TECHNOLOGY COMMERCIALIZATION FRAMEWORK

Prepared by BizLogx LLC

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Dear Mr. Valente and Mr. Chagnon,

We are pleased to deliver this Technology Commercialization Framework. In the form of the Third Frontier Project, the State of Ohio demonstrated great foresight in making available over $1 billion to fund activities ranging from applied research to product development. As stated by Michael Weitzman, however, "the limits to growth may lie not as much in our ability to generate new ideas, so much as in our ability to process an abundance of potentially new seed ideas into usable form." To address this challenge, the Ohio Department of Development recognized the need for a framework to help optimize technology commercialization activities and investment decisions. The ODOD therefore requested that we develop this Framework.

We based the Framework on an extensive review of the leading literature on technology commercialization. The Framework includes a map of the commercialization process and an analytical approach to help optimize commercialization activities and investment decisions during each of the five primary phases of commercialization. The Framework is not a cookbook or a list of best practices. Rather, we designed the Framework to assist research institutions, investors, economic development entities, businesses, entrepreneurs and others in optimizing the investment of scarce resources in context of transforming ideas, research and intellectual property into successful products and services.

The Framework takes a practical approach to commercialization. While interim progress and milestones can be meaningful, the Framework focuses on transitions - the acquisition of the resources required to engage in the next phase of technology commercialization. In-phase activities have a single purpose – the generation of the proof required to convince resource providers to provide the capital and other resources necessary to engage in the activities characterized by the next phase of commercialization. The Framework measures success one transition at a time.

The Framework also expressly acknowledges that contextual factors frequently have a greater impact on the potential success of a project than do the merits of the particular technology or commercial application. For example, the regional presence or absence of experienced investors, a large number of companies in the target industry, or providers of required expertise can prove determinative to success or failure.

We believe that the thoughtful application of the Framework can help economic development organizations, businesses, entrepreneurs, institutions, investors, and others optimize investment decisions and improve the likelihood of success. We look forward to supporting ODOD and other participants in the Ohio economy in furthering commercialization projects and programs.

Michael J. Mozenter

Stephen F. Berger

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EXECUTIVE SUMMARY

INTRODUCTION

Government, private industry, academics and practitioners are increasingly focused on the critical role that technology and information play in creating wealth and competitive advantage. The stakes are high and the rewards are growth and prosperity. Silicon Valley, Route 128 in Boston, Austin and the Research Triangle in Raleigh are the most commonly cited examples of technology commercialization driving significant economic transformations.

Citing these examples, many states, Ohio included, believe that one of the keys to long term economic success is the evolution of a manufacturing-based economy to a technology and information-based economy. To this end, federal and state governments are channeling millions of dollars into commercialization efforts, venture capital funds, early-stage business assistance organizations, research and development organizations, business attraction and retention programs and related activities, all in the hopes of sparking Silicon Valley type successes.

Despite the obvious rewards and several high profile success stories, the path from idea generation to commercial success remains a relative mystery. No existing roadmap, process or model provides the guidance necessary for government or private participants to predictably and efficiently use investment dollars to transform techno-market insights into commercial successes.

Faced with this problem, the Technology Division of the Ohio Department of Development (ODOD) retained BizLogx to develop this Technology Commercialization Framework[1] (referred to as "the Framework"). The Framework serves as a guide for the thoughtful analysis of technology commercialization initiatives (and related investments) at each phase of commercialization, from idea generation to commercial success. The Framework helps answer the following questions:

- In which phase of technology commercialization is a particular project located?
- Who are the most likely providers of the resources required to move to the next phase of technology commercialization?

1 Although we use the term "technology commercialization", the commercialization process described in this report applies equally to "technology-enabled commercialization", which includes the application of existing technologies to improve existing products or services or to create new ones.

- What proof will the resource providers require as a condition to investment?
- In addition to the challenges of proof generation, what additional challenges will the project face in attempting to transition to the next successive phase?
- How should participants and investors measure progress during each phase when proof of commercial success may be years away?

To answer these questions, BizLogx conducted an extensive literature review. The literature review spanned hundreds of the leading articles and books on the topic of technology commercialization.[2] BizLogx did not conduct case studies or primary research, although the literature did include the results of many empirical analyses.

Based on the literature review, BizLogx's team of experts and practitioners[3] developed a map of the commercialization process as well as an analytical framework to help government and private participants optimize their investments in technology commercialization. The Framework is not a "how to" manual or a detailed list of best practices. Rather, the Framework helps to improve the quality of decision making and investing at the project level by integrating into the analysis contextually specific challenges and opportunities that directly affect the likelihood of resource acquisition. Although many of the principles we discuss apply equally well to product, service or process innovations that are not based on new technology, the Framework is focused on technology and technology-enabled commercialization.

THE TECHNOLOGY COMMERCIALIZATION PROCESS

We developed the following roadmap from our extensive research into the literature on technology commercialization processes. We adopted certain terminology, concepts and graphics from the work of Vijay Jolly in his 1997 book *Commercializing New Technologies: Getting from Mind to Market*. We augmented Jolly's work with the thinking and research of leading academics and practitioners. As applicable, we reference these academics and practitioners throughout this report.

2 A list of all sources is included in the Reference section.

3 Team members and biographies are in the Appendix

The Phases

The follow diagram illustrates the primary phases and transitions in the BizLogx roadmap of technology commercialization[4]:

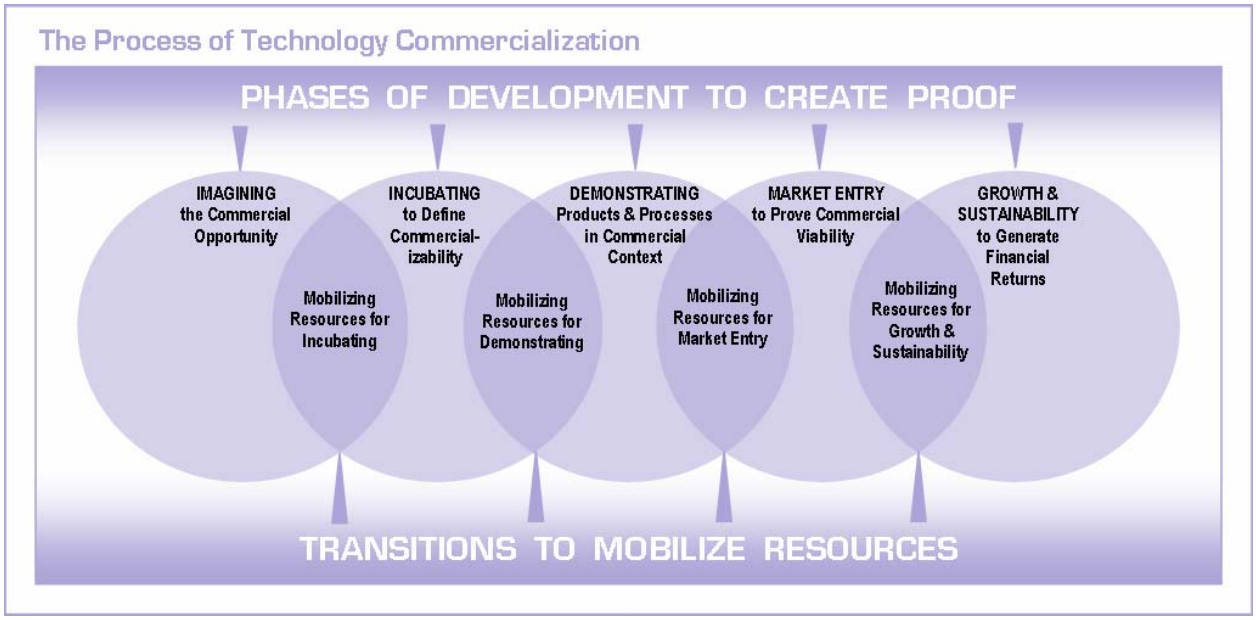

Figure 1. The Process of Technology Commercialization

In sequence, the five phases of technology commercialization are *Imagining, Incubating, Demonstrating, Market Entry* and *Growth & Sustainability*. We did not invent these terms or the five phase model. Numerous experts use a five phase model to describe the technology commercialization process. We simply integrated certain terminology and definitions to create the model we use in this Framework.

The *Imagining Phase* begins with the techno-market insight - the linking, if only in concept, of a technology and a market opportunity (often referred to as a "job to be done"). Activities focus on the generation of a "proof of principle" – the demonstration in a laboratory setting of critical components of the technology and the development of a related business case. The providers of resources for the *Imagining Phase* activities include, but are not limited to owners/entrepreneurs, corporate R&D budgets, university departmental budgets, and, directly or indirectly, government funding. Given the extreme commercial risk at this early stage of development, third party private financing is rare. The primary objective for *Imagining Phase*

4 Adapted from the commercialization process model of Vijay Jolly (1997)

activities is the generation of the proof required to attract the resources necessary to move to the next phase – *Incubating*.

The *Incubating Phase* is characterized by the following activities: definition of technical and product performance specifications, validation of technical capabilities in the context of the performance specifications, and further validation of the market and related commercial concept/business plan. Often referred to in the literature as the "Valley of Death" or the "Darwinian Sea", the *Incubating Phase* is, more often than not, the end of the road for commercialization initiatives. Insurmountable technical and market roadblocks frequently surface. Perhaps even more challenging, however, is resource acquisition. Because of the technical and market uncertainties, *Incubating* continues to embody enormous commercial risk. Unfortunately, this risk is coupled with the need for an increased level of resources. As a result, private money is scarce. Typical suppliers of resources for *Incubating* activities include the federal government, state governments, owners/entrepreneurs, corporate R&D budgets, university R&D budgets, and, to a limited extent, angel investors. Given the lack of tangible market validation, and open technology questions relating to issues such as manufacturability, private investors generally do not fund projects in the *Incubating Phase*. The scarcity of resources only increases the challenge of generating the proof necessary to attract the resources required to move to the next phase – *Demonstrating*.

During the *Demonstrating Phase*, project teams attempt to generate technical and market proof within a more defined commercial context. Activities focus on product development and market acceptance. Working prototypes, performance to commercial specifications, and manufacturability within defined cost and quality standards characterize the goals on the technical side. On the market side, *Demonstrating Phase* activities focus on generating evidence that customers will buy the product. The mix of resource providers now begins to include private sources. Corporations and angel investors are two of the primary contributors to *Demonstrating Phase* activities. Early stage venture capitalists sometimes invest in *Demonstrating Phase* projects, but more commonly save their resources for the next phase (*Market Entry)*. As with the prior phases, the *Demonstrating Phase* represents an insurmountable obstacle to a large percentage of commercialization initiatives. Those resource providers who fund market entry projects require more refined and tangible proof of product feasibility such as technical, performance, manufacturing, and market feasibility.

In the *Market Entry Phase*, participants enter the market to validate the commercial opportunity. Activities are those typically associated with an ongoing business – production, service, distribution, sales and marketing. As noted, venture capitalists and corporations are the primary providers of the resources required to fund *Market Entry Phase* activities. To move to the final phase, *Growth & Sustainability*, or to generate a financially attractive exit for earlier resource providers, the opportunity must generate positive business results (e.g. sales, growth and evidence of profitability). If the evidence indicates that the product/technology can fuel a wide variety of new products and opportunities, *Growth & Sustainability Phase* resource providers, such as venture capitalists, banks and the public equity market itself, will provide the resources necessary to advance. If, however, the opportunity generates positive business metrics, but is unlikely to serve as a platform for a variety of new products or spin-off opportunities, then an exit is the more likely result. Certain private equity firms as well as strategic buyers/acquirers provide the resources for the exit.

The *Growth & Sustainability Phase* involves the execution of a comprehensive business plan to increase market share and/or total revenue and profit in context of a self-sustaining business. The goals, value creation mechanisms and resource providers are those generally associated with a thriving business seeking to identify opportunities for growth and profitability. While the challenges are substantial and worthy of extensive discussion the *Growth & Sustainability Phase* is outside the scope of the Framework.

Transitions to Mobilize Resources

A Transition is best described as a sales process whose primary objective is to convince resource providers to invest in the activities of the next phase of commercialization. All transitions have two components – the acquisition of resources (the event) and the activities that culminated in that event. The event occurs when resource providers provide the investment necessary to perform the activities defined by the next phase of the commercialization process. Transition activities begin during the phase as proof is generated. The exact point in time (early or late in the phase) is dependent on nuances of the industry, project and resource providers.

In this sales process, participants use the proof generated within a phase to convince resource providers to make an investment. Especially in the earlier phases, the risks are high and the proof is more an indicator of progress than a determinant of commercial opportunity. As a result, transitions are extremely challenging processes. To accomplish an effective transition, participants must clearly understand the needs/desires of the targeted resource providers and,

more importantly, the proof the resource providers require as a condition to investment. *Successful commercialization is about successful transitions.*

Unfortunately, however, not all transitions are created equal. For our purposes, the best evidence (albeit imperfect) that a project is moving through the commercialization process is the consummation of resource acquisition. The acquisition of resources validates the proof and the opportunity at the point of the transition. In analyzing the quality of the transition, however, we focus on three criteria. Those criteria are "new", "smart" and "meaningful".

- To determine if the resources are "new", we ask the question – Are the resource from a third party that has not previously invested in the project?
- To determine if the resources are "smart", we ask the question – Is the resource provider experienced in the target industry and capable of bringing other necessary capabilities to the project if necessary?
- To determine if the resources are "meaningful", we ask the question – Is the investment significant when measured relative to the resource provider's total assets or considered in context of the resource provider's core strategy?

Negative answers to one or more of these questions do not mean that a transition has not occurred. Rather, they speak to the quality of validation of the opportunity. If the project is unable to attract a "new", "smart" and "meaningful" investment, the participants must consider the implications. Why didn't the project attract new, smart and meaningful resources? Are the participants so wrapped up in their enthusiasm and optimism that they fail to see warning signs regarding the viability of the concept? Resource acquisition is the best evidence that a project is advancing towards commercial success. Because resource acquisition is the "best evidence" (but not probative) of progress, participants must scrutinize the quality of the transition.

Complexity, Iteration and Context

As noted, Figure 1 is fairly representative of the numerous models and descriptions used by theorists and practitioners to conceptualize the commercialization process. The graphic is, however, deceptive on a number of critical points. First and foremost, the process appears linear, but in almost every instance, is complex and iterative. Especially in the earlier phases, false starts and dead-ends are the norm, not the exception. Even in the pursuit of resources during a transition, success frequently depends on a serendipitous turn of events rather than the execution of a sequence of planned steps. As Clayton Christensen (2003) pointed out,

approximately 90% of successful companies did not succeed on the basis of the business or opportunity described in their original business plans – an extremely compelling statistic.

Second, the basic process map does not show the critical role of context. Each opportunity germinates and develops in a unique environment. Contextual factors such as the skills, track records and relationships of the people involved; the local or regional availability of required resources; the availability of specialized equipment; the presence of businesses with experience in the targeted market; and a host of other similar factors are as determinative of success as the unique aspects of the technology or commercial concept. For example, an *Incubating Phase* opportunity seeking resources to perform *Demonstrating Phase* activities is less likely to succeed, even after generating the requisite proof, if the region lacks a relatively large number of angel investors or seed stage venture capital firms with experience in the target industry. As most entrepreneurs understand, proof is rarely objective in the world of resource providers. Proof deemed compelling by one resource provider is often dismissed as inadequate by others. Perspective, experience, focus and competition all influence a resource provider's view of proof. As a result, the absence of a large number of resource providers often translates into a low probability of transition. After all, how difficult is it to find reasons not to invest in an early stage technology commercialization initiative?

As an aside, it is important to note that resource acquisition is not just about financial investment. Required resources can take the form of personnel, expertise, capital equipment or facilities, to name a few. As another important side note, the concept of proof changes from phase to phase. While resource providers in each phase require some level of proof as to technical and market viability, the nature of the proof changes at each subsequent phase.

Measurement

Measurement serves two critical roles in the commercialization framework. First, applying measurement to a project helps define the desired outcomes. Second, measurement provides a mechanism for accountability. Rather than specific metrics (which are unique to each project), we propose a measurement framework that enables project teams or resource providers to develop a comprehensive set of metrics for short-term and long-term project evaluation.

The measurement framework consists of three categories of measurements – *Level A Metrics, Level B Metrics and Level C Metrics*. *Level A Metrics* are direct evidence of project or program

success. In context of the Technology Commercialization Framework, transitions (resource acquisitions) are the definitive *Level A Metric*. For the most part, *Level A Metrics* are objectively determinable and easy to measure. *Level B Metrics* are more challenging. Level B Metrics are tangible evidence that a project in on the path to achieving *Level A Metrics*. So, for example, a *Level A Metric* for a project in the *Demonstrating Phase* is an investment by a venture capital fund (funding *Market Entry Phase* activities).

A *Level B Metric* for this project might include the delivery of a term sheet detailing a potential investment and committing the resource provider to a defined set of diligence-related tasks within a relatively short time period. While less objective events might qualify as *Level B Metrics* – for example, numerous meetings with venture fund partners followed by extensive diligence – these less objective events have the potential to result in delusions of progress driven by unbridled optimism.

Finally, *Level C Metrics* are simply evidence that the project is engaged in the types of activities typically associated with similar projects. These activities (e.g. hiring qualified personnel, preparing patent applications, preparing a business plan, etc.) are vital activities, but do not represent evidence of progress toward the goal of Transition or commercial success. Rather, they simply indicate that the participants are executing their plan.

THE ANALYTICAL FRAMEWORK

The Analytical Framework builds on the Commercialization Process Roadmap and provides a 6-step process to move projects to the next phase of commercialization. The true work now begins – applying the Framework to a particular program or project. To do this, we propose the following analytical steps:

- Identify the appropriate phase of commercialization.
- Identify the resource providers required to fund the next phase of commercialization activities.
- Determine the proof required by the targeted resource providers.
- Identify the contextual factors that are likely to have a material impact on the chances of resource acquisition.
- Determine the appropriate measures of progress.
- Develop a plan to produce the proof and pursue the transition.

Identifying the Phase

Identification of the phase is not always easy. In general, the determination focuses on two categories of proof - proof relating to the technology/product and proof relating to the commercial concept/business plan. During the *Imagining* and *Incubating Phases*, technology/product proof tends to occur in the laboratory rather than in a commercial environment. In the later phases, technology/product validation occurs in a commercial environment, but also includes proof relating to packaging, manufacturing and costs. On the commercial concept/business plan, proof during the *Imagining* and *Incubating Phases* is more abstract.

If the project relates to a disruptive innovation (new benefits offered to new or less demanding customers) targeting new customers, proof generally comes in the form of secondary market research and business logic. Even with sustaining innovations (improving products or services that are currently in the market), business logic and secondary research form the commercial concept proof during the earlier phases.

During the *Demonstrating Phase* and beyond, the market becomes the source of commercial concept/business plan proof. Are customers buying the product? Is the opportunity generating targeted growth and margins? Are the value chain participants performing as anticipated? During *Market Entry* and *Growth & Sustainability Phases*, the proof evolves to standard business metrics. While none of the listed factors is determinative, they provide a useful guide.

Identifying the Resource Providers

The following chart provides some general guidance regarding the resource providers that generally invest at a particular phase:

Commercialization Phase	Resource Providers[5]
Imagining	• Owners/Founders • Corporate R&D • Research programs funded by federal agencies, foundations and universities
Incubating	• Owners/Founders • Corporate R&D • Angel Investors (limited) • Federal Programs

5 We have identified the primary resource providers. Other resource providers may participate but they are the exception, not the rule.

Commercialization Phase	Resource Providers[5]
	• Venture capital, universities and state governments provide some funding for Incubation to a much smaller degree
Demonstrating	• Corporations – Investment and R&D • Angel Investors • Venture Capital (limited)
Market Entry	• Corporations – Investment and R&D • Venture Capital • Angel Investors
Growth	• Corporations • Venture Capital • Commercial Lenders

Determining the Required Proof

The ultimate decision on proof requirements to support a project is made by the resource provider (the investor). Most resource providers can articulate in detail the criteria they generally apply to determine whether a particular investment fits within the scope of their investment parameters. These criteria usually include factors such as company size and stage of financial development (such as pre-revenue, post-revenue, pre-profitability and post-profitability). Other typical factors speak to targeted industries, degree of technology risk, completeness of management team and geographic preferences. To the project team, these factors are useful, but are merely a starting point. These factors represent the first level filter the resource provider applies to potential investments. They do not, however, speak to the specific proof the resource provider will deem persuasive in making an investment decision.

The specific proof emerges from the interaction between the resource provider and the project team. If the project team/champion manages to make it through the first level filters and captures the interest of the resource provider, a dialog begins. The resource provider will conduct an analysis of the project, typically evaluating the technology, the product, the market, the people, the competition, the financing and the financial projections to determine whether or not to make an investment. In many cases, the resource provider identifies gaps in the plan that require additional proof. These gaps are the origin of the proof requirements that stand between the project team and an investment.

Certainly, a written business concept or business plan will always be a component of the required proof. The written document serves as a roadmap for the opportunity and sets expectations regarding the hurdles to overcome and the nature of the opportunity. The written document also bolsters the participant's credibility by demonstrating a thoughtful and comprehensive approach to capturing the opportunity. As noted, however, proof is a relative

concept. While the resource providers at each stage require proof of technical viability and proof of the commercial concept, the specificity and nature of the proof changes with each phase. During the later phases, the required proof of technical viability and commercial concept flows from the market rather than the lab.

Finally, few elements of proof are uniformly compelling to all resource providers. To mitigate the risk that an individual resource provider will decide not to invest (for any number of reasons, many of which are independent of the merits of the technology or commercial concept), the project team has no choice but to initiate as many meaningful discussions with resource providers as possible. While this conclusion appears obvious, many project teams do not take into account the relative lack of qualified resource providers in assessing the likelihood of success.

Identifying Contextual Factors

As noted above under "Complexity, Iteration and Context", contextual factors may be as compelling indicators of potential success as the quality of the technical and commercial concept. Local market conditions, the local or regional presence of a large number of potential resource providers, the ability of the participants to credibly approach the resource providers, competition and the availability of non-financial resources (qualified personnel, expert assistance, testing facilities etc.) are examples of critical advantages or obstacles.

To assess contextual factors, the participant should shift focus from the market for the potential product or services *to the market for their project's opportunity at the current phase of commercialization*. In this analysis, the focus is on the likelihood of a successful transition (resource acquisition). In this market, the product is the project's opportunity. The customer is the resource provider. Sales and distribution are a critical component of the transition activities, which depend in large part on whether the project team can effectively market the opportunity to the resource providers. With this shift in focus, the project team should be able to more clearly determine the magnitude of the resource acquisition challenge.

As also noted, in the absence of a large market (a large number of potential resource providers), the likelihood of success, even for a relatively compelling opportunity, diminishes significantly. Especially in the earlier phases, resource providers tend to act on a local or regional basis. In addition, many resource providers focus on particular industries. As a result, the market of potential resource providers may be smaller than it first appears.

Determining Measures of Progress

Finally, the measurement framework must be applied to identify *Level A, B and C metrics*. Only by the careful identification and monitoring of performance to these metrics can progress be determined. In the absence of well-defined metrics, the inherent uncertainty of the commercialization process makes it next to impossible to identify progress, make timely course corrections or abandon unproductive courses of actions.

Developing a Plan to Transition

For the reasons outlined above, transition activities must be closely aligned with the proof required by potential resource providers and the context of the opportunity. Transition activities include resource provider identification, proof definition, proof marketing and resource acquisition. The specific activities are highly dependent on the industry, phase and context.

SUCCESS DRIVERS

In accordance with the literature, history and common sense, no formula exists to ensure success in technology commercialization. The literature does, however, contain a number of recurring themes regarding factors that appear to drive success. The list generally includes the following:

- A compelling commercial concept;
- Continuing validation through the acquisition of new, smart and meaningful investment;
- A champion well matched to the needs of the project, especially during the more uncertain early phases;
- Environments conducive to technology commercialization at the particular phase of project development (e.g. supportive organization and culture, compatible incentives, enabling legislation);
- Efficient access to external networks of resource providers; and
- An efficient mechanism to share information both within the organization and externally, with potential resource providers, including providers of non-financial assistance.

Although no one of these factors guarantees success, the positive contribution of each of these factors commonly is cited in the literature.

NTRODUCTION

This report, *Technology Commercialization Framework*, is designed to help the Ohio Department of Development and private participants in the commercialization of technology in the State of Ohio. The motivation for this report comes directly from three sources: the Third Frontier investment of $1.1 Billion to stimulate the economy in Ohio to generate more high paying jobs and new economic activity in technology businesses; the desire of ODOD to maximize the productivity of the State's investment in technology commercialization; and the desire of ODOD to help public and private entities to more efficiently and effectively use the resources provided by ODOD to successfully commercialization innovations.

THE PURPOSE OF THIS REPORT

The purpose of the report is to address specific ODOD needs as follows:

- A comprehensive analytical framework to support the preparation of economic development programs, the preparation of RFPs, the evaluation of proposals and the decision to invest funds in a project;
- A means to establish a minimum standard of analysis for proposals;
- A system of metrics that conveys ODOD's objectives, provides interim and ultimate performance evaluation measures, and allows for diagnostic evaluation of existing projects; and
- A standard set of guidelines that provide potential funding recipients with the tools to respond to RFPs and implement project plans with a higher probability of success.

THE SCOPE OF THIS PROJECT

To develop the Framework, BizLogx combined the expertise of the project team with a review of business, academic and government literature. The project team did not engage in primary or case study research.

PROJECT TEAM

ODOD, represented by Pat Valente and Norm Chagnon, engaged BizLogx LLC, represented by Steve Berger and Mike Mozenter, to conduct the research and prepare this report. BizLogx

used its internal resources as well as those of selected consultants. See the Appendix for biographies on the team members.

HOW TO USE THIS REPORT

This report is organized to provide the reader with information in a sequential manner. The information builds with each section resulting ultimately in the Analytical Framework. Understanding the Analytical Framework and how it can be applied to make better commercialization decisions is largely dependent on reading and understanding the prior sections.

We strongly recommend that the reader start with the Executive Summary. This will provide general awareness of the subject and the report content. The Background section then describes the factors that are fundamental to commercialization and sets the stage for the next section. The Commercialization Process Roadmap provides an in-depth description of the movement of a technology commercialization project from the initial techno-market insight through the various phases, and provides the understanding of phases, transitions and metrics that is essential to understanding the analytical framework. The Analytical Framework builds on the Commercialization Process Roadmap and provides a 6-step process to move projects to the next phase of commercialization.

1 BACKGROUND ON TECHNOLOGY COMMERCIALIZATION AND INNOVATION

This section provides important background information on technology commercialization and the process of innovation. Beginning with an overview of the importance of innovation and technology commercialization, we then summarize the fundamental aspects of commercialization. The summary addresses and defines fundamental concepts including process, resource providers, proof, context, validation and measurement. The summary also addresses a number of success drivers including the commercial concept, the idea of new, smart and meaningful money, the role of the champion, the importance of organizational support and culture, the support of networks of resources, and the need for communication.

THE IMPORTANCE OF COMMERCIALIZATION AND INNOVATION

"The Knowledge Economy", "Creative Destruction", "Globalization", "Off-shoring" - These buzzwords characterize the economic and social changes that the State of Ohio, the United States and the rest of the developed world have been experiencing for the past decade. These words also signal a period of transformation, which, among other things, has resulted in a fundamental change in the basis of competition. Competition used to focus on companies. Now competition occurs among localities, states, regions and countries. Manufacturing assets and distribution capabilities are no longer competitive differentiators. Today, information and knowledge are equal partners with assets in defining competitive advantage[6].

According to David Teece, "…it has long been recognized that economic prosperity rests upon knowledge and its useful application… [T]he increases in the stock of useful knowledge and the extension of its application are the essence of modern economic growth." In the past, productive assets and natural resources were the foundation of economic development and competitive strategy. Today, however, theorists and practitioners alike point to technology and information as the real drivers of wealth creation and competitive advantage. In the absence of successful productive commercialization processes, the potential value of technology, knowledge and information remains out of reach.

6 Many thinkers have contributed to the understanding of information and knowledge in competition. David J. Teece has been very articulate on the subject, particularly in "Capturing Value from Knowledge Assets: The New Economy, Markets for Know-How, and Intangible Assets."

Economist Martin Weitzman stated, "The ultimate limits to growth may lie not as much in our ability to generate new ideas, so much as in our ability to process an abundance of potentially new seed ideas into usable form" (Weitzman 1998). For any company, region, state or country wishing to drive value creation from technology and information, mastering the process of commercializing technology-based innovations it is an absolute necessity.

HOW TECHNOLOGY COMMERCIALIZATION CREATES VALUE

We are all familiar with the apocryphal story of a breakthrough technology that creates a new market, sets a new standard, obsoletes all that came before, and generates inconceivable wealth for its creators. Unfortunately, contrary to popular lore, these breakthroughs are extremely rare. Yet, less dramatic breakthroughs and innovations routinely create enormous value for those who can translate these breakthroughs into new or improved products or services. Geoffrey Moore, author of Crossing the Chasm, has outlined the following ways that innovation coupled with effective commercialization creates value and builds wealth:

- Introducing a *new technology* that, because of its features and benefits, creates a new market (cell phones);
- Finding new *applications* for existing technologies (GPS used for OnStar);
- Improving *product* performance (Pentium processors by Intel) or product usability (Palm handhelds);
- Making *processes* more effective or efficient (Dell's streamlining of the PC supply chain);
- Improving the *customer's experience* (Disneyland's amusement park management system);
- Improving the *customer-touching* processes (eBay's online auction and Amazon's e-commerce mechanisms[7]);
- Introducing a new *business model* that changes a value proposition (IBM's shift to on-demand computing); and
- Taking advantage of *structural changes* caused by disruptions like regulatory changes (Fidelity offers online financial services to compete with banks and brokerages).

Although some of these innovations are less newsworthy, they drive competitive advantages and value creation for industries in all phases of maturity. Improving the ability of Ohio entities (companies, inventors, entrepreneurs, universities, research institutes, and support entities) to

7 Who created online bookselling? Charles Stack, an Ohio-based bookseller, was the pioneer in this category, starting "books.com" in 1991, four years before Amazon entered the market.

commercialize innovations can have a profound impact on the competitiveness of the assets of the state, resulting in more high paying jobs and gross state product.

FUNDAMENTAL ASPECTS OF COMMERCIALIZATION

Although extremely varied, the literature on technology commercialization contains a number of consistent themes, observations and principles. Because of the high frequency of their occurrence and the relatively consistent meaning throughout the literature, we have concluded that many are fundamental to commercialization. The following are brief descriptions of some of those principles.

Process

Although commercialization commonly follows a complex and iterative path, with many false starts and dead-ends, successful commercialization ultimately proceeds through defined phases and transitions. Knowing with relative certainty the phase of a particular commercialization project, the objectives of that phase, the resources necessary to proceed to the next phase, and the source of those resources, is critical to success. Without this "you-are-here" map, projects flounder with misplaced goals, activities and expectations.

Resource Providers

Although the ultimate goal of successful commercialization is the creation of new or more competitive businesses generating high margins and creating high paying jobs, the creation and management of successful commercialization projects depends on a more focused perspective. At the process level, successful commercialization is largely dependent on successful transitions. A transition occurs at the point in time that a project attracts the resources required to perform the activities in the next phase of commercialization. These resource providers tend to vary from phase to phase. They provide a wide variety of resources including capital, facilities, equipment, and access to networks and information in technology, manufacturing, market, sales, distribution and related support services. It is only by properly identifying those resource providers who typically "invest" in the next phase of commercialization can the project team determine the information or proof required as a condition to investment.

Proof

As noted, the activities within each phase focus on proof generation – the proof which the identified resource providers require as a condition to making an investment decision. Proof

generally falls into two buckets – technical feasibility and market feasibility. Technical feasibility starts with proof of principle, evolves to reduction to practices, and ultimately product feasibility that includes issues such as performance to defined specifications, production within defined cost parameters and quality standards, and manufacturability. Market feasibility starts with a credible commercial concept, and proceeds to the preparation of a business plan and validation of critical components of the plan through direct market testing and validation, ultimately in the form of sales. While the resource providers at each phase focus on technical feasibility and market feasibility, the type of proof they require at each phase changes dramatically. Furthermore, proof is rarely objective. Proof deemed probative by one resource provider is often dismissed as inadequate by other resource providers.

Context

Unfortunately, there is no magic formula, instruction book, or step-by-step guide to successful technology commercialization. Each technology and market need presents a unique situation that requires a thorough understanding of internal and external factors in order to determine the plan for moving forward and the resources required. The following contextual factors, among others, can be as important in commercialization success as the unique aspects of the technology or business case:

- The skills, track records and relationships of the people involved;
- The local or regional availability of required resources;
- The availability of specialized equipment;
- The presence of businesses with experience in the targeted market and industry.

One of the primary challenges to successful commercialization is the identification of material contextual factors and the development of plans to leverage or overcome those factors.

Validation

One of the more frustrating aspects of managing technology commercialization is the lack of objective and tangible indicators of progress. The ultimate goal, the creation of viable and growing businesses, is often years away. How can a project or an investor know with any level of certainty that it is on the right path, especially in the earlier phases? The answer is straightforward – *resource acquisition*. The best evidence of progress is the acquisition of the resources required to transition to the next phase of commercialization.

From a validation perspective, however, not all resources are created equal. All other things being equal, the highest form of validation meets three criteria: new, smart and meaningful. For validation purposes:

- "New" means that the resource provider has not previously invested in this project and makes an independent evaluation of the project.
- "Smart" means that the resource provider is experienced in the industry and capable of bringing other necessary capabilities to the project if necessary.
- "Meaningful" means the investment is significant when measured relative to the resource provider's total assets or considered in context of the resource provider's core strategy.

Failure to satisfy each of these criteria does not necessarily undermine the validation or indicate that progress has not occurred. For example, existing investors often invest a second or third time, especially in the cases of internal corporate development or venture capitalists. Rather, the lack of third party investment and validation should raise the question in the mind of the project champion: "Why do potential investors judge this concept to lack viability?"

Measurement

Measurement is critical to determining progress and ensuring the efficient use of resources. The framework for identifying appropriate metrics and then measuring progress against those metrics is discussed in detail in the section titled Commercialization Process Roadmap. The selection and use of the right metrics provides for effective implementation of strategy and useful feedback to make resource allocation decisions that maximize the value of subsequent investments. The wrong metrics inhibit progress and result in non-productive investment.

SUCCESS DRIVERS

The literature contains a number of recurring themes regarding factors that appear to be correlated with success. While none of these are determinative and many are difficult to verify until after a project has succeeded or failed, they are nevertheless worthy of mention and consideration. These success drivers include the following: the commercial concept; the infusion of new, smart and meaningful money; the existence of a champion; the existence and nature of the organization and culture; the presence of a network of resources; and effective communication.

The Commercial Concept

The importance of developing and refining a compelling commercial concept is a common theme in academic research and is fundamental in business practice. The commercial concept identifies and describes an outcome that can generate sales and profit that meets the expectations of the team and the investors. The commercial concept may start as a "techno-market" insight and evolve into a business case and then into a comprehensive business plan. It is based on the collection of information and applied judgment of the project team and its supporters.

A commercial concept provides the focus for technology development, business development and resource allocation decisions throughout the commercialization process. One of the primary objectives within each phase is the generation of the information/proof required to refine the business concept. Unfortunately, participants will find it difficult to know with certainty whether their commercial concept is compelling. The only true test is whether resource providers actually make an investment.

New, Smart and Meaningful Money

As noted, practitioners and researchers generally agree that financial resources in the form of "new, smart and meaningful money" are an essential component of commercialization success.

Champion

The literature almost unanimously recognizes the role of the champion in commercializing technology. Champions recognize the potential of a commercial opportunity, adopt the project as their own, become an advocate and provide the direction and leadership necessary to obtain required resources. Projects that have champions are more likely to move through the commercialization process successfully than are those that do not have champions.

Organization and Culture

The organizational structure and the culture of the organization can have a huge effect on the success of a commercialization project. Organizations and their culture provide a major part of the context in which a commercialization project operates. Alignment between the needs of the commercialization project and the needs of the parent organization can be a major

determinant of success[8]. Lou Gerstner, former chairperson of IBM, emphasized the importance of culture in creating the conditions for success with this quote:

> "Culture is not part of the game. It is the game. Most of the really important rules aren't written down anywhere. Culture is what people do without being told."

Networks of Resources

Commercialization is rarely accomplished without the active and frequent participation of other players who provide information, resources and access to everything from technical capability to customers. Both formal and informal networks and geographic clusters of participants are drivers of success for commercialization projects. These networks provide critical input on technology, people, financing, product markets, value chains and competitive strategies[9]. Without a relatively large number of potential resource providers and a mechanism to access those resource providers, the odds of success diminish dramatically.

Communication

Communication refers to the systems of information exchange. Communication includes the concept of information sharing, but more specifically addresses the facilitation of sharing, including, but not limited to the translation of words and concepts across technical and business boundaries, the ability and willingness to have critical and candid dialogue about issues, and a culture that supports and encourages debate.

Communication as a success driver is applicable within the project team (in the form of internal communication) and between the project team and the networks that support it (external communication). In order to have effective resource allocation planning and prioritization, managers must encourage interaction among functional specialists, particularly between marketing and technology. These efforts allow functional specialists to learn from one another's unique perspectives and forge a vivid, commonly held image of the technology applied to

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8 The research on the importance of organizations and their cultures on success of innovative projects are based largely on case studies and interviews. Karen Zien and Sheldon Buckler have researched highly innovative companies and identified seven shared principles (Zien 1997). Although all the companies share these principles, they each have a unique and context driven implementation of the shared principles. Zien concludes, "Crafting a culture of innovation is a 'story of connections' between one person and other employees; between employees and external partners; between employees and the organization's purpose."

9 There is a tremendous amount of research on the role of networks and clusters as drivers of technology commercialization including Porter (1998) who has published widely on the role of regional industry clusters and Paytas et al (2003) who have recently completed a study for the Economic Development Administration that emphasizes the importance of regional industry clusters in building technology-based economies.

meet potential market needs[10]. The major implication for technology commercialization is that the number and quality of communication channels can directly influence the probability of success.

10 Four recent studies summarized by Bond (2003) support the importance of the interaction between marketing and technology. This interaction improves the output of the innovation process, speeds the improvement of brand quality and allows a firm to respond more quickly to environmental changes.

2 THE COMMERCIALIZATION PROCESS ROADMAP

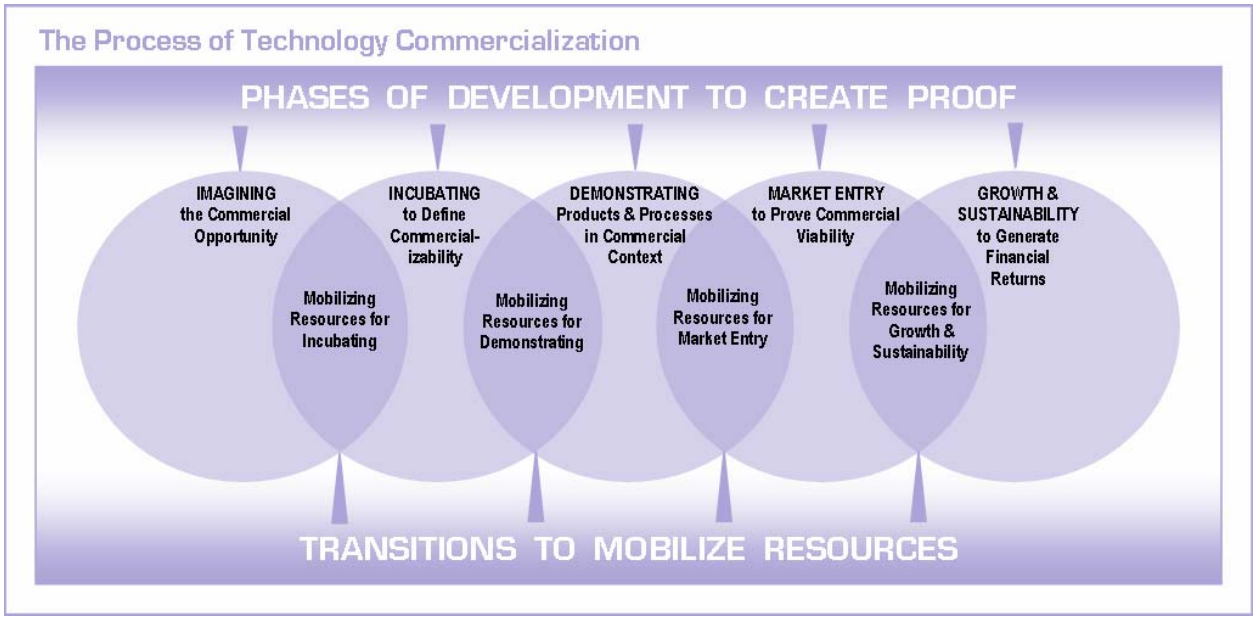
This section describes the commercialization process that serves as the foundation of the analytical framework in the next section. The section starts with an overview of the technology commercialization roadmap and contains a description of the concepts of phases and transitions, as well as a system of measurement. The section then includes a detailed description of those activities typically associated with technology commercialization within each phase. The phase descriptions address value creation, resource providers, proof generation, transition management and metrics to measure progress.

THE TECHNOLOGY COMMERCIALIZATION ROADMAP

Researchers and practitioners have proposed and use a variety of technology commercialization models. Many of these models focus on a discrete component of the commercialization process such as technology development, product development, licensing or venture creation. Less specialized models span the entire process from basic research and idea generation to market entry and business growth. Fortunately, despite the rapid proliferation of new models and related nomenclature, we found considerable consistency, particularly with regard to the phases of technology commercialization.

We developed the following roadmap, the Technology Commercialization Roadmap, from our extensive research into the literature on technology commercialization processes and best practices. We adopted certain terminology, concepts and graphics from the work of Vijay Jolly in his 1997 book *Commercializing New Technologies: Getting from Mind to Market*. The Jolly model addresses the entire continuum of technology commercialization from pre-commercial activities through product introduction and improvement. The Jolly model emphasizes the role and importance of transitions (Jolly refers to them as bridges). We augmented Jolly's model with the thinking and research of leading academics and practitioners, and we reference these academics and practitioners throughout this report.

The following graphic illustrates our characterization of the Technology Commercialization Roadmap in its simplest form.



The Roadmap contains five phases. Each phase overlaps with the prior and subsequent phases. The phases are *Imagining, Incubating, Demonstrating, Market Entry and Growth & Sustainability.* The overlapping areas of the circles graphically represent the four critical transitions between phases. The concepts of phases and transitions provide a convenient way to segment the process into sets of activities with common goals. The process also includes a measurement framework for identifying and applying a system of metrics. The measurement system is not visible in the graphic. We will discuss each phase, transition and the related measurement system in detail later in this section.

The Concepts of Phases and Transitions

The process organizes commercialization activities into phases and transitions. The primary objective of the activities within a particular phase is proof – specifically, the production of information that provides proof acceptable by a resource provider to determine whether to invest time, money or other resources in the commercialization effort. The type of proof varies based on the phase of development, the industry, the nature of the project and the resource provider. Proof is always tailored to the needs and wants of the targeted resource providers.

A transition, the movement of a project from one phase to the next, has two components – the event itself and the activities that culminated in the event. The event occurs when resource providers provide the investment necessary to perform the activities defined by the next phase of the commercialization process. The activities are part of an ongoing process to leverage

proof to attract required resources. Transition activities begin during the proof generation process. The exact point in time (early or late in the phase) is dependent on nuances of the industry, project and resource providers.

Transition activities are most analogous to traditional sales activities and processes. In sales, companies leverage the characteristics, functions and features of their products or services to convince a potential buyer (resource provider) to make a purchase. In transition activities, participants leverage proof of technological capability, market potential and related information to convince a resource provider to make an investment (purchase) in the form of time, money or other required resources. To accomplish an effective transition, participants must clearly understand the targeted resource providers, and more importantly, the proof they require as a condition to investment. Successful commercialization is about successful transitions. As with sales, a larger market measured in terms of the number of potential customers (resource providers) dramatically improves the odds of success. After all, in most sales situations, only a small percentage of potential customers choose to buy. In context of the prospect of investing in a technology commercialization opportunity, potential resource providers do not have to search for reasons to hold on to their wallets.

A Measurement Framework

Metrics play two very important roles. First, they help define the desired outcome of the particular project or program. Second, they provide a mechanism for accountability. Rather than specific metrics (which are unique to individual projects), we propose the application of a measurement framework to develop project-specific metrics for short-term and long-term project performance evaluation.

The framework consists of three categories of metrics – *Level A, Level B, and Level C*.

Level A Metrics are direct evidence of project success demonstrated by a transition (resource acquisitions). For the most part, *Level A Metrics* are objectively determinable and easy to measure. One of the major pitfalls in determining *Level A Metrics* is looking too far into the future of the overall commercialization process – beyond the bounds of the current phase and the next transition.

Consider measurements for a Wright Center of Innovation. Wright Centers are collaborative R&D entities that combine research organizations (universities or research institutes) with

corporations focused on a specific application area such as fuel cells or regenerative medicine. The purpose of a Wright Center is to develop a technology so that a commercial entity will incorporate the technology into a product or process and introduce it to the marketplace. An example of *Level A Metrics* for a Wright Center is:

Level A Metric

• Self-sustaining levels of revenue from licenses and from research funded by public and private sources
• Development of technologies with commercial potential that impact Ohio as measured by:
  ▪ A license or sale of technology or
  ▪ A private equity investment to commercialize the technology

Level B Metrics are tangible evidence that the project is on the path to achieving *Level A Metrics*. *Level B Metrics* are the most challenging to identify. As with *Level A Metrics*, *Level B Metrics* also measure an investment by potential resource providers. Rather than the investment that triggers the transition (the *Level A Metric*), the *Level B Metrics* measure the level of interest of potential resource providers. A project should satisfy *Level B Metrics* only with evidence that a potential resource provider is seriously considering an investment. The most obvious evidence of a *Level B Metric* would be a term sheet which details the terms of a proposed investment and commits the resource provider to a defined set of diligence activities within a specified period. As a rule, investors only issue term sheets after conducting substantial diligence. Of course, potential investors can demonstrate serious interest prior to the issuance of a term sheet. For a corporate resource provider, serious interest might take the form of ongoing meetings with senior business development executives or ongoing meetings with management or operating personnel who own the P&L that would be affected by the investment. A serious commitment to diligence would also represent a *Level B Metric*. Unfortunately, however, these "softer" measures of commitment provide the project team with a powerful opportunity for self-delusion. "Good meetings", even with senior executives or investors, are frequently not evidence of interest or commitment. Further, deciding whether a meeting is a "good meeting" is extremely subjective, especially in context of the unbridled enthusiasm and optimism of most project proponents/champions. As a result and whenever possible, *Level B Metrics* should be tied to tangible and unambiguous evidence of interest and increasing commitment.

An example of *Level A* and *Level B Metrics* for a Wright Center is:

Level A Metric	Level B Metric
• Self-sustaining levels of revenue from licenses and from research funded by public and private sources • Development of technologies with commercial potential that impact Ohio as measured by: – A license or sale of technology – A private equity investment to commercialize the technology	• Research funding from commercial sources in the form of collaborations as well as contract research. • Scientific research funding from federal, state and private sources

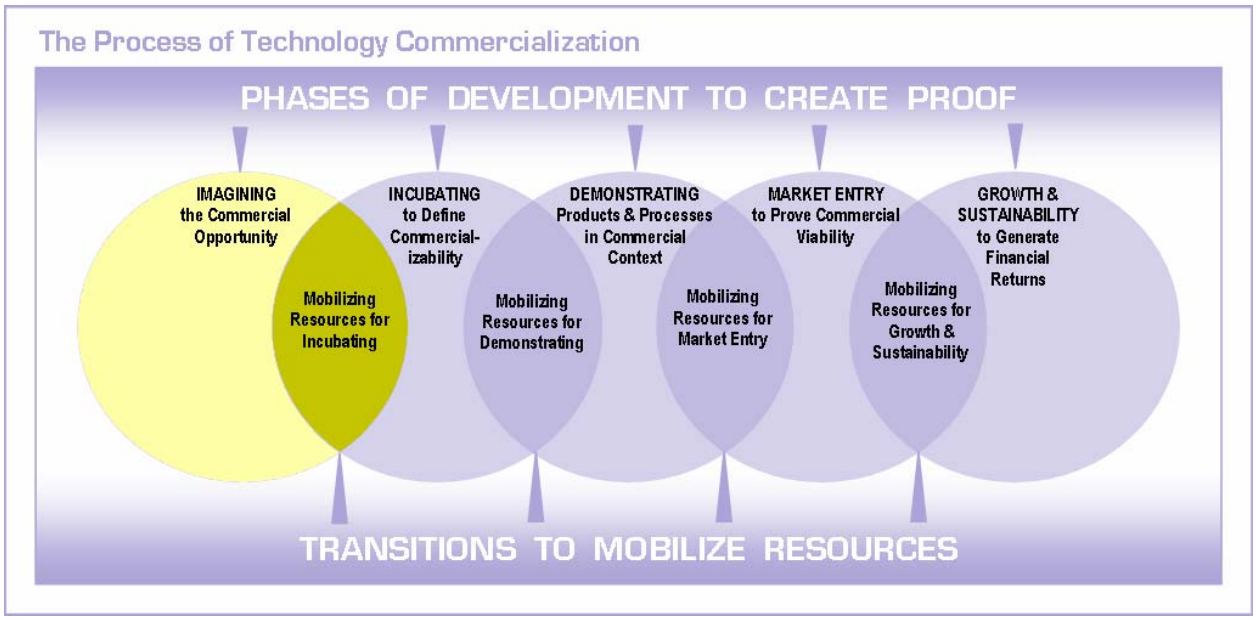
Level C Metrics measure the results and key activities of the short-term operations of the project. The successful performance of these activities is important to the success of the commercialization initiative, but it does not independently provide validation of progress towards the goal of transition or commercial success. Examples of activities to be measured with *Level C Metrics* include hiring qualified personnel, filing patent applications, preparing business plans and conducting certain types of experiments. The achievement of in-phase partnering relationship, the receipt of additional capital to fund in-phase activities or the achievement of certain financial milestones could qualify as *Level C Metrics*. In the case of patent filings or experiments, filing the patent or conducting the experiment would be considered activities to be measured by *Level C Metrics*. Depending upon the circumstances, however, the granting of the patent or the results of the experiment could be considered *Level B Metrics* if, for example, a potential resource provider made the patent grant or the results of the experiment a condition to investment. *Level C Metrics* simply measure whether the project team is performing the types of activities typically associated achieving the results measured with *Level B or Level A metrics*.

An example of *Level A, Level B* and *Level C Metrics* for a Wright Center is:

Level A Metric	Level B Metric	Level C Metric
• Self-sustaining levels of revenue from licenses and from research funded by public and private sources • Development of technologies with commercial potential that impact Ohio as measured by: – A license or sale of technology – A private equity investment to commercialize the technology	• Research funding from commercial sources in the form of collaborations as well as contract research. • Scientific research funding from federal, state and private sources.	• Invention reports, patent applications and patents with commercially valuable claims.

In the following sections, we describe each phase and transition and include example metrics.

IMAGINING THE COMMERCIAL OPPORTUNITY



Phase Description -- Imagining

The *Imagining Phase* begins when a technological capability and a market need become connected. This phase, and the entire commercialization process, starts when scientific knowledge or technical capability is linked in some way to a "job to be done" (Christensen, 2003) that represents a market need[11]. The linkage can start as nothing more than the belief that a specific technology can be applied to solve a specific problem[12] or that a specific market would value a solution that was better, cheaper, easier to use, or more convenient. Because of the high degree of technical and market uncertainty, this phase is characterized by iteration. False starts and dead-ends are common. Given the difficulty of matching technical

11 Most research and business practices support the idea that commercialization does not begin until the establishment of a connection between a technology and a market need. An alternative view is articulated by researchers at Sandia National Labs (Myers 2002), who have characterized a three-stage technology development model based on their experience in developing and commercializing new technologies that have the potential to change markets. During the first stage, they develop a technical proof of concept independent of commercial application. During the second stage, they attempt to establish the viability of the technology for at least one potential commercial application. This second stage is analogous to *Imagining Phase* in our process. During the third stage, they "cross the chasm" and establish the innovation as the solution of choice for the majority of buyers.

12 A technology in search of a market need is not included in the definition of imagining as the connection between the technology and the need has not been made. For example, a technology that makes a specific material more durable is not a commercial opportunity until the technology can be applied to a market opportunity where increased durability of that material is needed and sufficiently valued in the marketplace.

capabilities to anticipated or proposed performance specifications (developed on the basis of loosely defined market needs), iteration is unavoidable. The goal is to produce technical and business concept proof deemed sufficient by *Incubating Phase* resource providers. Not surprisingly, the in-phase search for adequate resources is also a significant challenge, especially during the *Imagining Phase*.

Sony is well known for its ability to innovate. In a speech in 1988, Kozo Ohsone described the imagining process as applied at Sony[13]:

> "We always have an image of how an ideal product would look and perform in our minds. This is not dreaming on our part, but a concrete plan for which exact product specifications have been drawn up. Unfortunately, it is usually impossible for us to begin producing this idea version of our product immediately. Instead, a step-by-step plan must be formulated to guide us in reaching our goal. There are a number of factors which determine how quickly this can be accomplished, but the three most important ones have always been size, weight and performance. In order to reduce the size and weight of our Walkman without sacrificing quality, we had to develop new integrated circuits, batteries, motors, recording heads and transport systems, and to fit everything into a case the size of a cassette tape."

How Value Is Created in the Imagining Phase

Combining a technological capability and a market need in such a way that it results in the identification of a commercial opportunity is the first step in value creation. Value accumulates over time as the project successfully addresses the technical and market issues associated with the opportunity. Value becomes tangible when the resource provider for the next phase commits to provide resources, the most reliable evidence of the commercial value arising from the connection between technology and need. Prior to that recognition, the perceived value is not tangible and has no verifiable economic worth.

Estimating the upside potential of an opportunity during the *Imagining Phase* can be very difficult, particularly when the opportunity involves a new technology that offers currently unavailable capabilities or when the approach to the market (strategy) represents a departure

13 This quote was taken from Jolly 1997 as referenced in Sony, The Case of the Walkman (Tokyo: Sony's Innovation Management Series 1, June 1998) p. 7.

from the way customers are currently served. Collectively, the uncertainty of the technology, people, and market requires the resource providers to make many assumptions in order to place a value on the innovation. The value at this stage is highly speculative. One researcher estimates that it takes 3000 raw ideas (techno-market insights) to produce one successful business[14]. It is therefore no surprise that validation and resources are hard to come by during the *Imagining Phase*.

Activities in the Imagining Phase

To attract the resources necessary to fund the proof requirements of the next phase (Incubating), the project team must develop a business concept and demonstrate proof of principle.

Proof of Principle[15]

In general, a proof of principle is the demonstration in a laboratory setting of critical components of the technology that enable the core functionality of the commercial application. During this phase, the technical proof does not generally include manufacturability, production costs or reliability. The proof involves the successful application of basic scientific and engineering principles to the solution of basic components of a specific problem.

Proof of principle varies significantly depending upon the business sector as shown in these examples:

- In the life sciences, the term ''proof of principle'' is achieved ''when a compound has shown the desired activity *in vitro* that supports a hypothesis or concept for use of compounds" (Branscomb 2000).
- In software development, the term "proof of principle" has been described as "teams work simultaneously on all phases of the problem. The analysis team generates requirements. The design team discusses requirements and feeds back complexity issues to the requirement team and feeds critical implementation tasks to the implementation team. The testing team prepares and develops the testing environment based on the requirements... One of the goals of this stage is for the

14 Stevens (1997) estimates that 3000 raw ideas translate into 300 "Ideas Submitted", 125 "Small Projects", 9 "Early Stage Developments", 4 "Major Developments", 1.7 "Launches" and 1 "Success".

15 An in-depth discussion of technical risk reduction, including proof of principle, is provided in Branscomb 2003.

teams to convince themselves that a solution can be accomplished" (Branscomb 2000).

Business Case

The development of a business case during the *Imagining Phase* is also critically important to moving the project forward. In the *Imagining Phase*, the business case is the first compelling articulation of the commercial concept. The business case provides the description of the market need (the "job to be done") in sufficient detail to convince *Incubating Phase* resource providers to fund the project. The business case also provides a guide for subsequent technology and product development. The components of a business case are determined in part by the nature of the opportunity, the sector involved and the technology. In general, a business case would include the following:

- A description of the market need or "job to be done"
- A definition of the target market segments
- An articulation of the value proposition (the value to be generated from the person or entity with the "job to be done")
- A description of the current mechanisms for performing the "job to be done", including a brief discussion of existing competitors or substitutes
- A definition of the structure of the value chain (providers of capabilities necessary to make, sell, deliver and support the product or service, including, but not limited to, manufacturing, distribution, warehousing, transportation and servicing)
- An estimate of the cost structure, profit potential and required capital

Unlike a traditional business plan, the business case delivered during the *Imagining Phase* does not include items such as management team, detailed pro-forma financials or detailed calculations of required financing. These and other aspects of the business concept will be left to the proof in later phases.

Resource Providers in the Imagining Phase

The resource providers in the *Imagining Phase* provide the capabilities, infrastructure and funding needed to generate the proof required by the resource providers in the *Incubating Phase.* The *Imagining Phase* resource providers are typically "owners", non-profit institutions or public entities. "Owners" have rights to the inputs or have a claim on the outcome of products of the *Imagining Phase* activities. Examples of "owners" in the *Imagining Phase* are corporations, universities, research institutes, and/or inventors-entrepreneurs. Non-profit institutions or public

entities include federal, state or foundation programs designed to stimulate innovation or achieve other program goals relating to technology commercialization or economic development. Angel investors and venture capitalists rarely provide funding during the *Imagining Phase*.

Not surprisingly, funding for *Imagining Phase* activities (and for *Incubating Phase* activities) is extremely difficult to find. The commercial concept is highly speculative and the technology has not been tested in context of a commercial application. Commercial resource providers cannot and do not fund *Imagining Phase* projects since they cannot effectively quantify uncertainties and draw conclusions about the full potential value of the innovation (Branscomb 2002). This leaves owners, non-profits and public entities (each of whom has other reasons to provide funding) to support *Imagining Phase* activities.

Even in context of owner, non-profit or public funding, the initial funding for Imagining Phase activities tends to resemble bootstrapping. Bootstrapping generally refers to internal funding sources. Projects that reside within private companies typically compete for incremental resources from existing research or business development budgets. Those employees who manage these projects and resources allocate discretionary funds to keep projects moving. Projects that originate inside universities or research institutions often seek funding from university budgets, the federal government or from private corporations who sponsor particular types of basic or applied research. Projects that originate with entrepreneurs and do not have the luxury of tapping into an organization's existing budgets or applying for government grants tap into their own personal assets as well as "friends and family." In none of these cases is the funding abundant or easy to access.

During the last ten years or so, states have begun to fill some of the gap in funding available for *Imagining* and *Incubating Phase* activities. Noting the lack of funding, the State of Ohio helped form validation funds. The validation funds are venture funds, generally associated with a public entity or research institution. The validation funds typically fund business concept development, the early stages of applied research, legal fees for patent applications and other similar activities. The goal of the validation funds is to provide recipients with the capital to generate sufficient proof to attract other funding, public or private. Validation funds typically limit their investments to under $250,000, with an average investment in the range of $50,000 to $150,000. Although we found little research to estimate the benefit of this type of funding, we did come across a study of a validation fund program in Sweden (Klofsten 1999). The program invested

approximately $3 million USD from 1994 to 1996 in 132 firms. The investments ranged from $6,000 to $30,000. According to the study, the program funding significantly increased the probability that the recipient would receive an investment from a third party (possibly akin to a next phase resource provider).

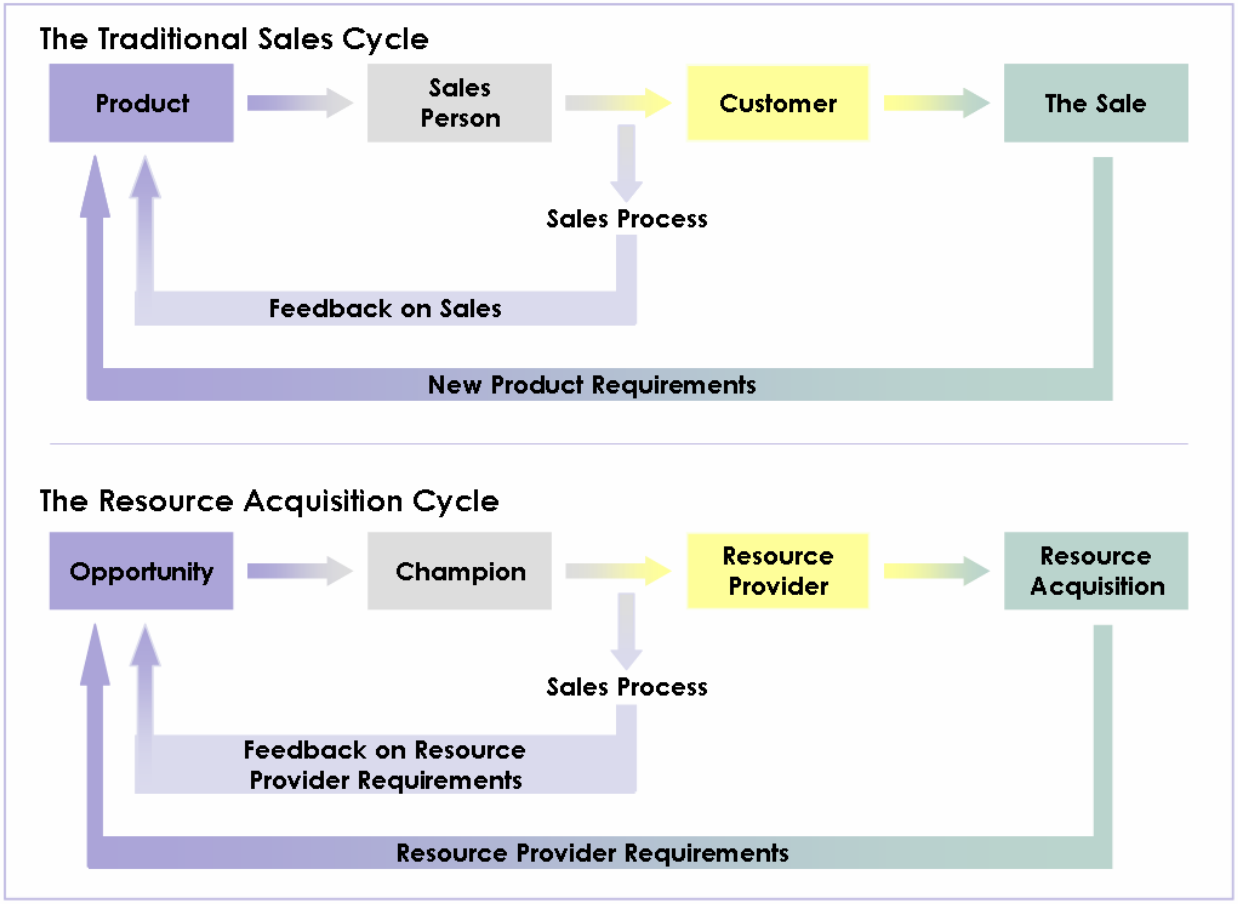
It is important to note that not all required resources are cash or cash equivalents. Especially during the *Imagining Phase* and *Incubating Phase*, other resources may prove critical. Expertise that provides assistance, validation, new ideas and creative solutions to problems is often a critical component of required proof. Required resources also sometimes take the form of specialized facilities for testing or laboratory work.

Transitioning to the Next Phase -- Incubating

The resource acquisition process (obtaining the resources required to conduct *Incubating Phase* activities) is largely a sales and marketing process. To carry the analogy a step further, the product is the commercial concept/opportunity. The target market is the set of potential resource providers. Market research takes place when the project team contacts potential resource providers to learn their requirements for proof. Product development is the equivalent of the in-phase activities or proof generation. The compelling product features/functions (those the customers value in making a purchase/investment decision) are the fundamental aspects of the business concept bolstered by the proof generated by phase activities. The customer needs ("job to be done") are the unique institutional goals and objectives of the resource providers. The sales person is generally a combination of the champion and the current resource providers[16].

16 The champion and other team members learn about the requirements of the *Incubating Phase* resource providers and then focus the *Imagining Phase* project to deliver the proof needed to help the *Incubating Phase* resource provider achieve his or her goals. In essence, the project (including its technology, its commercial opportunity and all its resources and capabilities) is "sold" in the figurative sense into the next phase of development. The *Incubating Phase* resource providers are "buying" the project into their phase because they see it as a way to achieving their goals, whatever those goals may be.

The Analogy Between Sales and Resource Acquisition



The transition activities start early. Champions contact *Incubating Phase* resource providers and support networks when they believe the value proposition is sufficiently concrete to engage a resource provider in a serious discussion. By "sufficiently concrete", we mean backed by some level of proof that the potential resource provider is likely to find interesting, even if the proof is not yet sufficient to merit an investment. These conversations help the champion to align in-phase activities with the needs of the next phase resource providers. As with market research, however, these contacts provide some of the best information available regarding customer/resource provider needs. The information is not, however, foolproof. Market research is an inexact science. Customers/resource providers frequently cannot provide the researcher with objective guidance on whether a particular product, set of features or proof will be compelling. Nevertheless, meaningful interaction with potential resource providers generates the best available information on their proof requirements.

Gaining access to potential resource providers is not always easy. Access and meaningful dialog often hinge on the salesmanship, enthusiasm and evangelical zeal of the champion. And, as noted several times, not all required resources are financial. For example, contact with and the active participation by other researchers who can validate the basic technology and provide solutions to technical challenges is often a critical aspect of proof. At the same time, however, the champion must convince these non-financial resource providers to devote time and energy to the project. Finally, because the process is anything but objective, the chance of a successful transition often depends on the number of quality dialogs the champion can develop with potential resource providers. Any single resource provider can, and often does, decide against investment for reasons external to the opportunity and internal to the resource provider.

Having established the dialog and identified the desired proof, the transition challenge turns back to effective project management. Iteration between the technology development project plan and market needs/business concept is constant in this early stage. Champions frequently have to develop new project plans, reallocate resources and change the mix of capabilities in order to respond to the proof requirements (Vohora 2004, Jolly 1997).

Leadership is the least tangible of the transition activities, but can determine success or failure. Given the constant change in direction, the need for an ongoing sales process, the uncertainties of early stage technology development and the changing market and competitive factors, effective leadership is often the only thing holding the opportunity together[17].

Metrics for the Imagining Phase

The *Level A Metric* is the acquisition of the resources necessary to engage in *Incubating Phase* activities. The primary *Level B Metrics* are tangible evidence that potential resource providers are seriously considering an investment. An example of a *Level B Metric* would be a term sheet from an angel investor or an indication that the project has been named a finalist for a grant or other similar award. Secondarily, some of the proof requirements may also qualify as *Level B Metrics* if the proof causes potential resource providers to increase their commitment of time and resources devoted to diligence and related activities. These secondary metrics are tough

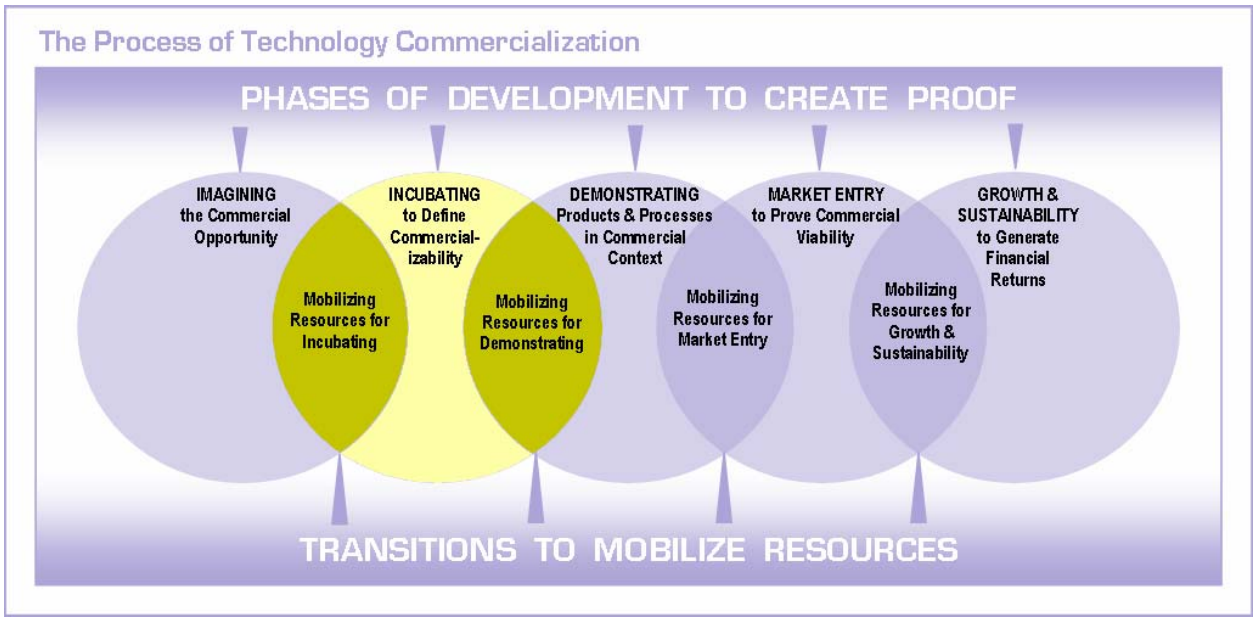
17 Markham (2001, 2002) has researched champions extensively and concluded that projects (particularly early stage projects) with champions are critically important to the commercialization process.

to measure and present enormous potential create the illusion of progress where no progress is occurring. The *Level C Metrics* are extremely project specific. They measure day-to-day activity often in context of the tasks or milestones of a project plan.

Phase	A Metric	B Metric	C Metric
Imagining (Transition to Incubating)	The funding to move to the *Incubating Phase*	Tangible indications of interest by potential resource providers. Possibly, technology or business case milestones.	Determined by project plan (tasks and milestones).

It is important to note that financial measures such as NPV and IRR are not relevant metrics to quantify value at during the Imagining phase. Even pro-forma financials are too speculative to provide useful proof. Financial valuations at this phase tend to be heavily discounted and are unlikely to build a positive business case that would be helpful in achieving funding for *Incubating Phase* activities (Loch 2002).

INCUBATING TO DEFINE COMMERCIALIZABILITY



Phase Description -- Incubating

Incubating is the phase in which the following first occur: definition of technical and product performance specifications; validation of technical capabilities in context of the performance specifications; and initial validation of the market opportunity. The performance specifications and validations are "first generation" and will be subject to continuing refinement and validation in later phases. During *Incubating*, project teams typically focus on developing more refined technical and market proofs. In this phase, the project team applies basic scientific and engineering principles to the solution of specific problems. At the same time, the project team begins to validate the marketplace and customer needs by using good market research practices. Other typical activities include prototype development, market research, and alpha and beta testing. Research and development during this phase is "applied", not "basic".

An example of this phase is articulated by Rob Kuhling, a partner with ONSET Ventures (Roberts 2004):

> "The basic principle of what we do is to take as much risk out of the equation for as little money as possible in as short a period of time as we can. This means something different each time, depending on the business model and the industry. In medical devices, the early risk reduction points are proving that the technology works in animals, proving it works in humans, and then demonstrating that it can obtain FDA approval."

Commentators have assigned a number of names to this phase to emphasize the enormous challenge inherent in transforming an idea (*Imagining Phase*) to a first generation product (*Demonstrating Phase*), and, as difficult, acquiring the resources to do so. The commentators use terms such as "Valley of Death" and "Darwinian Sea" to characterize this challenge. With few available resources, intense competition for those resources, the substantial sums often needed to fund the journey, and the inefficiency of the marketplace (connecting ideas/opportunities to resource providers), the commentators' characterizations are frighteningly accurate.

How Value Is Created in the Incubating Phase

As Jolly (1997) tells us, "No technology- based idea is intrinsically commercializable. It has to be made so." The invention must be validated and shaped into a business plan with potential for revenue and profit. During the *Incubating Phase*, value creation occurs as the invention goes through a rigorous technology development protocol resulting in a working model. The length of time and the resources required are a function of the type of technology, the degree of newness of the application, the targeted sector and the experience and expertise of the people and organizations attempting to do the work. Elements of the protocol may include proving the technology via a working model, developing a set of relevant applications for the technology, subjecting the soundness of the concept to a peer review journal, showing how the technology can be manufactured at an appropriate scale and at a reasonable cost, and validating that the technology can work with other interfacing technologies, products and/or parts (Branscomb 2000). It should be noted that even after significant laboratory testing and validation, assessing the value of the idea during this phase continues to be very subjective as the technology is still insulated and protected from marketplace pressures (Branscomb 2000, Jolly 1997).

To create value, the project team must prove the viability of the product and maximize its expected value before significant time and resources have been allocated. Resource providers focus on the project team's ability to validate the technology and business case in a timely and cost effective manner. The resource providers often use the validation as a "go/no go" decision relative to investment. Conversely, failure to create sufficient value at this phase is an early indicator that the technology is not ready to move forward and that commercialization efforts should be abandoned. Most *Incubating Phase* projects fail to move forward (Stevens 1997).

In certain industries (e.g. pharmaceuticals, medical devices, instruments and controls, etc.), IP protection becomes a critical factor in resource acquisition. Although patents and related IP rights provide little evidence of progress towards commercialization, they can dramatically impact the magnitude of the commercial opportunity. The plan to protect the invention using patents and/or trade secrets is therefore an important part of value creation in the *Incubating Phase*. A patent, a freedom to operate opinion or similar events can also have a material impact on the project's ability to attract non-financial resources, such as collaboration by other researchers or commercialization partners. Patent applications also facilitate sharing technology and/or prototypes as part of technology or commercial validation. As Lane (1999) notes, "If [the development team] is unwilling to protect or properly disclose [the technology] then the [commercialization] process is likely to end."

Moving beyond *Incubating* is extremely challenging. More often than not, *Incubating* activities provide the evidence needed to "pull the plug" and move on. Unless key metrics are met and laboratory value translates to marketplace potential, there is no reason to continue the commercialization process. As with other phases, the only way to establish this value with reasonable certainty is the transition. If the opportunity attracts the necessary resources to perform *Demonstrating Phase* activities, the value has been established.

Activities in the Incubating Phase

This phase has two specific goals: to reduce the technical risk by demonstrating key performance characteristics, at least in the laboratory; and develop a comprehensive business plan to better define the business risks and provide a plan for mitigating those risks as the product approaches the market.

Reduction to Practice

Technical risk reduction[18] in the *Incubating Phase* is often referred to as "reduction to practice," and is defined by Branscomb (2000) as:

> "Reduction to practice means that a working model of a product has been developed in the context of well-defined and unchanging specifications. Product design and production processes can be defined that have sufficient ''windows'' for variability as to constitute a reliable product made through a high yield, stable process. In simple English,

18 An in-depth discussion of technical risk reduction, including reduction to practice, is provided Branscomb 2000.

> the technical risk has been sufficiently reduced when the innovator-entrepreneur can say to his managers and investors, ''Yes, I can do that, and do it at a cost and on a schedule in which we can all have confidence.''

As with the "proof of principle" discussed earlier, the term "reduction to practice" takes on sector-specific meaning. For example, in software, it is referred to as the ''prototype'' stage (or alpha version). One commentator described the stage as follows: ''The requirements and the requirement document are frozen and placed under change-order control. Changes in requirements are still allowed but should be very rare… One of the goals of this stage is for the team to convince non-team members that the solution can be accomplished." (Branscomb 2000).

Business Plan

During the *Incubating Phase*, the project team can better define the market risk, and can outline a plan for mitigating the risk, but can do little to actually reduce the risk. The business plan is the mechanism the team uses to define the risk and describe mitigation strategies. The *Incubating Phase* business plan is the first credible attempt to describe in detail the path to commercial success. During this phase, the project team conducts secondary, and in some cases, primary research to validate aspects of the market opportunity. The plan must demonstrate good business practice and judgment consistent with the sector and this phase of commercialization.

Because of the abundance of quality guides to the preparation of business plans, we chose not to provide a "how-to" guide on business plan preparation. A quality business plan that credibly presents the opportunity and the team behind the opportunity is nevertheless a condition to transition at all phases of commercialization.

Resource Providers in the Incubating Phase

Incubating can be extremely resource intensive in terms of both the quantity and diversity of required resources. The high cost of incubating and the high level of technical and market risk combine to create what is often referred to as the Early Stage Funding Gap (Brancomb 2000).

The Early Stage Funding Gap

This gap starts in the *Imagining Phase* and extends, in some cases, into the *Demonstrating Phase*. Vohora (2004) describes the funding gap and the overall difficulty of transition (which he calls "critical junctures") as follows:

> [W]e suggests that a venture's inability to overcome each critical juncture arises due to three key deficiencies. First, is the scarcity of a particular physical, financial, human or technological resource. Second, is an insufficient level of social capital to enable information and resources to be acquired or even accessed through either a partnership or alliance relationship with another resource provider. Finally, inadequacies in the internal capabilities required by the venture to employ resources and knowledge productively to enhance its performance and value may exist. We further propose that although these weaknesses and inadequacies are generic across all critical junctures, the nature of the required stocks of resources, social capital and internal capabilities differs across each dependent upon the phase of development ....

In essence, Vohora points to the inadequacy of resources (financial, social, physical and technological).

Why is there an Early Stage Funding Gap? The answer lies partly in understanding the difference between the goals of research funds and investment funds. Public and non-profit sources of research funding target discovery and invention. Investment funds target commercialization and investment return. Research funds measure productivity in terms of invention reports, patents and scientific insights. Investment funds measure productivity based on investment return. Neither research funds nor investment funds have as their objective the creation of commercial innovations. This gap in objectives is one of the root causes of the Early Stage Funding Gap[19].

Early Stage Funding Sources

The amount and sources of funding available to fill the early stage funding gap is not well established in the literature. A recent NIST (National Institute of Standards and Technology) study

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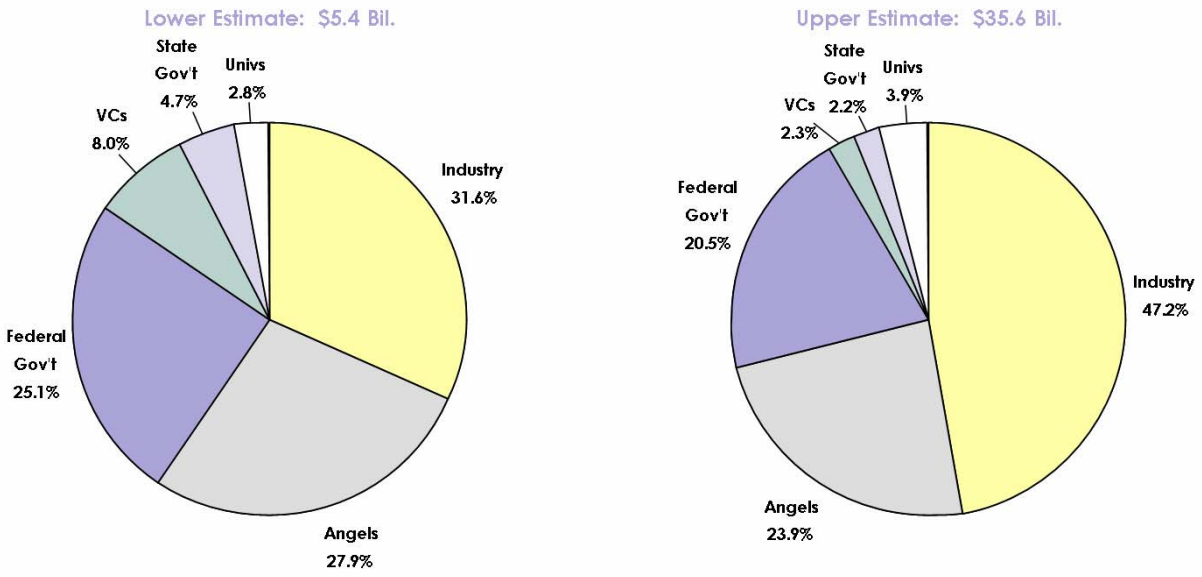
19 According to Sohl (1999), the Early Stage Funding Gap is driven by two other market inefficiencies -- capital and information. The capital gap is nothing more than the demand for high risk capital exceeding the supply (the cost to successfully commercialize a radical innovation is at least 10 times the cost of the original research). The information gap is the inefficiency of matching private investors with investment opportunities. It is a time consuming process to match the two resulting in "promising deals being overlooked or prematurely discarded."

estimated the range of funding invested in early stage projects at between $5 and $37 billion as of 1998. The following graphic from the NIST report estimates funding by source. For the purposes of this report, "early stage projects" are the equivalent of *Imagining* through *Demonstrating Phase* projects. The NIST study based the lower and upper estimates on alternative definitions of early stage technology development activities.

Estimated distribution of funding sources for early-stage technology development, based on restrictive and inclusive criteria



Note: The proportional distribution across the main funding sources for early-stage technology development is similar regardless of the use of restrictive or inclusive definition criteria.

Source: Branscomb 2002, p. 23.

According to the NIST study, the three largest providers of financial resources for early-stage technology development are industry, angels and the Federal government. Although industry appears to be the largest funding source, much of industry's funding is for internally generated opportunities. Given the size of industry's investment and the trend in certain industries to shift from internal R&D to partnering with third parties to perform basic or applied research, we believe industry may become a more important funding source for *Incubating Phase* activities. At this time, however, industry is not likely to be the primary source of capital for early stage technology development.

By comparison, the Federal government has historically been the primary funding source for basic research. In addition to basic research, the Federal government has a number of programs (SBIR, ATP, CRADA, SBTT) in addition to direct R&D contracting that provide funds for early stage technology development (Bodde 2004).

The relative surprise in terms of the magnitude of investment for early-stage technology development is angel investors. As noted by commentators, angels do not, as a rule, invest in the *Imagining Phase*. The technology risk is too high and the business concept too speculative. As a result, the impact of angels is felt most during the Incubating and *Demonstrating Phase*s. As a group, angels are predominately affluent, well-educated, middle-aged successful entrepreneurs and business owners who tend to invest in the industry in which they made their money. Angels invest for both financial return and personal reasons that include economic development, mentoring and diversion (fun). Many angels become actively involved in their investments either directly or through a surrogate angel. They tend to invest close to home defined as a half-day travel time. They prefer high-growth opportunities. Angels tend to operate independently but frequently participate in loosely joined networks or alliances. They invest patiently with a 5-7 year time horizon (Freear 2002, Sohl 2003). Angels can, and frequently do, serve as a conduit to additional sources of capital (e.g. other angels, industrial investment or venture capital).

Angel investment frequently qualifies as "new, smart, meaningful money" since angels bring personal involvement and expertise that provides some validation of the commercial concept. They also make personal investments that are meaningful in the context of the size of their investment portfolio. Angels have traditionally provided substantially more financing to new commercial concepts (*Incubating* and *Demonstrating Phase*) than have venture capitalists. Sohl (1999) estimates that the current US market of angel investors numbers about 350,000, with an annual investment of $30 billion in 50,000 deals, an investment size ranging from $100,000 to $2 million with 6-8 investors per deal.

Transitioning to the Next Phase -- Demonstrating

As with the transition from *Imagining* to *Incubating*, the transition from *Incubating* to *Demonstrating* is fundamentally a sales process conducted by the project champion and fueled by the proof generated with *Incubating Phase* activities. A project team's ability to acquire these resources, and the mechanisms for such acquisition, are highly context sensitive. Potential resource providers are the source of the required proof. Typical proof steps include construction

of a prototype that performs near commercial specifications, early implementation with commercial test partners (alpha testing), and achievement of certain regulatory milestones or other steps that appear to reduce and/or define the remaining technical or market risk. *Demonstrating Phase* resource providers have less appetite for technology risk than *Incubating Phase* resource providers. At the same time, the *Demonstrating Phase* resource providers have a greater appetite for business concept validation (e.g. the size of the market, the alignment of the market need and the proposed product, the precise mechanism for executing the business strategy etc.).

Combining an increasing need for resources, especially cash, with a relatively high degree of risk, this transition is extremely difficult. As noted with the transition from *Imagining* to *Incubating*, the project team must understand the market of resource providers. If the team cannot generate a relatively large number of opportunities to connect with targeted resource providers, the likelihood of transition is low even if the opportunity is otherwise compelling. Context-specific drivers of success might include:

- a strong regional network of angel investors with experience in the target industry
- strong existing relationships with corporate investors
- a well-established track record of related successes
- the ability to leverage existing investors or other strong relationships to access new resources.

As also noted, the targeted resource providers often focus their investment regionally, so the project team's assessment of potential resource providers should have a local or regional focus.

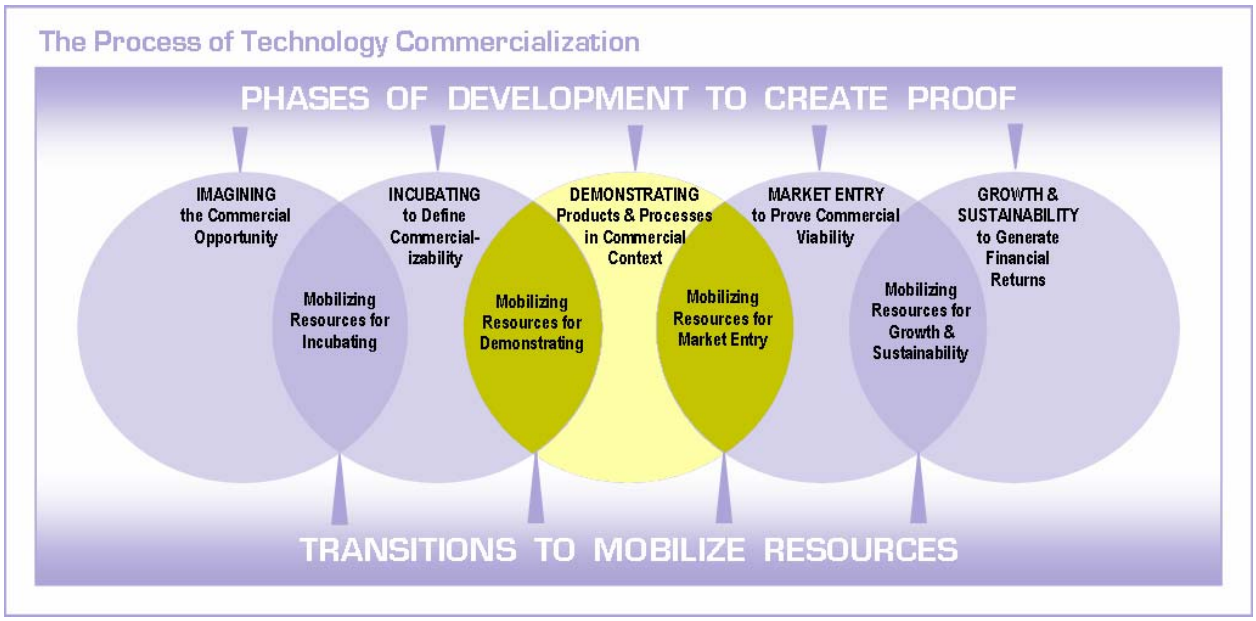
Metrics for the Incubating Phase

The *Level A Metric* is the acquisition of the resources necessary to engage in *Demonstrating Phase* activities. The primary *Level B Metrics* are tangible evidence that potential resource providers are seriously considering an investment. An example of a *Level B Metric* would be a term sheet from an angel investor group. Secondarily, some of the proof requirements may also qualify as *Level B Metrics* if the proof causes potential resource providers to increase their commitment of time and resources devoted to diligence and related activities. Tasks or milestones that reduce technical risk, improve the business plan or confirm the alignment of the product and the market need may qualify as *Level B Metrics*. While tempting to use the completion of the business plan as a *Level B Metric*, the only credible evidence regarding the quality of the business plan is the acquisition of resources (the *Level A Metric*). These secondary

metrics are tough to measure and present enormous potential to create the illusion of progress where no progress is occurring. The *Level C Metrics* are extremely project specific. They measure day-to-day activity often in context of the tasks or milestones of a project plan.

Phase	A Metric	B Metric	C Metric
Imagining and Transition to Incubating	The funding to move to the *Incubating Phase*	Tangible indications of interest by potential resource providers. Possibly, technology or business case milestones.	Determined by project plan
Incubating and Transition to Demonstrating	The funding to move to the *Demonstrating Phase*	Tangible indications of interest by potential resource providers (for example, a term sheet from an Angel investor). Possibly evidence of a "reduction to practice".	Determined by project plan

DEMONSTRATING PRODUCTS AND PROCESSES IN COMMERCIAL CONTEXT



Phase Description -- Demonstrating

The *Demonstrating Phase*, is when the project team generates proof in a more tightly defined commercial context. Specifically, the proof focuses on whether the products and processes are consistent with the commercial context. Typical examples of proof are whether the product can be produced at or around a target cost, whether the product can perform to commercial specifications, and whether target customers want to buy the product at or around projected price points. In other words, this phase answers questions such as can we build it, does it work and will customers buy it? This phase is one-step short of full market introduction, but it uses many of the same resources.

An excellent example of the challenges of the *Demonstrating Phase* is the story of RCA's Selectavision VideoDisc. The development program started in 1964 to develop an audio-visual player to sell for less than $500 and could run affordable prerecorded programs as had become the norm in the audio business. Market surveys clearly established the need for such a device. After pursuing several technologies, RCA settled on the capacitance-grooved disc as the best solution. The product was launched in 1981 (17 years after the program started!) and was introduced at $499 with discs priced between $15 and $25 at retail. The product failed despite providing a superior quality picture. By 1981, the videocassette recorder had been introduced, and although inferior in quality, it provided the customer with the option record their own programs (Jolly 1997).

How Value Is Created in the Demonstrating Phase

An important characteristic of the *Demonstrating Phase* is that the focus shifts from the technology to the product's end user (Jolly 1997). Correspondingly, value creation in this phase has a similar focus that includes the following:

- Satisfaction of customer needs
- Manufacturability
- Cost and time to complete development
- Cost to distribute
- Performance to commercial specifications
- Market acceptance (customer purchase and use)
- Value chain support (manufacturing, distribution, service, etc.)

Value is created when the project team sells "market ready" versions of the product to early adopters, charges prices close to those anticipated in the business plan and obtains customer feedback deemed compelling by potential resource providers (e.g. why did they buy, what else did they consider, is it meeting the need, would they buy again, etc.). The project team must also make substantial progress in defining and generating commitment from necessary participants in the value chain. As always, context dictates the specific nature of the proof outlined above.

Activities in the Demonstrating Phase

In this phase, the project team/business must generate proof relative to the foundational assumptions in the business plan. The team must produce a market ready product for a cost at or near target assumptions (or have a credible plan to achieve these costs at scale production). The product must perform in accordance with design specifications[20]. The project team must generate evidence that the targeted customers (those identified in the business plan) will pay at or near anticipated prices for the product. The project team must also generate evidence of the potential for increasing sales. The resource providers will also expect the project team to be able to credibly characterize competitors and substitutes. In sum, the market acceptance goals include successful user testing under real conditions, commitment from the distribution channels to support introduction, and initial product sales at prices that represent a viable gross margin

20 A major area of activity in the *Demonstrating Phase* is product design and development. Robert Cooper and others have thoroughly researched the new product development process for which there is considerable documentation on best practices in the literature (Cooper 2001, 2002, 2003).

under reasonable volume assumptions.

Resource Providers in the Demonstrating Phase

This mix of target resource providers (those who can provide resources to perform *Market Entry Phase* activities) now includes corporations, angel investors and venture capitalists. Although the project team must devote a great deal of attention to the acquisition of financial resources, the team must also gain the commitment of value chain partners (e.g., product design firms, development experts, marketing firms, manufacturers, distributors and others). During this phase, the focus begins to shift. Formerly, the resource providers and project team devoted a majority of their attention to the question of whether the technology worked and performed to specification. The focus now shifts to the question of whether the business model works. The involvement of value chain partners on terms that enable the project to generate anticipated margins is a critical point of proof. Without this proof, resource acquisition is unlikely.

Transitioning to the Next Phase -- Market Entry

This transition involves leveraging the proof generated during the *Demonstration Phase* to acquire the capital, expertise and other resources necessary to fund proof generation during the *Market Entry Phase*. As noted, resource providers look to the *Demonstration Phase* to generate proof through market activities. Relevant proof includes items such as actual sales at prices that represent a viable level of gross margin, customer endorsement of the value of the product or service as compared to current alternatives, and external indicators of market size. In most industries, the *Market Entry Phase* resource providers will not assume significant technical risk and will require tangible evidence regarding the market opportunity. Context, as always, is important. Although these resource providers are not as geographically constrained as the resource providers in prior phases, geography is still a significant factor. The number of venture capitalists or strategic investors located in the region is frequently a driver or inhibitor of success. At a minimum, success depends on the ability of the participants to gain credible access to resource providers. If the participants lack a direct relationship with resource providers and cannot find a credible entrée to the resource providers, the odds of success decrease dramatically.

The sales analogy is particularly applicable in connection with this transition. The business plan is the sales document. The business plan should directly address the proof outlined above. While the proof requirements often vary by resource provider, the proof required by the *Market Entry* resource providers is fairly uniform. Their focus is on the magnitude of the business opportunity.

They act on the basis of tangible evidence of product performance, market acceptance, customer recommendations and other early indicators of success.

Despite the increasing levels of business proof, the competition for resources is intense. Corporate investors and venture capitalists often sort through hundreds or even thousands of business plans before making an investment. Venture capitalists are notoriously particular in making an investment decision. A fact deemed compelling by one VC can be, and often is a deal killer from the perspective of another. The project team/business should not make the mistake of assuming the investment process is objective. People make the decisions. People have biases and frequently make decisions based on these biases. *Demonstration Phase* opportunities still include enormous risk. Potential investors do not have to search for reasons not to invest. As a result, the project team/business must again focus on its ability to present the opportunity to a relatively large number of qualified resource providers. In the absence of a large number of credible introductions to qualified resource providers, the likelihood of success is low.

Corporate investors present the challenges described above and two additional challenges. First, the opportunity must compete against internally generated projects and opportunities. The champions of these internal projects are known to the decision makers. For this and other reasons, corporations frequently assign a higher level of certainty to the projected results/returns to be generated by these internal projects. Second, the corporate investors will pay special attention to whether the opportunity fits with the corporation's strategic direction. Corporate investors commonly decline to invest in otherwise attractive opportunities because of a lack of perceived alignment with strategic direction. As with the VCs, the only way to mitigate this risk is to approach a relatively large number of corporations. If the region lacks a concentration of corporations with an interest in the industry targeted by the opportunity, the likelihood of success decreases (Paytas 2004).

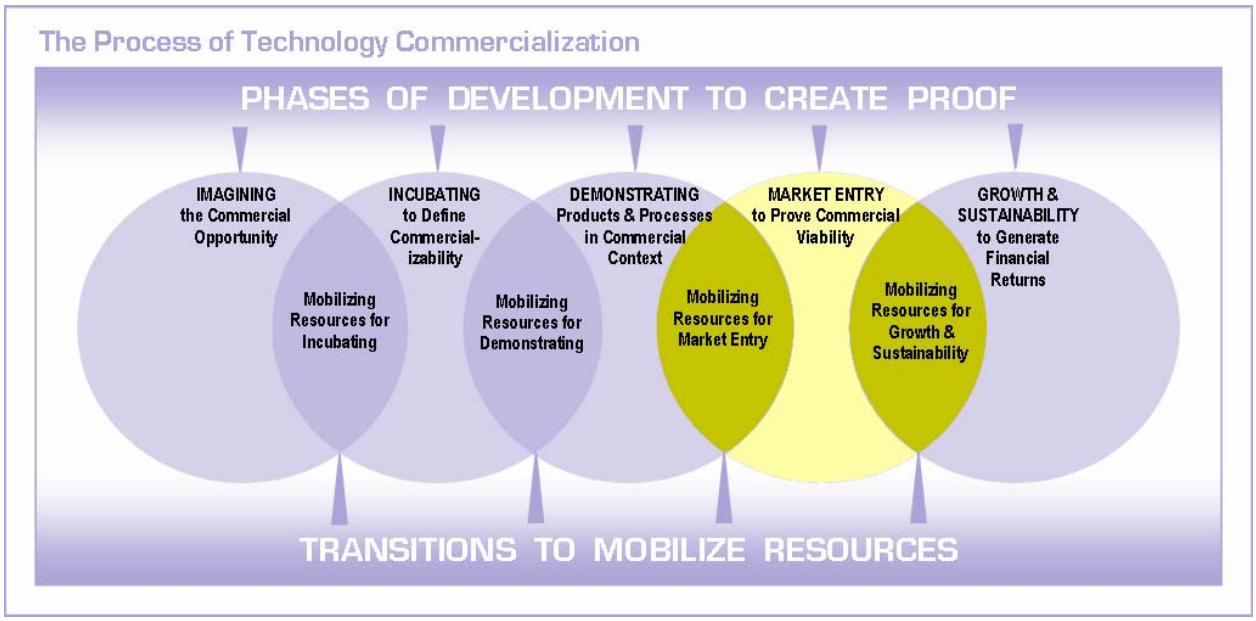
Metrics for the Demonstrating Phase

The *Level A Metric* is the acquisition of the resources necessary to engage in *Market Entry Phase* activities. The primary *Level B Metrics* are tangible evidence that potential resource providers are seriously considering an investment. An example of a *Level B Metric* would be a term sheet from venture capitalist or corporate investor. Secondarily, some of the proof requirements may also qualify as *Level B Metrics* if the proof causes potential resource providers to increase their commitment of time and resources devoted to diligence and related activities. Tasks or

milestones that confirm customer acceptance, evidence sales momentum, establish manufacturability at target costs or other similar proof steps may qualify as *Level B Metrics*. While tempting to use these criteria for *Level B Metrics*, the only credible evidence regarding the probative nature of these factors is the acquisition of resources (the *Level A Metric*). Sometimes, the level of diligence or interaction can considered a *Level B Metric*, since, as noted, VCs generally do not engage in discussion or diligence with the vast majority of companies that submit business plans. As noted, however, these secondary metrics are tough to measure and present enormous potential to create the illusion of progress where no progress is occurring. The *Level C Metrics* are extremely project specific. They measure day-to-day activity often in context of the tasks or milestones of a project plan. The *Level C Metrics* during the *Demonstration Phase* include project plan tasks, but they can also include the achievement of interim business milestones.

Phase	A Metric	B Metric	C Metric
Imagining and Transition to Incubating	The funding to move to the *Incubating Phase*	Tangible indications of interest by potential resource providers. Possibly, technology or business case milestones.	Determined by project plan
Incubating and Transition to Demonstrating	The funding to move to the *Demonstrating Phase*	Tangible indications of interest by potential resource providers (for example, a term sheet from an Angel investor). Possibly evidence of a "reduction to practice".	Determined by project plan
Demonstrating and Transition to Market Entry	The funding to move to the *Market Entry Phase*	Tangible indications of interest by potential resource providers (for example, a term sheet from an VC or a marketing and distribution agreement with a corporate partner)	Determined by project plan

MARKET ENTRY TO PROVE COMMERCIAL VIABILITY



Phase Description – Market Entry

Market Entry is the phase during which participants develop and execute a market entry strategy that establishes the market and financial viability of the product or business. In this phase, the project team/business uses resources to scale production, service, distribution and marketing. This phase generates the proof required to validate the viability of the business opportunity driven by the product. The objective is to generate positive business metrics (e.g. growth, profits, cash flow, etc.). With these positive metrics, the project team/business generates two possible scenarios relating to resource acquisition. In the first scenario, as in prior phases, the resource provider funds the activities in the next phase – Growth & Sustainability. In the second scenario, the resource provider funds a profitable exit (profitability to be measured from the perspective of existing equity holders), usually in the form of an acquisition. As with other phases, the proof is specific to targeted resource providers.

How Value Is Created in the Market Entry Phase

The primary distinction in proof between an opportunity that attracts the resources necessary to engage in *Growth & Sustainability Phase* activities and one that is more suited to resources in context of a profitable exit is whether the product/technology can fuel a wide variety of new and profitable business opportunities. If so, the opportunity may attract the resources necessary to transition to the *Growth & Sustainability Phase*. If the opportunity is growing and profitable,

but the technology does not fuel a wide variety of new and profitable business opportunities, then an acquisition/profitable exit is the most likely result.

Activities in the Market Entry Phase

As noted, proof in the *Market Entry Phase* consists primarily of generating those business metrics that confirm the viability of the business. Specifically, the team must demonstrate the ability to scale production within tightly controlled cost parameters, generate predictable and increasing sales, handle customer service and generate the standard list of business metrics traditionally used to determine whether or not a business is at least viable, or at most, the core of a high growth, diversified opportunity.

Resource Providers in the Market Entry Phase

The list of resource providers that invest in the performance of *Growth & Sustainability Phase* activities are venture capitalists, banks, strategic buyers/acquirers, the public financial market (an IPO) and the market itself (through increasing sales leading to revenues, profits and cash flow). While venture capitalists or other private equity funds sometimes fund acquisitions, the primary resource provider for a profitable exit is a strategic buyer/acquirer in the form of an existing company.

Transitioning to the Next Phase -- Growth & Sustainability (or to a Profitable Exit)

The transition to Growth & Sustainability involves leveraging the proof generated during the *Market Entry Phase* to:

- Acquire the financial commitments and contractual agreements from essential members of the value chain to expand distribution;
- Reduce manufacturing costs;
- Provide the level of service and support needed for revenue and margin growth to achieve the financial returns required for long term viability of the business; and
- Confirm that the underlying product or technology can serve as the platform for a large number of related products and services.

This transition is almost solely dependent on the financial success of the *Market Entry* activities. Companies may achieve financial success for all stakeholders in the *Market Entry Phase*, but never transition to a self-sustaining organization. If the company meets all of the criteria listed above except for the last one, the company can still generate an attractive return for all shareholders, but it must look to an exit in the form of a sale or merger. As noted, these mergers,

if timed properly, can generate positive returns for all stakeholders. Few companies ever achieve sustainability measured in terms of increasing growth and profitability over a relatively long time period (a decade or more).

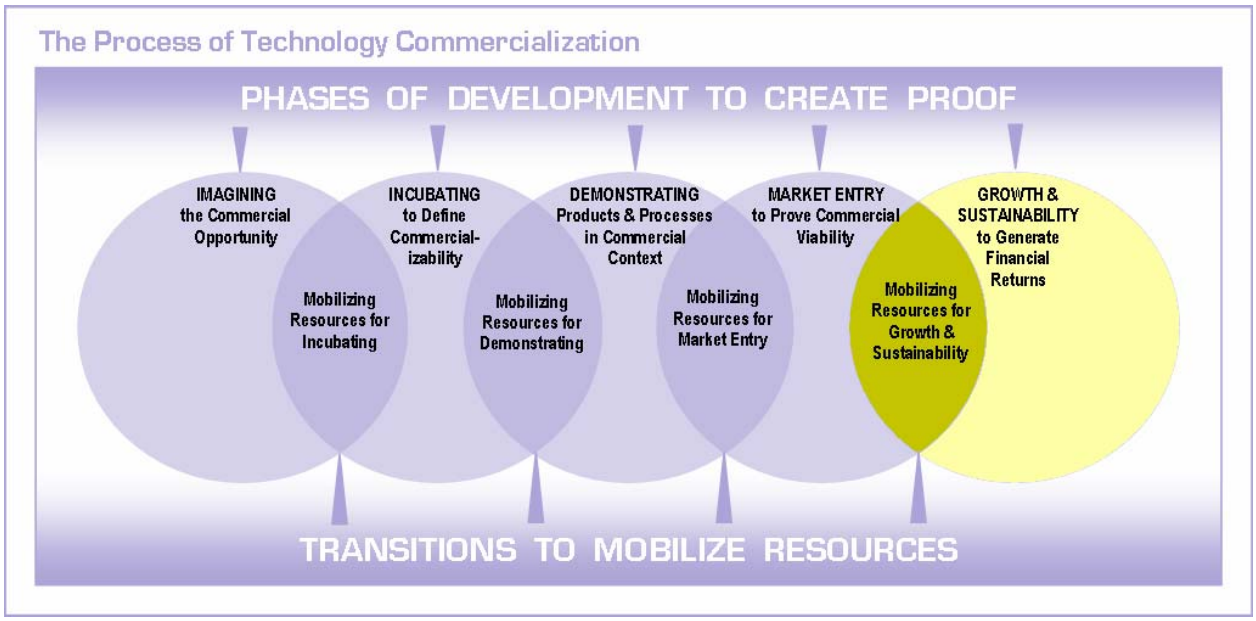
In both cases, the company must initiate the equivalent of a sales process to attract the targeted resource providers. In the case of transitioning to the *Growth & Sustainability Phase*, the company will leverage existing financial performance and assets to attract the necessary funding. In some cases, the financial performance of the company will speak for itself – as in negotiating with the bank for a line of credit or asset-backed loan. If, however, the company desires a venture capital investment, the company will have to pursue a sales cycle similar to that described in connection with the prior transition, with one major difference. Since the proof of technical and business viability is now primarily generated by the market, the risk is reduced. As a result, the market for resource providers (venture capitalists) will not be as geographically constrained as in prior phases.

Metrics for the Market Entry Phase

The *Level A Metric* is the acquisition of the resources necessary to engage in *Growth & Sustainability Phase* activities or to consummate a profitable exit. The primary *Level B Metrics* are tangible evidence that potential resource providers are seriously considering an investment. In addition, however, a *Level B Metric* at this advanced stage of commercialization could be standard metrics of financial performance since resource providers now begin to look at financial performance as a primary factor in making an investment. If, however, the objective is a sale of the company, then the primary *Level B Metric* would be a term sheet. The *Level C Metrics* are again company specific. They measure day-to-day activity often in context of the tasks or milestones of a project plan. At this phase, however, interim financial metrics or other company specific tasks associated with ramping up production, accelerating sales, improving service or other similar activities might qualify. The strategic objectives are to enhance the competitiveness of the product through product improvements, line extensions, and new distribution channels to position the product for continued growth and to take full advantage of the opportunity.

Phase	A Metric	B Metric	C Metric
Imagining and Transition to Incubating	The funding to move to the *Incubating Phase*	Tangible indications of interest by potential resource providers. Possibly, technology or business case milestones.	Determined by project plan
Incubating and Transition to Demonstrating	The funding to move to the *Demonstrating Phase*	Tangible indications of interest by potential resource providers (for example, a term sheet from an Angel investor). Possibly evidence of a "reduction to practice".	Determined by project plan
Demonstrating and Transition to Market Entry	The funding to move to the *Market Entry Phase*	Tangible indications of interest by potential resource providers (for example, a term sheet from an VC or a marketing and distribution agreement with a corporate partner)	Determined by project plan
Market Entry and Transition to Growth & Sustainability	The funding to move to the *Growth & Sustainability Phase*	Tangible indications of interest by potential resource providers (for example, a term sheet from an VC, a loan from a commercial bank, the acquisition of the product by a competitor or partner)	Determined by project plan

GROWTH & SUSTAINABILITY TO GENERATE FINANCIAL RETURNS



Phase Description – Growth & Sustainability

Growth & Sustainability is the phase characterized by executing on a comprehensive business plan to increase market share and/or total revenue and profit in context of a self-sustaining business. The objectives, value creation mechanisms and resource providers are those typically associated with a thriving business seeking to identify opportunities for growth and increased profitability. While the challenges are substantial, a detailed discussion of this phase is beyond the scope of this report.

3 ANALYTICAL FRAMEWORK

INTRODUCTION TO THE ANALYTICAL FRAMEWORK

The first section of this report (Background) provides information important to understanding the process of technology commercialization and addresses the link between innovation and value, the fundamentals of technology commercialization, and the success drivers. The second section (The Commercialization Process Roadmap) provides a detailed description of the Phases, Transitions and Measurements of the technology commercialization process. This section (Analytical Framework) builds on the prior sections and provides a six step process to assist the user in developing a plan to move to the next phase of commercialization.

The Framework focuses on the issues that affect the transition from one phase of commercialization to another. The current literature lacks a coherent description of the transition process, yet transition activities are critical (and sometimes determinative) in moving projects towards the market. Successful commercialization is about successful transitions, and this analytical framework focuses on the mechanism of successful transitions.[21]

HOW TO USE THE FRAMEWORK

The Frameworks consists of the following six steps:

Step 1 Identifying the appropriate phase of commercialization.

Step 2 Identify the resource providers required to fund the next phase of commercialization activities.

Step 3 Determine the proof required by targeted resource providers.

Step 4 Identify the contextual factors that are likely to have a material impact on the chances of resource acquisition.

Step 5 Determine the appropriate measures of success.

Step 6 Develop a plan to produce the proof and pursue the transition.

21 The creation of a credible business plan is a vital step in the commercialization process. This framework does not attempt to replicate or add to the existing body of knowledge and practices for the development of a business plan. We assume that the project team possesses or can access the expertise and experience to perform the various forms of analysis required to develop a project plan and a business plan appropriate to the phase and the needs of the phase-specific resource providers.

Step 1 – Identifying the Phase

To determine the location of the project within the technology commercialization process, participants must first analyze the current state of proof. As explained in Section 2 (The Commercialization Process Roadmap), proof fits into two distinct categories – technology/product development and commercial concept development. Generally speaking, the least developed category of proof dictates the phase. In other words, if the business plan appears to be more advanced in its proof (relative to resource provider requirements) than the technology, then the technology dictates the phase. The stage or status of technology development and commercial concept development are strong indicators of the degree of progress towards commercialization, recognizing that a precise determination is not always possible.

Especially in the earlier phases, the precise status of proof is difficult to define. Another clue regarding the project's location within the technology commercialization process is the identity of those resource providers who have provided the majority of project funding to date. For example, if the participants believe they are in the Market Entry Phase, but the project has yet to attract private capital from venture capitalists or industry, the participants should consider whether the transition from the Demonstration phase to the Market Entry phase has actually occurred.

Technology Development

The following chart provides some general guidance regarding the types of technology proof associated with the activities in the individual phases:

Phase	Technology Proof
Imagining	Proof of Principle
Incubating	Reduction to Practice
Demonstrating	Commercial Product
Market Entry	NA
Growth	NA

In attempting to determine whether the project has generated the types of proof listed in the table above, the project team may find it useful to consider the following. First, during the earlier phases (*Imagining* and *Incubating*), a substantial portion of the proof, testing and validation is internal. By internal, we mean that project team members or existing partners/resource

providers generate a great deal of the development work, testing and feedback. As the technology moves through the commercialization process, the proof, testing and validation takes on an external focus. Specifically, potential customers become the source of the proof and validation. The location of the testing moves from the lab and controlled environments to customer sites.

The following questions are characteristic of *Imagining Phase* technology development:

- Is the science understood?
- How and why does the technology work?
- Has the technology achieved laboratory proof of principle?
- Is there a reasonable likelihood of achieving reduction to practice?
- If embedded in the product concept, is the technology reliable?
- Is the innovation free to operate within its targeted markets or is it constrained by existing patents or other forms of intellectual property?
- Are there dominant patents that impact this technology?
- What is the plan to protect this technology and what is the status of those actions?

The following questions are characteristic of *Incubating Phase* technology development:

- Does the project team understand the technology well enough to adapt it to market needs?
- Has the project team completed the patent and literature search and do they have freedom to operate?
- Has the project team secured adequate protection for the technology and related applications to allow for market introduction?
- Has the project team reduced the technology to practice in the form of a working model based on well-defined and unchanging specifications?
- Has the project team developed product design and production processes that would appear to support the manufacture of a reliable product?

The following questions are characteristic of *Demonstrating Phase* technology development:

- Have the target technical product specifications been determined?
- Is there a well-defined stage gate process in place to support the management of the design and development process?
- Is the technology, as embedded in the commercial product, reliable?

- Has the project team incorporated feedback from lead users[22] into the design?
- Has the project team addressed system integration issues?
- Has the project team identified all necessary design and manufacturing processes required to support market entry?
- Has a pilot run demonstrated functionality consistent with the product concept definition?
- Are the facilities adequate for near-term production?

These lists are representative of the types of questions that the project team should ask and answer at the particular phases of development. For additional guidance on the phase of technology commercialization, refer to Section 2 (The Commercialization Process Roadmap).

Commercial Concept Development

The following chart provides some general guidance regarding the types of commercial concept proof associated with the activities in the individual phases:

Phase	Commercial Concept Proof
Imagining	Business Case
Incubating	Business Plan
Demonstrating	Market Entry Plan
Market Entry	Growth Plan
Growth	NA

In the earlier phases, most of the evidence or validation of the business case is indirect.[23] Solid business principles, secondary market research, logic, analogies and similar information form the foundation for the business case. As the project proceeds to later phases, market feedback begins to provide the validation of the business case. Potential and current customers become the source of the feedback.

22 The term "Lead users" is not well defined in the literature. It can refer to those customers who are the initial purchasers of new technology called "innovators" by Moore in his book *Crossing the Chasm: Marketing and Selling High-tech Products to Mainstream Customers*, or lead users can be customers who due to their size and market position can set the commercial direction for the product such as a system integrator, a marketing firm with large share or a distributor who can drive product selection at the end user level. Either way, the role of the lead user is to provide reliable input on the specifications, functionality, features and packaging of the product to ensure successful market entry.

23 Sustaining innovations (incremental improvement in the performance of existing products) may represent an exception to this generalization.

In addition to the information contained in Section 2 (The Commercialization Process Roadmap), the following questions are representative of each of the indicated phases. The following questions are characteristic of an *Imagining Phase* business concept development:

- Has the project team clearly linked a technology to a "job to be done"?
- Has the project team identified competitive alternatives to the use of the technology to perform the "job"? [24]
- Has the project team identified targeted market segments?
- Has the project team identified unique and differentiated benefits that are likely to be valued by targeted customers?
- Can the project team articulate a value proposition for the product?
- Does the project team possess a general understanding of the required value chain relating to the product?
- Can the project team estimate the cost structure and potential profit potential?

The following questions are characteristic of an *Incubating Phase* business concept model (business plan):

- Has the project team clearly articulated the product concept in sufficient detail to enable product design and development processes to begin?
- Has the project team characterized the market for this product through industry acceptable market research techniques?
- Is the opportunity large enough, growing fast enough and profitable enough to support the anticipated investment?
- Has the project team identified the value chain and defined a credible mechanism to obtain required relationships with value chain participants?
- Has the project team prepared a comprehensive business plan?
- Has the project team submitted the business plan to potential resource providers or other third party reviewers for feedback?

The following questions are characteristic of a *Demonstrating Phase* business concept (market entry plan):

24 Ulwick has identified three distinct types of inputs that are fundamental to the innovative process and its successful execution: determine the jobs the customers is trying to get done; the outcomes the customer is trying to achieve when performing these jobs in a variety of circumstances; and the constraints that stand in the way of the adoption of a new product or service (Ulwick 2004).

- Has the project team characterized the market for the product through industry acceptable market research techniques and can the team quantify the opportunity in terms of growth and profitability potential?
- Does the project team possess a credible plan for obtaining the participation of critical value chain members?
- Have early customers provided credible and positive feedback relating to the functionality and value of the product?
- Has the project team begun to generate sales to target customers at or near projected prices?
- Can the project team clearly articulate the sales/distribution strategy, and has the project team begun to generate tangible evidence that the strategy will be effective?
- Is the product ready for general release, determined in terms of performance characteristics, reliability, manufacturability, service and related criteria?

If the analysis of technology/product and commercial concept is inconclusive, the project team can then refer to the status of the project relative to the major milestones in the project plan for additional guidance. Performance against milestones may provide insight into the degree of development of both technology/product and commercial concept, but should not be a starting point because of serious questions regarding the use of an internal plan as a proxy for validation of commercialization progress.

On a final note, the foregoing analysis lacks specific guidance regarding the *Market Entry* and *Growth Phases*. As noted throughout this report, success during these phases depends more on traditional business metrics[25] than on the principles outlines in this report. As a result, we chose to omit a detailed analysis of these latter phases.

Step 2 – Identifying Potential Resource Providers

Given the project's current location in the technology commercialization process, the project team must then identify the resource providers who are most likely to fund the next phase. The table of *Resource Providers by Phase of Commercialization* lists those resource providers typically associated with funding the activities within each Phase.

[25] Traditional business metrics are the financial and operating measuring that on-going businesses use to measure performance.

Resource Providers by Phase of Commercialization

Commercialization Phase	Resource Providers
Imagining	• Owners/Founders • Corporations • Public and non-profit research programs many of which receive funding from the Federal government (e.g. foundations and universities).
Incubating	• Corporations • Angel investors • Federal programs • Venture capitalists, universities and state governments provide funding for Incubating to a much smaller degree.
Demonstrating	• Corporations • Angel investors • Venture capitalists
Market Entry	• Corporations • Venture capitalists • Angel investors
Growth	• Corporations • Venture capital • Commercial lenders • Public markets

While the table provides a useful starting point in the identification of potential resource providers for the project, the project team should ask the following questions to qualify the list and determine whether the project team can reasonably secure access to such providers:

- What type of resource provider (angel, venture capitalist, company, etc.) has the project team identified as the best fit for the project or most receptive to projects of this type?
- What is the rationale for the identification of the targeted resource providers?
- Has the project team been able to validate the rationale through multiple conversations or meetings with intermediaries or others knowledgeable in resource acquisition?
- After listing the targeted providers, the project team should attempt to evaluate its access to resource providers with questions such as:
  - Does the region possess a substantial number of the targeted resource providers?
  - Do the regionally based targeted resource providers know the technology, product or market?
  - Do the regionally based target resource providers have a history of investing in similar opportunities at a comparable stage of commercialization?
  - Does the project team have a direct connection with the resource providers (i.e. a credible entrée)?
  - Does the project team have indirect connections to the resource providers through other relationships?

The purpose of these questions is three-fold. First, the questions help the project team understand the most likely sources of resources. Second, the questions help the project team determine whether the market of potential resource providers (generally geographically constrained, especially in the earlier phases and usually constrained by experience and track record within a narrow set of industries) is large enough to ensure a reasonable number of opportunities to obtain resources. Third, the questions help the project team determine whether it will be able to secure a credible entrée to a significant portion of the targeted resource providers. Simply put, the existence at a national or global level of a large number of potential resource providers is not helpful to the project if the region lacks an abundance of those providers and the project team has little ability to access those providers.

Angel Investors:

An excellent example of the fit between projects and resource providers is the profile of angel investors. Angels have a well-documented limitation of investing in industries and/or technologies with which they have had prior success and experience. They also tend to invest in deals that are within a one-half day travel radius and often look for opportunities to interact with the company on a regular basis.

Step 3 – Determine the Proof Requirements

The ultimate decision on proof requirements to support a project is made by the resource provider (the investor). Most resource providers can articulate in detail the criteria they generally apply to determine whether a particular investment fits within the scope of their investment parameters. These articulations usually include factors such as company size and stage of financial development (e.g. pre-revenue, post-revenue, pre-profitability, post-profitability, etc.) Other typical factors speak to targeted industries, degree of technology risk, completeness of management team, and geographic preferences, among others. To the project team, these factors are useful, but are merely a starting point. These factors represent the first level filter the resource provider applies to potential investments but they do not speak to the specific proof the resource provider will deem persuasive in making an investment decision.

The specific proof emerges from the interaction between the resource provider and the project team. If the project team/champion manages to make it through the first level filters and captures the interest of the resource provider, a dialog begins. The resource provider will

conduct an analysis of the project, typically evaluating the technology, the product, the market, the people, the competition, the financing and the financial projections to determine whether to make an investment. In many cases, the resource provider identifies gaps in the plan that require additional proof. These gaps are the origin of the proof requirements that stand between the project team and an investment.

Of course, those who haves been through the process have experienced that the interaction and analysis is less than scientific. First impressions, emotions, experience, competition for the resource provider's resources (and time) and a host of intangible factors often play an important role in the investment decision. Since the project team cannot control these external and subjective factors, the project team must adopt a strategy to mitigate the uncertainty that they introduce. The first step in this strategy is a simple numbers game. The project team must do whatever it can to ensure contact, feedback and interaction with as many resource providers as possible. The second step is more straightforward. The project team must consider the proof requested by the potential resource provider, determine if the proof is attainable and then attempt to build and manage a relationship with the resource provider that leads to an investment. This relationship building is the sales process referred to throughout this report in connection with transition activities.

One of the many challenges for the project team or champion is the selection of the point in time to initiate contact with potential resource providers. The champion should initiate communication early enough to provide useful feedback to the project team to ensure the commitment of scarce resources. However, initiating contact too early has the potential to undermine the credibility of the opportunity since the opportunity at that time may fall too far outside the resource provider's filters. To manage this challenge, the project team may wish to consider consultation with intermediary organizations (public or private). Consultants, publicly funded business assistance organizations, attorneys, accountants and others often act as filters or proxies for resource providers. These organizations and individuals can often bridge the gap and provide relatively precise guidance regarding proof requirements.

Step 4 – Identify Contextual Factors

In Step 4, the project team's focus shifts from the technology and commercial concept to an assessment of the market of resource providers who might be willing to invest in the project. More specifically, the project team must evaluate the unique obstacles it faces and the advantages it possesses to obtain the resources required to transition to the next phase. Despite

a compelling commercial concept based on validated technology, a host of other factors, both external and internal, may present insurmountable challenges to securing desired resources.

The purpose of this context analysis is to provide the foundation of the resource acquisition strategy and plan that drives the transition activities. As noted throughout this report, transition activities are fundamentally a sales process. The project is the product, the resource providers make up the market, and the solicitation and communication with potential resource providers is the sales and distribution process. We organized the context analysis into four sections: product, market, sales and distribution, and competition. To illustrate this context analysis, we use a hypothetical example of a project with technology to produce fuel cell batteries for cell phones.

Product

For the most part, the project stands on its own. The technology and related commercial concept possess a defined set of attributes relative to competitive technologies within the same industry. Of course, in the market for resources the project also competes with technologies and commercial concepts in completely different industries. For directly competitive opportunities, the project team must attempt to understand as completely as possible existing technologies as well as other projects targeting the development of competitive solutions. The project team cannot change the competitive environment, but it can attempt to position the opportunity as well as possible. Knowledge of direct competition is critical to this positioning. For purposes of our analysis, competition is the relevant contextual factor.

> ***Example – The Product***
>
> The product is a fuel cell power source for devices such as cell phones, PDAs and laptops. As currently contemplated, the application for cell phones must provide 20 hours of talk time and 100 hours of standby time before requiring a recharge. The project currently has a functioning prototype and a comprehensive business plan supported by primary market research.

Market

The "market" in this case is the universe of resource providers who typically invest in projects like this one. The market changes over time and is a function of geography, sector, and the phase of commercialization. For example, angel investors typically limit their investing to a locality or

region that they can reach with less than one-half day of travel. Angels tend to focus on industries in which they have prior experience and they work with projects that are in the *Incubating* and *Demonstrating Phases*. Venture capitalists generally will travel further than angels will, but they frequently have self-determined geographic limitations. Most venture capitalists focus on a limited set of industries, and they invest primarily in the *Market Entry* and *Growth Phases*, although early and seed stage venture capitalists sometimes invest in *Demonstrating Phase* activities.[26] Federal agencies that fund research operate on a national basis but largely focus on R&D of interest to their agencies. The federal government is one of the larger providers of funding to *Imagining* and *Incubating Phase* activities. Federal research programs tend to be more focused on research than commercialization. In contrast, federal contract research tends to focus on technology applications that meet unique program needs (e.g. energy, defense, environment, etc.) and may have commercial application, usually with modification.

The primary questions in measuring contextual factors that affect the size and availability of the resource provider market are:

- If the targeted resource providers are geographically constrained, how many targeted resource providers exist in the project team's region?
- Of the targeted resource providers who meet the geographic constraint, how many, if any, focus on or have a track record of investing in the project team's industry?
- Can the project team and/or champion gain access to these resource providers by virtue of a direct relationship, indirect relationship, reputation or other link?
- Is the amount of desired resources consistent with the historical size of investments by the targeted resource providers?

With intense competition for resources and the enormous impact of subjective factors on resource decisions, the odds of success with any single resource provider are low. The only way to mitigate this risk is to gain access to a relatively large number of resource providers. If the targeted group of potential resource providers is small in number, the project team may face an insurmountable hurdle, even with a relatively compelling technology and commercial concept. As noted many times, a resource provider does not have to look hard to find a credible reason to not invest. This is true for providers of financial resources as well as other needed resources, including, but not limited to resources such as expertise and specialized facilities.

[26] Early and seed stage venture capitalists often display similar characteristics to angel investors in terms of geographic focus.

Example -- The Market

To validate market acceptance, the project needs $1,500,000 to fund commercial design, product development and customer trials with major battery suppliers.

The targeted types of investors are venture capitalists and corporations who may want access to the technology. Over 50 venture firms have previously invested in portable battery technology, but only ten of those have experience with fuel cells and fifteen have access to cell phone suppliers. Of the ten venture firms that have prior experience in fuel cells, only two have previously invested in a portable battery technology. Of the five major battery companies, none has any experience with fuel cells other than internal R&D projects. In addition, each of the five major suppliers of cell phones has expressed interest in fuel cell power.

The project team is located in Ohio. About half of the targeted venture firms have offices within reasonable proximity to the project team. One of the battery companies in located in Ohio. Only one of the major cell phone suppliers is located close to Ohio, but all five have demonstrated a willingness to enter into product development alliances with smaller firms, independent of geography.

Sales & Distribution Channels

The "Sales & Distribution Channels" refer to whether or not the project team/champion can efficiently and credibly tap into the market of resource providers described in the "market" section immediately above. In other words, does the project team have access to resource providers or networks of resource providers either directly or through others? Does the project team have the credibility based on prior experience in the field and/or based the current project to get access to and the attention of the resource providers? Does that access extend to enough resource providers to offer choice and the potential for competition between resource providers?

Example -- The Sales & Distribution Channels

The champion has an extensive network of connections with funders of battery technology research primarily because of her prior experience as a researcher in the corporate R&D department of a major battery supplier. Additionally, two of the project's current angel investors (funders of reduction to practice and business plan development) have prior experience in cell phone manufacturing and can connect with three of the cell phone suppliers. One of the angels has prior experience in fuel cells as an investor in a venture funded fuel cell company that went public in the late 1990s. This investor has significant credibility with and access to at least five venture capitalists.

Competition

For purposes of resource acquisition, "competition" means competition for the scarce dollars of resource providers. As noted, the competition can be direct (other projects with competitive technology and comparable commercial concepts within the same industry) or indirect (unrelated projects that offer resource providers a different path to a return on investment).

Example -- The Competition

Six competitors have demonstrated commercially viable portable fuel cell products. Two of the six are large cell phone suppliers. The other four are venture-backed firms. Because the market is large ($6 billion annual sales in batteries), there are an undetermined number of start-ups in various stages of commercialization pursuing fuel cell and alternative technologies. Investors in this space have many choices and can invest in companies in various phases of commercialization.

Contextual factors, like competition, can take a variety of forms and can have an enormous impact on success. Unfortunately, contextual factors often have a greater impact on the likelihood of a successful transition than the merits of the commercial concept or technology.

Step 5 – Determine Success Measures

This step is to determine the measures of success that are most appropriate for the specific context of the project. The subject of measurements was introduced in the Commercialization Process Roadmap section where the concept of A*, B and C Level Metrics* is defined and in each

phase, examples of such metrics are provided. Using that information, determine the measures for this project that are appropriate for the phase of development.

Example -- Measurements

The project team has learned from discussion with potential investors, industry participants and experts in the field, that a commercially viable cell phone battery must provide 30 hours of talk time and 100 hours of standby time before recharging (instead of the 20 hours originally anticipated by the project team in the *Incubating Phase*). The project team has also learned that cell phone distribution has increasingly consolidated by virtue of a number of recent mergers. As a result, three suppliers now control 80% of the volume. The project team has therefore determined that any one of the suppliers represents an enormous opportunity. Accordingly, they have targeted the 15 venture firms that can get them access to these suppliers.

The *Level A Metric* is straightforward – closing a $1.5 million investment by one or more of the 15 venture firms.

The *Level B Metrics* are more challenging. Possible examples of *Level B Metrics* are: (i) demonstrating the 30-hour capability using current resources; (ii) gaining access to at least 10 of the targeted venture firms; and (iii) entering into substantive discussions with at least five venture firms within 3 months of having the 30-hour prototype.

The *Level C Metrics* include milestones associated with demonstrating the 30-hour capability, modifying the business plan to reflect the higher costs of the 30-hour fuel cell, and developing a plan to use existing investors to make introductions to the 15 targeted venture firms.

Step 6 – Develop a Plan to Produce Proof and Execute Transition

After completing the tasks identified by the first five steps of the Framework (identifying the phase, the targeted resource providers, the required proof, relevant contextual factors and appropriate metrics), the project team must now develop and execute a plan to produce the proof and obtain required resources.

As explained in Step 3, proof is sometimes a moving target. The investment decision often depends as much on subjective, external factors as it does on the proof. As explained in Step 4,

contextual factors frequently provide as much guidance regarding resource acquisition challenges, as do the particular strengths and weaknesses of the technology and the commercial concept. Before the expenditure of scarce resources and commitment to a resource acquisition plan, the project team must therefore accurately define and estimate the market of potential resource providers (Step 2).

Assuming the analysis of the market of potential resource providers indicates a relatively large number of targets, the project team must then develop a set of transition activities (e.g. a sales and communication plan) to initiate contact with these resource providers and manage the relationship towards a successful Transition/investment. The transition activities plan will include tasks such as the following: assign responsibility for initiating contact, prepare written communication materials (business plans and related presentations), identify individual contacts within targeted resource providers (or persons who can facilitate such contacts), manage communications, gather and integrate feedback into proof generation activities, and generate and discuss terms of investment.

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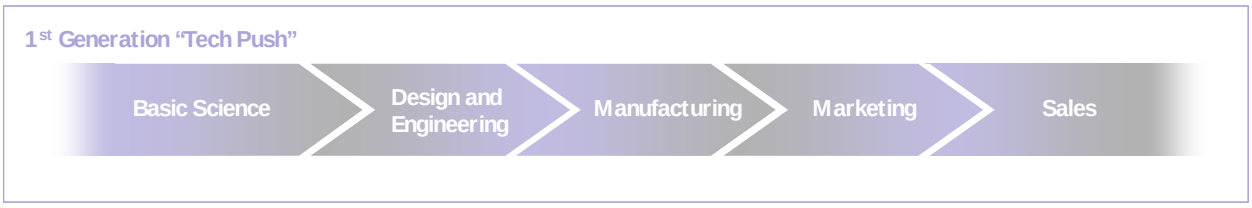
APPENDIX

EVOLUTION OF THE PROCESS OF TECHNOLOGICAL INNOVATION AND COMMERCIALIZATION

In a set of articles during the early 1990's, Rothwell organized the history of technological innovation and commercialization and into five generations. These generations are instructive in terms of setting the context in which technology commercialization happens today.

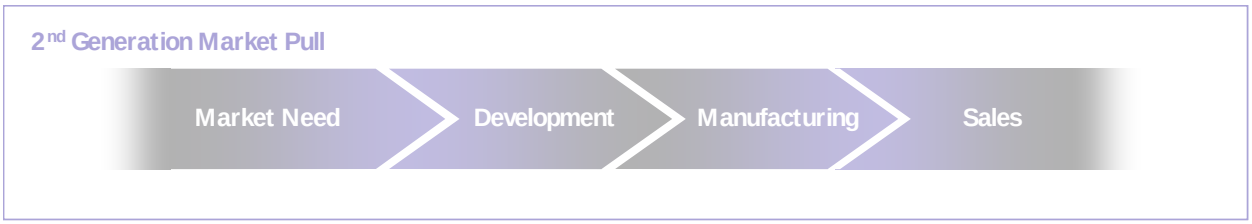
1ST GENERATION "TECH PUSH" – 1950S TO MID-1960

The 1950s through the early 1960s were a period of rapid economic growth driven in part by the creation of many new industries based on technological innovations and capabilities. Society, government and businesses devoted substantial resources and energy to commercializing the increasing flow of scientific discoveries and technological innovations from the nation's laboratories and universities. The process of moving technology from the lab to the marketplace was considered linear, as reflected in the following diagram.



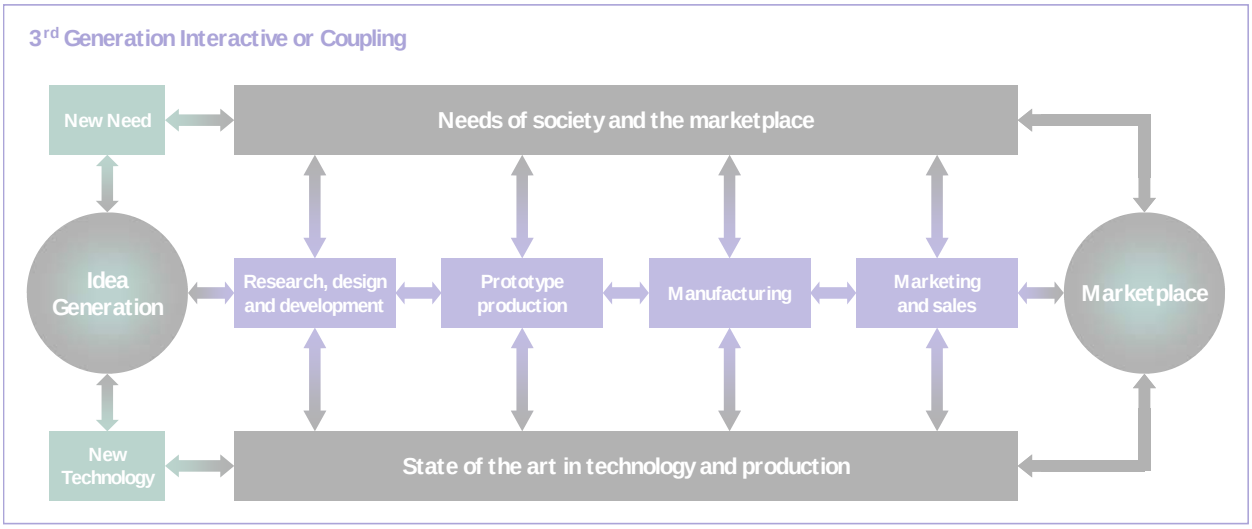
2ND GENERATION "MARKET PULL" – MID-1960S TO EARLY 1970S

The mid-1960s through the early 1970s was a period of slower growth with an emphasis on rationalizing the use of resources, increasing productivity and struggling for market share. Demand side factors became the major drivers of innovation. Still considered linear, the technology commercialization process as then understood began with "market need", as shown in the following diagram.



3RD GENERATION "INTERACTIVE OR COUPLING" – EARLY 1970S TO MID-1980S

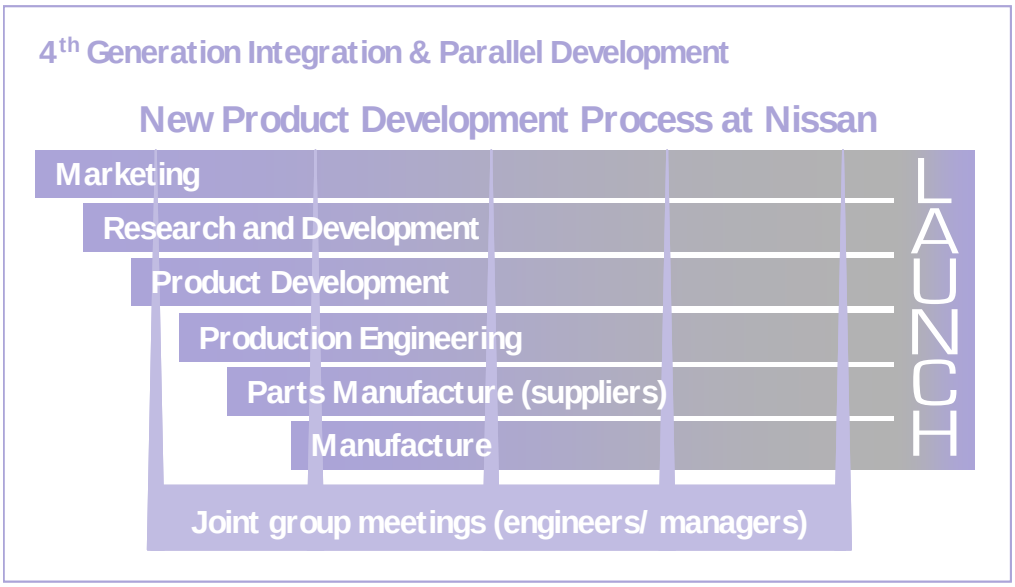
Economic crisis and severe resource constraints characterized this period. The 1970s and early 1980s included two major oil crises, stagflation and growing structural unemployment. Resource allocation decisions and investment practice were dominated by cost reductions, scale optimization, consolidation and rationalization. Empirical research suggested that the "Tech Push" of the 1st Generation process and the "Market Pull" of the 2nd Generation process represented possible, but not likely paths for technology commercialization. The research revealed a more complex interaction between the two. Academics and practitioners began to view the commercialization process as complicated, or at least iterative, rather than linear. The following diagram illustrates the 3rd Generation process:



The recognition that the innovation process was complex and non-linear led to studies that highlighted the multiple factors that influence success or failure Rothwell organized these factors into two groups - project execution factors and corporate level factors. Sadly, at least for those looking for a clean, objective formula for technology commercialization, Rothwell also recognized the context sensitive nature of these factors. In other words, Rothwell saw that the impact of individual factors on success or failure depended on micro and macro economic factors, local and regional availability of capital, the reputation of the entrepreneur or researcher, the existence (or not) or angel investors with experience in the target industry, the local or regional presence of a relatively large number of businesses that could benefit from the commercialization of the technology and a host of other factors. Researchers also began to explore the role of key individuals (Champions) as critical and necessary drivers of success.

4TH GENERATION "INTEGRATION AND PARALLEL DEVELOPMENT" – EARLY 1980S TO EARLY 1990S

During this period of economic recovery from the early 1980s through the early 1990s, industry looked to technology, alliances and global strategy to gain competitive advantage. Product life cycles shortened, speed to market became important, as did optimization for manufacturing efficiency. The Japanese led the world in the use of parallel rather than serial development processes, intensive information exchange and functional overlap. Many companies are only just beginning to master these techniques. This 4th Generation process, which involves parallel and cross-discipline development, represents yet another degree of complexity as depicted in the following diagram of the Nissan development process.



5TH GENERATION "SYSTEMS INTEGRATION AND NETWORKING" – EVOLVING TODAY

The fifth generation process focuses on speed, efficiency and flexibility to drive innovation. The process is characterized by the following:

- Integrated and parallel development activities,
- Strong and early vertical linkages among the various functions (development, manufacturing, marketing etc.),
- IT-based design and information systems.

The process also emphasizes horizontal linkages such as collaborative, pre-competitive research, joint R&D ventures and R&D alliances. The fifth generation process resembles a well-functioning network, with the flexibility to deploy resources where and when needed without the transaction costs associated with prior generations of the technology commercialization process.

Most firms today are struggling with the demands of the fourth generation process of integration and parallel development. While trying to implement a fourth generation process, firms face the globalization of markets, increasing regulatory pressures and the accelerating costs of research, development and technology commercialization. These factors require the firms to achieve greater speed and efficiency in new product development. The fifth generation model identifies the trade off between development time and development cost by recognizing that there is an optimal range of development times that offer minimum development costs. Only a small number of firms appear to have truly embraced the network, fifth generation model, and for many firms, the model may prove to be more a theoretical goal than a practical reality, at least in the short term. Firms must nevertheless be aware of opportunities to reduce cost and improve information exchange as primary mechanism's to reduce the cost and time to bring innovations to market.

BIZLOGX PROJECT TEAM BIOGRAPHIES

Steve Berger has 25 years experience in business development, general management and marketing, primarily in healthcare and high tech industries. This experience has focused on starting new product and service businesses as well as restoring growth to mature businesses. He has been an entrepreneur, creating successful new ventures, and a corporate new ventures and business development manager, leveraging core competencies and market positions to restore growth in highly competitive marketplaces and adding new product lines to existing franchises. Steve received his M.B.A. from Harvard and a B.S. from the US Air Force Academy. He is also a Lecturer at the Fisher College of Business at The Ohio State University.

Mike Mozenter has worked with software, technology and services companies in a variety of capacities, with a focus on strategy development, financing, business development and sales execution. Mike has invested in and served on the boards of numerous technology companies while a Vice President with Bank One Capital Partners and as a Managing Director and General Partner of Wingset Investments Ltd. Mike also served as the CEO of two early stage technology companies - an online transaction management system vendor that helped health insurers, hospitals and doctors streamline certain health care administrative functions, and a company that developed data mining and visualization technologies focused on detecting insurance fraud and related criminal activity. In these roles, Mike gained extensive experience in those marketing and sales tactics critical to the success of growing technology and service firms.

Since founding BizLogx, Mike focused his attention on helping clients implement practical and cost effective strategies to acquire customers, attract capital and otherwise address the needs of rapidly growing technology and service firms. Mike has a J.D. and a B.A from Duke University and a Masters of Management from the Kellogg School of Management at Northwestern University.

Kate Bergin specializes in Strategic Market Planning. She redefines how companies do business by developing customer-centric planning, analysis and measurement strategies. She engages her clients in a change management protocol that challenges long-standing corporate thinking on the relationship between organizations, their employees and their customers. She has consulted internationally and her areas of expertise include strategic planning, branding, customer relationship management, customer lifetime value, segmentation, and database marketing for business planning purposes. She has also applied her knowledge to start-up high technology companies and company spin-offs. She specializes in helping companies build their marketing infrastructure which include a complete 'go to market strategy' including targeting, positioning, product packaging and message development. Kate has an M.B.A. from the Kellogg School of Management at Northwestern University and a B.S. in Finance from the University of Notre Dame.

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