong>PP1:</strong> Includes: Process Research</td>
<td><strong>PP2:</strong> Includes: Design Processes</td>
<td><strong>PP4:</strong> Includes: Test, Review Processes</td>
<td><strong>PP5:</strong> Includes: Measures Process Times, Quality, Costs</td>
<td><strong>PP6:</strong> Includes: Early Production Results, Redesign</td>
<td><strong>PP7:</strong> Includes: Standardized Process</td>
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<tr>
<td></td>
<td>Marketing</td>
<td>Identifying the requirements of available markets for a product.</td>
<td><strong>M1:</strong> Includes: Market Research</td>
<td><strong>M2:</strong> Includes: Market Fit &amp; Segmentation</td>
<td><strong>M3:</strong> Includes: Forecast Demand &amp; Marketing Plan</td>
<td><strong>M4:</strong> Includes: Review Marketing Plan</td>
<td><strong>M5:</strong> Includes: Test Market through Production Run</td>
<td><strong>M6:</strong> Includes: Revise Marketing Plan</td>
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<td></td>
<td>Supply Chain Management</td>
<td>Establishing the chain of business entities for manufacture and distribution</td>
<td><strong>SCM1:</strong> Includes: Identify Sourcing &amp; Outsourcing Options</td>
<td><strong>SCM2:</strong> Includes: Configure Supply Chain</td>
<td><strong>SCM3:</strong> Includes: Detailed Design of Supply Chain</td>
<td><strong>SCM4:</strong> Includes: Model Supply Chain Performance</td>
<td><strong>SCM5:</strong> Includes: Execute Production Run</td>
<td><strong>SCM6:</strong> Includes: Adjust Supply Chain</td>
<td><strong>SCM7:</strong> Includes: Standardize Sourcing &amp; Outsourcing</td>
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<tr>
<td></td>
<td>Human Resources</td>
<td>Defining the personnel requirements for the supply chain and acquiring human resources</td>
<td><strong>HR1:</strong> Includes: Identify Project Leaders &amp; Responsibilities</td>
<td><strong>HR2:</strong> Includes: Create Leader Positions, Other labor roles &amp; Responsibilities</td>
<td><strong>HR3:</strong> Includes: Create Hiring, Firing, &amp; Promotion Plan</td>
<td><strong>HR4:</strong> Includes: Review Labor Costs, Reassign or Dissolve Labor. Decide to Outsource?</td>
<td><strong>HR5:</strong> Includes: Recruit, Create, Train, &amp; Supervise for Production Run</td>
<td><strong>HR6:</strong> Includes: Review Staff Costs, Reassign or Dissolve Labor, Decide to Outsource?</td>
<td><strong>HR7:</strong> Includes: Manage Human Resources.</td>
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<tr>
<td></td>
<td>Accounting &amp; Information Systems</td>
<td>Implementing the AIS system for all business functions.</td>
<td><strong>AIS1:</strong> Includes: Research Information Technology</td>
<td><strong>AIS2:</strong> Includes: Design Accounting &amp; Other Information Systems</td>
<td><strong>AIS3:</strong> Includes: Plan &amp; Support IS Implementation</td>
<td><strong>AIS4:</strong> Includes: Install &amp; Test IS</td>
<td><strong>AIS5:</strong> Includes: Audit IS through Production Run</td>
<td><strong>AIS6:</strong> Includes: Revise from Audit</td>
<td><strong>AIS7:</strong> Includes: Support &amp; Standardize IS</td>
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<tr>
<td></td>
<td>Financial Management</td>
<td>Acquiring capital for the commercialization project</td>
<td><strong>FM1:</strong> Includes: Identify Sources of Capital, Financing Rates</td>
<td><strong>FM2:</strong> Includes: Define Capital Configuration</td>
<td><strong>FM3:</strong> Includes: Prepare Capital Plan</td>
<td><strong>FM4:</strong> Includes: Examine Capital Costs &amp; Risks</td>
<td><strong>FM5:</strong> Includes: Acquire Capital</td>
<td><strong>FM6:</strong> Includes: Revise Estimates &amp; Capital Plan</td>
<td><strong>FM7:</strong> Includes: Manage Capital Resources</td>
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<tr>
<td></td>
<td>Legal Management</td>
<td>Satisfying legal &amp; regulatory requirements</td>
<td><strong>LM1:</strong> Includes: Identify Liability Requirements, Tariffs, Partners</td>
<td><strong>LM2:</strong> Includes: Design Liability Protections, Warranties, Patent &amp; Product Regulatory Standards</td>
<td><strong>LM3:</strong> Includes: Design Contracts &amp; Procedures</td>
<td><strong>LM4:</strong> Includes: Review Protections &amp; Standards by External Certifiers</td>
<td><strong>LM5:</strong> Includes: Monitor &amp; Control Production Run</td>
<td><strong>LM6:</strong> Includes: Revise Contracts &amp; Standards</td>
<td><strong>LM7:</strong> Includes: Monitor &amp; Control Claims</td>
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</table>
The actions performed within these cells for Product 4 become important in overcoming barriers to the process of commercialization for products with similar characteristics. According to the interview, some of the actions performed in the above cells include:

- **Process Research (PP1):** Have all areas of the process signed off on the product’s use?; What issues need to be research by the group to facilitate the use of the product?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

- **Standardized Processes (PP7):** Does the product fit into a standard system well? Is a salesman needed to solve problems with the system as the product is introduced?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

- **Market research (M1):** What do other builders do to get a product on the market?; Establish a need for the new product from current demand: the field, clients, and distributors; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

- **Market Fit & Segmentation (M2):** Distributors must be on hand to address problems; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

- **Forecast Demand & Marketing Plan (M3):** Distributors must be on hand to address problems; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

- **Test Marketing through Production Run (M5):** Can a sample home be produced at cost that will sell the product?; Distributors must be on hand to address problems; Sequence note: Have the other areas of commercialization been satisfied before we can progress?
• Revise Marketing Plan (M6): Does the product require a revised marketing system?; Sequence note: Have the other areas of commercialization been satisfied before we can progress;

• Configure Supply Chain (SCM2): Does the product have a long lead time?; Should a product in stock be used instead of a lead time item?; Do suppliers offer a locked in cost rate? Do the products need to be ready for installation when they arrive?; Sequence note: Have the other areas of commercialization been satisfied before we can progress;

• Identify Project Leaders (HR1): Has a champion been established to introduce the product to the process meeting?; Sequence note: Have the other areas of commercialization been satisfied before we can progress;

• Monitor and Control Claims (LM7): Is there a third party who should sign off on the drawings based on the local regulations?; Is the product adjusted for different local regulations?; Sequence note: Have the other areas of commercialization been satisfied before we can progress;
CHAPTER NINE: SUB-SLAB INSECT ABATEMENT INNOVATION

Product 5 is an innovative product used for insect abatement in sub-slab treatments. Product 5 is geared towards the residential construction market. In our description, we refer to the company who developed Product 5 as Eagle Corporation.

Eagle Corporation is a subsidiary of a large Chemical corporation that provides pesticides and insecticides in the US and abroad. Eagle is charged with providing these same solutions for the construction industry. Therefore, Eagle has the backing of a large company that already understands the process of commercialization and has used a tested process for many years towards successful product innovation. Eagle Corporation is smaller in size than its parent corporation, but many of its departments are shared with the larger corporation. Therefore, Eagle has access to the technical, marketing, and business resources of this larger corporation. Eagle did not divulge its size in respect to number of employees or annual sales.

Protection of homes from insects and pests has historically happened in two ways: the use of metal sheets placed between masonry foundations or concrete slabs and wood framing and the spraying of insecticide and pesticide on the ground under the home prior to placing the slab on grade. Sometimes both systems are included versus only one. This system has worked relatively well, but also has limits. One limit is the environmentally poor application of spraying large amounts of the product all across a home site. Another limit is the various holes that the foundation eventually gets which allow access to insects. Eagle, as a manufacturer of previous applications, noticed these limits as an opportunity to produce a new product that resists large spraying and seals foundation holes. Product 5 contains two layers of durable plastic that have termiticide between the layers. Once installed on foundation holes, Product 5 is also sealed within the concrete foundation to block infiltration from insects due to foundation shrinkage. While an innovative product, Product 5 is also an innovative process that redefines the current system of protecting a foundation from insect infiltration. Eagle Corporation supplies the product, but does not apply it.
As part of the supply path, Eagle Corporation might require some raw materials upstream, but produces many of its own ingredients for Product 5. Further, Eagle manufactures Product 5 and uses the resources of its parent company to distribute. Eagle does feel that the most important pieces of its supply path are the developers, installers, inspectors, and end-users. This portion of the market requires the most attention from Eagle’s efforts in commercialization.

Eagle’s commercialization for Product 5 (Figures 9.1 & 9.2) is similar to other products developed in its parent corporation. This larger corporation has a history of successfully bringing products to market. The process begins with market research by contacting the installers of their current products and end-users to ask for limitations with the product and possible ideas for a better product. Once the marketers have established an area for improvement, they go to the technical research department within the parent company to see about technical feasibility. If technically feasible, then the financing side of the company looks at the costs of producing the new product. With the costs and technical feasibility projected, the marketing department again talks to people outside of the company to forecast demand. A champion, who is then assigned to the product, will see it through all steps of commercialization until it reaches the market. This process is similar to Product 4, but Product 5 has one person directing its commercialization and solving the problems as opposed to a committee. Eagle also has two sides to its corporation and this is reflected in the product’s development: the people who deal with the outside ramifications of the product and the people who look at a product’s internal process. Therefore, the human resources step of assigning a champion changes between an inside manager and an outside manager depending on where the product needs to be developed. The outside manager will get the product through initial research on the product then release it to the inside manager. The inside manager directs the commercialization steps for product development and prototyping within the company. Then, the outside manager will make sure all production happens and that the financing is in place to distribute and get the product out to the market. The outside team will also provide support for the product when it is emerging onto the market. This separation of inside and outside duties is important to Eagle’s commercialization process and contains actions that could improve the success of other new products getting to market.
Figure 9.1: Product 5 Timeline

Product #5 Timeline
Figure 9.2: Product 5 Timeline Part 2

Product #5 Timeline: Part 2
According to Eagle’s hierarchy, the critical cells of importance during commercialization for Product 5 are the following: Technical research (PD1); Market research (M1); Market Fit & Segmentation (M2); and Identify Sources of Capital (FM1). This list does not, however, show the total amount of areas along commercialization mentioned by Eagle during the entire interview. The matrix presented in Table 9.1 provides this total number of times Alpha Corporation mentioned specific actions for cells along their commercialization process for Product 5. According to these numbers, few other cells along commercialization hold more importance for Eagle. This chart seems to demonstrate that most cells, while not mentioned as a specific step, are contained within an inside or outside set of actions. Eagle assumes that all typical commercialization actions are happening for the product while not specifically mentioning them. The cells they specifically called out as important in the interview are truly the ones that seem most important.

Eagle’s sequence reinforces the importance of the champion in the process of commercialization. Either as an inside outside developer of Product 5, the champion makes sure of its success and is integral to it process.

**Table 9.1: Expert Consensus for Product 5**

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<thead>
<tr>
<th>Functional Area</th>
<th>1</th>
<th>2</th>
<th>3</th>
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Figure 9.3: Product 5 Commercialization Sequence

<table>
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<tr>
<th>Functional Areas</th>
<th>Definitions</th>
<th>Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product Design</strong></td>
<td>Specifying the technical design of a product.</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
<tr>
<td><strong>Process Planning</strong></td>
<td>Establishing the needed production capability and capacity.</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
<tr>
<td><strong>Marketing</strong></td>
<td>Identifying the requirements of available markets for a product.</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
<tr>
<td><strong>Supply Chain Management</strong></td>
<td>Establishing the chain of business entities for manufacture and distribution</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
<tr>
<td><strong>Human Resources</strong></td>
<td>Defining the personnel requirements for the supply chain and acquiring human resources</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
<tr>
<td><strong>Accounting &amp; Information Systems</strong></td>
<td>Implementing the AIS system for all business functions</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
<tr>
<td><strong>Financial Management</strong></td>
<td>Acquiring capital for the commercialization project</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
<tr>
<td><strong>Legal Management</strong></td>
<td>Satisfying legal &amp; regulatory requirements</td>
<td><strong>Concept</strong> 1, Feasibility 2, Planning 3, Review Planning 4, Early Production 5, Review Early Production 6, Standardization 7, Market Release 8</td>
</tr>
</tbody>
</table>
All of the different views of Eagle’s commercialization offer critical cells along commercialization. All mentioned include:

- Technical research (PD1)
- Market research (M1)
- Market Fit & Segmentation (M2)
- Identify Sources of Capital (FM1)

The actions performed within these cells for Product 1 become important in overcoming barriers to the process of commercialization for products with similar characteristics. According to the interview, the actions performed in the above cells include:

- Technical research (PD1): Research the product’s design in respect to codes; What type of products installers and client desire?;
- Market research (M1): What areas have higher volume and demand;
- Market Fit & Segmentation (M2): How does the product change depending on the area and its demand?; Does the cost of the product take it out of the market?;
- Identify Sources of Capital (FM1): What is the cost of producing the product?; Is it possible to produce this product at the cost needed?
CHAPTER TEN: FINDINGS AND FUTURE WORK

Due to a lack of generic models that offer a path for commercializing innovative products in the residential construction industry, we have produced one. Our process is based on generic models in industry and the guidelines of current literature. Through this process, we aim to benefit recent failures of entrepreneurial business ventures in the commercialization of such products.

The generic model matrix accepts different data inputs from industry case studies of successful products. Each input validates portions of commercialization important to construction industry products through cells, actions, and sequences. This thesis presents five such case studies and draws their important inputs. As a result, the findings of this thesis will begin to populate detailed sheets of the important cells with actions and sequences noted in the studies. Each detailed view in Figure 10.1 is considered a blow-up of the generic cell along the generic commercialization model.

Based on case studies one through five, the highlighted areas of Table 10.1 contain importance to the commercialization process. It serves as a modified version of the generic commercialization model of Table 3.1.

Table 10.1’s largest concentration of important actions happen between phases 1 and 4. This signifies the importance of early actions within commercialization to the perceived success of the product. These early actions are mostly steps needed to establish a proper basis for the commercialization process, while later areas not mentioned pertain to the process of applying this basis. Table 10.1 reinforces attitudes labeling early stages as vital to the product’s development (Casto, 1994). Still, this attitude neglects the side of commercialization which keeps score. This perspective is often one of engineering, where the product must be properly produced and standardized for successful commercialization. A limit to these findings might therefore be that all interview subjects had an educational background of business, not engineering. Future interviews of engineers might reveal phase 5 through 8 as most important. Future work might also note the importance of early steps for “inventors” versus “innovators.” Inventors often will only move a product far enough along the commercialization process
Table 10.1: Highlighted Summary of Important Cells

<table>
<thead>
<tr>
<th>Functional Areas</th>
<th>Definitions</th>
<th>Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Design</td>
<td>Specifying the technical design of a product.</td>
<td>Concept 1  Feasibility 3  Planning 4  Review Planning 5  Early Production 6  Review Early Production 7  Standardization 8  Market Release 9</td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>Defining the personnel requirements for the supply chain and acquiring human resources.</td>
<td>SCM1: Identify Sourcing &amp; Outsourcing Options  SCM2: Configure Supply Chain  SCM3: Detailed Design of Supply Chain  SCM4: Model Supply Chain Performance  SCM5: Execute Production Run  SCM6: Adjust Supply Chain  SCM7: Standardize Sourcing &amp; Outsourcing  SCM8: Improve Supply Chain Management, Discover New Sources</td>
</tr>
<tr>
<td>Human Resources</td>
<td>Implementing the AIS system for all business functions.</td>
<td>HR1: Identify Project Leaders &amp; Responsibilities  HR2: Create Leader Positions, Other Labor Roles &amp; Responsibilities  HR3: Create Hiring, Firing, &amp; Promotion Plan  HR4: Review Labor Costs, Reassign or Dissolve Labor. Decide to Outsource?  HR5: Recruit, Create, Train, &amp; Supervise for Production Run  HR6: Review Staff Costs, Reassign or Dissolve Labor. Decide to Outsource?  HR7: Manage Human Resources.  HR8: Review Human Resources for New Generation Product</td>
</tr>
</tbody>
</table>
for patenting and selling/ licensing of rights. Limited resources often demand this stopping point in the innovation process.

Looking at entire phases of the process which are not mentioned, phases 5 and 8 have zero highlighted cells. This finding could mean that the phases do not contain importance to the commercialization process. It could also mean that phase 5 is mostly considered by a subject to belong in phase 4 or phase 6. Future models might combine the phases for clarification of these findings. Phase 8’s omission could signify a different definition by these subjects for acceptance of a product. According to these five interviews, full production and standardization of the product might be a better definition of acceptance into the market. Future models might omit this last phase as a result of this work.

The functional areas that seem to offer the least amount of importance to the model are Accounting and Information Systems and Financial Management. The lack of importance for AIS makes sense since we had the omission of keeping score before (with a concentration on phases 1 through 4). Possibly all of the subjects have external accounting systems and therefore did not mention these actions as important. Charlie Corporation specifically mentioned its lack of accounting as a critical mistake. Still, the lack of the financial management functional area is the most confusing. If interviewed again, I would find it hard to believe that none of these corporations found financing important. For the larger corporations, this might signify a wealth of R&D dollars. It might also signify a general mindset that financing is a necessary evil, but not among the most important actions within commercialization. The sequence diagrams showed finance actions as important follow-up steps, they were just not mentioned specifically, for example.

The sequences presented in Case Studies 1, 2, 4 and 5 offer an interesting view into the role of champions. A champion would be the person that ensures all sides of the product development are completed properly and therefore successful. Delta used a process planning step as its champion, a group that met often to discuss the progress of the product through its process, and then ensure that obstacles were out of its way. Eagle had individuals take on the product’s development, depending on whether it was inside or outside the company. Since these are larger companies, I assume that the firm has an
atmosphere of encouraging innovation and that is why they allocate resources to a full-time champion of products. Compared with Charlie, this offers a view into the importance of this sequence for product success, since Charlie had problems and no real champion. In Case studies 1 and 2, the president of the company was developing the product and therefore the champion.

Based on the process in Phase one of defining the generic model broadly from literature and interview influences, I do not find that the model is under-specified. The current version seems to have cells that can be removed without a large impact, not cells that need to still be added.

The commercialization model is directed at product-specific development, while it reflects firm-related activities. This distinction suggests the requirement of firm-related activities for proper product development. The findings for this study will attempt to compare similar products in the future, not firms, for beneficial process. Similar firm-related activities will be the basis of similar product success.

The sequence diagrams, while only listed within actions and considered as between cells, seem to promote further study of the diagrams themselves. These diagrams suggest a “messy” process, even though these products and firms have placed an order for success. This messy nature suggests that portions of the product development might either limit control or remain unable for control. Future study could embrace these uncontrollable cells, actions, or sequences.

According to actions reported by case studies one through five, the following actions are important to be considered for the cells of commercialization highlighted in Table 10.1. Sequences of importance are noted in this listing as well. These actions will be used as details for the individual cells of the generic commercialization model in Tables 3.1 and 10.1. An example view of these detailed sheets is presented in Figure 10.1.

- Technical research (PD1): Look at current technology and its quality; Sequence note: Have the marketing and financing issues been discovered for this stage?; Finding websites that will aid your technical research; Attending conferences that
will aid your technical research. Sequence note: Have the marketing and supply chain issues been discovered for this stage?

- Conceptual design (PD2): Establish the technical market limits for the product; Sequence note: Have the marketing and financing issues been discovered for this stage?; Allowing for the ability to improve the product; Defining the technical side of the product in drawings; Creating a design competition among firms to understand who best identifies with your concept; Sequence note: Have the marketing and supply chain issues been discovered for this stage?

- Detailed Design (PD3): Identify & capitalize on problems; Will financing last?; Resolve technical issues; If negotiations produce a new product idea, be sure to capture it first; Sequence note: Have the marketing and financing issues been discovered for this stage?; Identifying the third party designer for your product via personal interviews. Sequence note: Have the marketing and supply chain issues been discovered for this stage?

- Process Research (PP1): Have all areas of the process signed off on the product’s use?; What issues need to be research by the group to facilitate the use of the product?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

- Select Processes (PP2): Research facility acquisition; Does equipment support the business plan?; Identify the local possibilities for manufacturing your product or the need to outsource;

- Design Processes (PP3): Does equipment support the business plan?; Acquire facilities that support the business plan;

- Test, Review Processes (PP4): Do the facilities support the business plan?; Does the process requirement need a change in the technical design?

- Standardized Processes (PP7): Does the product fit into a standard system well? Is a salesman needed to solve problems with the system as the product is introduced?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

- Market research (M1): Understand the attributes needed in the product from a marketing company perspective, including: Pricing, weathering, Nailability,
Current products and their limits; Sequence note: Have the product design and financing issues been discovered for this stage?; Attending industry shows that will aid in marketing ideas for the product; looking through industry publications for marketing ideas. Sequence note: Have the product development and supply chain issues been discovered for this stage?; What do other builders do to get a product on the market?; Establish a need for the new product from current demand: the field, clients, and distributors; Sequence note: Have the other areas of commercialization been satisfied before we can progress?;

• Market Fit & Segmentation (M2): Plan for market changes: availability, costs, natural disasters, and reflect this back into market and technical research; Defining the Market; Advertising for the market; Sequence Note: Has the market fit been satisfied early and have the human resources steps been satisfied?; Sequence note: Have the product design and financing issues been discovered for this stage?; Distributors must be on hand to address problems; Sequence note: Have the other areas of commercialization been satisfied before we can progress?;

• Forecast Demand & Marketing Plan (M3): Identify problems; capitalize on problems; Will product change the market?; Does the market still support the business plan?; Begin outside sales by soliciting builders; Sequence note: Have the product design and financing issues been discovered for this stage?; Distributors must be on hand to address problems; Sequence note: Have the other areas of commercialization been satisfied before we can progress?;

• Review Marketing Plan (M4): Have you established similar views of the product for the market?; Review branding and market needs; Establish other new or pending products; Possible return to prototype development; Sequence note: Have the product design and financing issues been discovered for this stage?;

• Test Marketing through Production Run (M5): Can a sample home be produced at cost that will sell the product?; Distributors must be on hand to address problems; Sequence note: Have the other areas of commercialization been satisfied before we can progress?;
• Revise Marketing Plan (M6): Does the product require a revised marketing system?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

• Manage Sales M7: Design and insert a feedback form for field operations to let you know where you are not succeeding with your product. Sequence note: Have the product development and supply chain issues been discovered for this stage?

• Identify Sourcing and Outsourcing Options (SCM1): Identifying the facilities needed for your product and whether they will be overseas; Looking for complementary products required for your product and their supply path. Sequence note: Have the marketing and product development issues been discovered for this stage?

• Configure Supply Chain (SCM2): Does the product have a long lead time?; Should a product in stock be used instead of a lead time item?; Do suppliers offer a locked in cost rate? Do the products need to be ready for installation when they arrive?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?; Look for distribution options; Determine partnering options;

• Model Supply Chain Performance (SCM4): Does the supply chain require a new version of the product?

• Identify Project Leaders (HR1): Has a champion been established to introduce the product to the process meeting?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

• Create Leader Positions, Other labor Roles & Responsibilities (HR2): Find the right people with the right skills; Develop a team and identify its weaknesses;; Develop roles of champions; Develop leadership skills of the team members; Establish human resources expectations; Hire technical talent; Hire outside salesman;

• Create Hiring, Firing, & Promotion Plan (HR3): Establish cross-training techniques: all personnel must know multiple tasks; Establish lessons learned & incentives to learn quickly;
• Design Accounting and Information Systems (AIS2): Establish accounting system for product;

• Prepare Capital Plan (FM3): Figure out how to pay for this stage of the development; Sequence note: Does the financing reflect the product design and technical issues been discovered for this stage?

• Estimate Capital Costs & Risks (FM4): Figure out how to pay for this stage of the development; Sequence note: Does the financing reflect the product design and technical issues been discovered for this stage?

• Identifying liabilities, regulatory requirements, and partners (LM1): Determine partnering options; Determine regulatory barriers for product; Identify confidentiality agreements needed; Identifying possible partners and their requirements legally; Identifying the regulations regarding the product; Finding a lawyer to perform patent searches;

• Designing liability protections (LM2): Design partnering agreements; Establish a patent pending process and apply to all versions of the product; Paying a lawyer to draft partnership agreements; Paying a lawyer to file a patent;

• Design Contracts & Procedures (LM3): Always include language that offers a way out; Establish rights to the market without the brand;

• Review Standards & Protections from External Certifiers (LM4): Establish a “back door” person for negotiations; Conduct negotiations for rights; Establish “working document” outline.

• Monitor and Control Claims (LM7): Is there a third party who should sign off on the drawings based on the local regulations?; Is the product adjusted for different local regulations?; Sequence note: Have the other areas of commercialization been satisfied before we can progress?

Now that the important cells, actions, and sequences of cases one through five have been identified, Figure 10.1 offers an example of how this information might be organized as a process within the cells of commercialization for an innovative product in the residential construction industry. This figure is offered as the basis for future work.
Figure 10.1: Detailed Commercialization Cell M2

Feasibility Phase: Market Fit & Segmentation

Objectives of Commercialization

- **General**
  - Define Market Fit
  - (Generically, the product's fit into the market is estimated and the market segments are defined.)

- **Specific**
  - Determine Costs for Markets
  - CS2
  - Determine if On-location Assistance is required for Market
    - CS4
  - Determine Advertising Avenues for the Market
    - CS3
  - Determine Availability of Markets
    - CS2
  - CS5
    - Does the product need to change based on the location?
    - CS5
    - Does the cost of the product take it out of the market?
    - CS5
    - Does the product need to change based on demand?

Process

- (How we will perform our objectives)

Deliverable

- (A measurable outcome)

Knowledge of the product's fit into the different areas of the market.

The market research completed, the product's fit into the market is estimated and segments of the market are targeted.
Figure 10.1 is an enlarged example of the actions and sequences required for area M2 of the generic commercialization model. The detailed sheet identifies its location along the generic model across the top and in its “ID” number. Each detailed page offers a basic description of the upcoming actions performed in this cell. Objectives of the cell are then divided between general and specific. Often, the specific objectives are actions directly obtained from the interviews. Also, more specific actions from the interviews will be used to populate the “process” columns, where appropriate. Each detailed cell will eventually provide a deliverable that must achieved before moving to the next phase of commercialization, similar to Goldsmith and Rourke. This complete set of detailed cell deliverables is the subject of future work.

While no current model for the commercialization process of innovation in residential construction is available, this thesis presents the basis for such work. This work provides a generic model that can be used by industry for commercialization, but this model would not be specific to the construction industry. Based on the successful commercialization of construction industry products, detailed sheets which contain actions and sequences of importance, when placed in the cells considered important, will provide this specific model. Future work might assemble additional case studies in an attempt to further this unique version of the generic commercialization model. This specific model will offer important cells, actions and sequences for limited-resource innovators to achieve success in this difficult process.
REFERENCES


Websites:

